



HAL
open science

Description de l'éthogramme des ovins et observations en élevage de brebis laitières

Léa Delhom

► **To cite this version:**

Léa Delhom. Description de l'éthogramme des ovins et observations en élevage de brebis laitières. Médecine vétérinaire et santé animale. 2023. dumas-04303534

HAL Id: dumas-04303534

<https://dumas.ccsd.cnrs.fr/dumas-04303534v1>

Submitted on 23 Nov 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

Année 2023

DESCRIPTION DE L'ÉTHOGRAMME DES OVINS ET OBSERVATIONS EN ÉLEVAGE DE BREBIS LAITIÈRES

THÈSE

pour obtenir le diplôme d'État de

DOCTEUR VÉTÉRINAIRE

présentée et soutenue publiquement devant

la Faculté de Médecine de Créteil (UPEC)

le 24 octobre 2023

par

Léa, Andrée, Denise DELHOM

sous la direction de

Alline DE PAULA REIS

JURY

Président du jury :	M. Karim ADJOU	Professeur à l'EnvA
Directrice de thèse :	Mme Alline DE PAULA REIS	Maître de Conférences à l'EnvA
Examineur :	M. Yves MILLEMANN	Professeur à l'EnvA

Liste des enseignants intervenant dans l'encadrement des thèses de Doctorat vétérinaire

Version juillet 2023



Liste des Professeurs et Maîtres de conférences titulaires de l'HDR

M	Adjou	Karim	Professeur	DPASP
M	Audigié	Fabrice	Professeur	DEPEC
M	Bellier	Sylvain	Professeur	DSBP
M	Blaga	Radu	Professeur	DSBP
M	Blot	Stéphane	Professeur	DEPEC
M	Boulouis	Henri-Jean	Professeur émérite	DSBP
Mme	Chahory	Sabine	Professeur	DEPEC
M	Chateau	Henry	Professeur	DSBP
Mme	Chetboul	Valerie	Professeur	DEPEC
Mme	Crevier-Denoix	Nathalie	Professeur	DSBP
M	Degueurce	Christophe	Professeur	DSBP
M	Denoix	Jean-Marie	Professeur	DEPEC
M	Desquilbet	Loic	Professeur	DSBP
Mme	Dufour	Barbara	Professeur émérite	DPASP
M	Eloit	Marc	Professeur	DSBP
M	Fayolle	Pascal	Professeur émérite	DEPEC
M	Federighi	Michel	Professeur	DPASP
M	Fontbonne	Alain	Professeur	DEPEC
Mme	Gilbert	Caroline	Professeur	DSBP
M	Grandjean	Dominique	Professeur	DEPEC
Mme	Grimard-Ballif	Bénédicte	Professeur	DPASP
Mme	Haddad-Hoang Xuan	Nadia	Professeur	DPASP
M	Jouvion	Gregory	Professeur	DSBP
M	Kohlhauer	Matthias	Professeur	DSBP
Mme	Le Poder	Sophie	Professeur	DSBP
Mme	Le Roux	Delphine	Maître de conférences HDR	DSBP
M	Manassero	Mathieu	Professeur	DEPEC
Mme	Maurey-Guéneq	Christelle	Professeur	DEPEC
M	Millemann	Yves	Professeur	DPASP
Mme	Pilot-Storck	Fanny	Professeur	DSBP
M	Ponter	Andrew	Professeur	DPASP
Mme	Risco-Castillo	Véronica	Maître de conférences HDR	DSBP
Mme	Rivière	Julie	Maître de conférences HDR	DPASP
Mme	Robert	Céline	Professeur	DSBP
M	Tiret	Laurent	Professeur	DSBP
M	Tissier	Renaud	Professeur	DSBP
M	Verwaerde	Patrick	Professeur	DEPEC
Mme	Viateau	Véronique	Professeur	DEPEC

Liste des Maîtres de conférences et Ingénieurs de recherche DMV

M	Arné	Pascal	Maître de conférences	DPASP
Mme	Barassin	Isabelle	Maître de conférences	DPASP
Mme	Barbarino	Alix	Ingénieur de recherche (DMV)	DEPEC
Mme	Benckekroun	Ghita	Maître de conférences	DEPEC
Mme	Bertoni	Lelia	Maître de conférences	DEPEC
M	Bolnot	Francois	Maître de conférences	DPASP
Mme	Canonne-Guibert	Morgane	Maître de conférences	DEPEC
Mme	Chevallier	Lucie	Maître de conférences	DSBP
Mme	Cochet-Faivre	Noëlle	Maître de conférences	DEPEC
Mme	Cordonnier-Lefort	Nathalie	Maître de conférences	DSBP
Mme	Coudry	Virginie	Ingénieur de recherche (DMV)	DEPEC
Mme	Crepeaux	Guillemette	Maître de conférences	DSBP
M	Crozet	Guillaume	Maître de conférences	DPASP
Mme	De Paula Reis	Alline	Maître de conférences	DPASP
M	Delsart	Maxime	Maître de conférences	DPASP
Mme	Denis	Marine	Ingénieur de recherche (DMV)	DPASP
M	Deshuillers	Pierre	Maître de conférences	DSBP
M	Gauthier	Michel	Maître de conférences associé	DPASP
Mme	Guérin	Virginie	Maître de conférences	DSBP
Mme	Guétin-Poirier	Valentine	Maître de conférences	DPASP
Mme	Jacquet	Sandrine	Ingénieur de recherche (DMV)	DEPEC
M	Kurtz	Maxime	Ingénieur de recherche (DMV)	DEPEC
Mme	Lagrée	Anne-Claire	Maître de conférences	DSBP
Mme	Le Dudal	Marine	Ingénieur de recherche (DMV)	DSBP
Mme	Legrand	Chantal	Maître de conférences associé	DSBP
M	Mammeri	Mohamed	Maître de conférences	DSBP
Mme	Manguin	Estelle	Maître de conférences	DEPEC
Mme	Marignac	Genevieve	Maître de conférences	DSBP
Mme	Marotto	Stéphanie	Ingénieur de recherche (DMV)	DEPEC
Mme	Maurice	Emeline	Ingénieur de recherche (DMV)	DEPEC
Mme	Mespoulhes-Rivière	Céline	Ingénieur de recherche (DMV)	DEPEC
Mme	Mtimet	Narjès	Maître de conférences	DPASP
M	Mortier	Jérémy	Maître de conférences associé	DEPEC
M	Nudelmann	Nicolas	Maître de conférences	DEPEC
M	Pignon	Charly	Ingénieur de recherche (DMV)	DEPEC
M	Polack	Bruno	Maître de conférences	DSBP
Mme	Quéré	Émilie	Ingénieur de recherche (DMV)	DEPEC
Mme	Ravary-Plumioën	Bérangère	Ingénieur de recherche (DMV)	DPASP
M	Reyes-Gomez	Edouard	Maître de conférences	DSBP
Mme	Rose	Hélène	Maître de conférences associé	DSBP
M	Tanquerel	Ludovic	Maître de conférences	DEPEC

Remerciements

Au Président du Jury de cette thèse, Karim ADJOU, Professeur à l'EnvA,

Pour avoir accepté de présider cette thèse. Sincères remerciements.

A Mme Alline DE PAULA REIS, Maître de conférences à l'EnvA,

Pour avoir accepté de diriger cette thèse en faveur du bien-être animal. Pour vos précieux conseils, vos corrections minutieuses et vos références apportées tout au long de ce travail. Sincères remerciements.

A M Yves Millemann, Professeur à l'EnvA,

Pour avoir accepté d'être l'examineur de cette thèse. Sincères remerciements.

A ma famille,

Sans vous je n'aurai jamais pu intégrer une école vétérinaire. A mes parents, pour m'avoir soutenu pendant les moments les plus difficiles et pour avoir toujours cru en moi. A mes grands-parents, je suis extrêmement reconnaissante pour tout ce que vous m'avez apporté dans ma vie, maintenant c'est à moi de vous rendre la pareille. A mon frère, je n'ai pas trop eu le choix mais je t'aime quand même. A Luc, merci d'être là pour me faire rire en toutes circonstances.

A mes amis,

Merci d'être là pour moi et de me supporter depuis tant d'années. Aux bavettes, mon groupe d'amis d'enfance, vous comptez énormément pour moi, j'espère qu'on restera toujours aussi soudés. Aux chaudières, mes repères pendant 5 années à l'école, je vous aime. Au copain, merci pour tous ces moments passés ensemble, surtout pour nos vacances à Puy Buhlon. Au G10, merci pour toutes les bêtises qu'on a faites ensemble. A Iris, la personne qui a le plus compté pour moi dans cette école.

Table des matières

Table des matières	1
Liste des figures	3
Liste des tableaux	5
Liste des abréviations	7
Introduction	9
Revue de littérature	11
1. Qu'est-ce qu'un éthogramme ?	11
A. Définitions.....	11
a. Le bien-être animal	11
b. Éthologie et éthogramme	12
B. Élaboration d'un éthogramme	12
a. Étapes de l'élaboration d'un éthogramme	13
b. Étude du comportement et observations préliminaires.....	13
c. Conditions d'observation	15
d. Méthodes d'observation	15
e. Outils de mesure des comportements.....	16
f. Description des comportements	17
g. Quantification des comportements.....	17
2. L'expression de comportements normaux dans le cadre du bien-être animal	18
A. L'étude du comportement animal	18
B. Pourquoi étudie-t-on le comportement des animaux ?	19
C. L'importance de l'expression de comportements normaux chez les animaux d'élevage	19
D. Altérations comportementales en élevage	20
E. Protocoles d'évaluation du bien-être animal chez les ovins.....	21
a. Le protocole AWIN.....	21
b. Le protocole IDELE.....	25
c. Le protocole australien.....	27
d. Le protocole EBBEL.....	27
e. Discussion sur la qualité de l'évaluation comportementale dans les protocoles	28
Première partie : Description de l'éthogramme ovin	29
1. Introduction	29
2. Article.....	29
The ethogram of the sheep: an illustrated review	29
A. Introduction.....	29
B. Sheep's time budget	30
C. Sheep's ethogram.....	33
a. Sensorial reactivity.....	34
b. Social behaviours	36
c. Ingestion	43
d. Exploration	46
e. Kinesis	47
f. Body care.....	50
g. Territorialism.....	52
h. Rest and sleep.....	52
i. Behavioural deficits and stereotyped behaviours.....	53
3. Conclusion.....	55
Deuxième partie : Évaluation du comportement de brebis laitières dans le cadre d'une évaluation du BEA	57

1. Introduction.....	57
2. Materials and methods.....	58
A. <i>Movie recording</i>	58
B. <i>Observation of the movies</i>	58
a. Identification of present or absent behaviours: binary behaviour study	58
b. Defining the frequency of observation of the behaviours.....	59
3. Results.....	62
4. Discussion	70
A. <i>Methodology</i>	70
B. <i>Discussion of the results</i>	71
a. Observable behaviours	71
b. Non- observable behaviours.....	74
C. <i>Creation of an animal behaviour assessment protocol</i>	76
a. Making the film	76
b. Observation of sheep behaviour in the film	76
c. Completing the observation table	77
d. Example.....	77
5. Conclusion.....	79
Conclusion générale.....	81
Liste des références bibliographiques.....	83
Annexe 1 : Exemple de l'éthogramme du chien domestique (d'après Smith, 2019)	91
Annexe 2 : Liste des 21 adjectifs utilisés pour évaluer l'état émotionnel de l'animal en utilisant la méthode QBA (d'après Dwyer et al., 2015).....	92
Annexe 3 : Résultats d'observations des comportements en élevage avec une notation binaire (0 = comportement non observé ; 1 = comportement observé).....	93
Annexe 4 : Résultats du nombre d'occurrences des comportements observés en élevage	94
Annexe 5 : Résultats du nombre d'occurrences des comportements observés en élevage pour 100 animaux ainsi que les intervalles de confiance à 95 % associés.....	95
Annexe 6 : Tableau d'observation à remplir pour évaluer la partie comportementale du BEA en élevage ovin laitier.....	96

Liste des figures

Figure 1 : Procédure utilisée dans l'étude des comportements (adapté de Martin et al., 1993)	14
Figure 2 : Comportement social normal chez les ovins (à gauche) et isolement social (à droite) (d'après Dwyer et al., 2015)	22
Figure 3 : Comportement de démangeaison (d'après Dwyer et al., 2015).....	22
Figure 4 : Test d'approche humaine familière. A gauche, les brebis fuient l'éleveur. A droite, les brebis s'approchent et cherchent le contact de l'éleveur (d'après Dwyer et al., 2015).....	24
Figure 5 : Exemple de résultats obtenus avec le protocole AWIN (adapté de Dwyer et al., 2015).	24
Figure 6 : Exemple de résultats de la méthode QBA obtenus grâce au protocole AWIN (adapté de Dwyer et al., 2015).....	25
Figure 7 : Mise en place du test à l'Homme (d'après Gautier, 2015)	26
Figure 8 : Étapes de la réalisation du protocole EBBEL (Jolly, 2020).....	27
Figure 1 : Desert bighorn ewes' time budget observed in 2000 in the Chihuahuan desert (adapted from Mooring et al., 2003)	31
Figure 2 : Merino sheep's average time budget in pasture between 10 a.m. and 4 p.m. (adapted from Michelena et al., 2006).....	32
Figure 3 : Sheep's field of vision (adapted from Boularand et al., 2013).....	34
Figure 4 : Spatial measures used to describe social organisation in sheep (Lynch et al., 1992)....	38
Figure 5 : Statistical distribution of oestrus duration in ewes (American Sheep Industry Association, Inc., 2015).....	43
Figure 6 : Percentage of sheep grazing according to time of day (Lynch et al., 1992).....	43
Figure 7 : Time spent displaying abnormal behaviours by individually housed by sheep (Lauber et al., 2012).....	54
Figure 1A: Behavioural observation chart and expected standards using video recording.	77
Figure 1B: Observation chart filled in with the results obtain in Farm 21.	78

Liste des tableaux

Tableau 1 : Temps d'observation nécessaire par point lors de la réalisation de la méthode QBA (d'après Dwyer <i>et al.</i> , 2015)	23
Tableau 2 : Notation de la réactivité au couloir (d'après Gautier, 2015).....	26
Table 1 : Sheep's sensorial reactivity behaviours (adapted from Fraser, 1983).....	35
Table 2 : Frequency of leadership by age in sheep (Arnold and Maller, 1974)	39
Table 3 : Sheep's affiliative behaviours (adapted from Fraser, 1983)	40
Table 4 : Sheep's agonistic behaviours (adapted from Fraser, 1983 and McGlone, 1986)	42
Table 5 : Sheep's ingestion behaviours (adapted from Fraser, 1983).....	45
Table 6 : Sheep's exploratory behaviours (adapted from Fraser, 1983)	47
Table 7 : Sheep's kinetic behaviours (adapted from Fraser, 1983).....	49
Table 8 : Sheep's body care behaviour (adapted from Fraser, 1983)	51
Table 9 : Sheep's rest and sleep behaviours (adapted from Fraser, 1983).....	53
Table 10 : Stereotypical behaviours in sheep (adapted from Fraser, 1983 and Lauber <i>et al.</i> , 2012)	55
Table 1: Observation chart used in the binary behaviour study. The Frequency column represents the frequency of presence of the behaviour within the farms.....	59
Table 2: Observation chart used in the behaviour frequency study.	60
Table 3: Binary behaviour observation (Present (1) or absent (0)) in the 18 sheep dairy farms before or after milking.	63
Table 4: Number of occurrences per 100 animals of each behaviour in the 18 sheep dairy farms before or after milking. The column Mean/100 animals corresponds to the mean of the frequencies of the different farms.	64
Table 5: The 95 % confidence interval for the number of occurrences per 100 animals of each sheep ethogram behaviour in dairy farms, before or after milking.....	68

Liste des abréviations

AWIN: Animal Welfare INdicators

BEA: Bien-être animal

FAWC: Farm Animal Welfare Council (Conseil relatif au bien-être des animaux d'élevage en Grande-Bretagne)

OIE: Organisation mondiale de la santé animale

QBA: Qualitative Behaviour Assessment

REM: Rapid Eye Movement (Mouvements oculaires rapides)

NR : Not rated

SD: Standard deviation

CI: Confidence interval

Introduction

Les moutons (*Ovis aries*) sont des petits herbivores ruminants de la classe des Mammifères, de l'ordre des Artiodactyles, de la famille des Bovidés et de la sous-famille des Caprinés. Dans le langage courant, les moutons désignent un ensemble où la femelle est la brebis et le mâle le bélier, tandis que le jeune mâle est un agneau et la jeune femelle une agnelle.

Descendant du mouflon (*Ovis musimon*), le mouton a été domestiqué très tôt – il y a environ 11 000 ans en Palestine – au sein de sociétés sédentarisées depuis plusieurs millénaires. L'Égypte, la Mésopotamie et l'Asie Mineure vont peu à peu faire évoluer le mouflon en mouton, dès 3000 avant J.-C., et celui-ci essaiera ensuite vers l'Europe. Après plusieurs siècles, l'intensification de ce contrôle, notamment avec la contention des animaux en captivité, a provoqué chez ces derniers des modifications morphologiques jusqu'à l'espèce ovine que nous connaissons aujourd'hui (Vigne et al., 2011). Les moutons sont aujourd'hui répandus dans le monde entier et élevés pour leur production de laine, de viande et de lait. Ils sont plus d'un milliard dans le monde dont 7 millions en France.

Les moutons ont une espérance de vie de quinze à vingt ans en captivité. Ils sont rustiques, grégaires, vivent souvent en troupeaux denses et communiquent grâce à des bêlements ou par marquage olfactif (Bomsel, 1999). Le mouton est apte à se reproduire dès l'âge d'un an. Le rut a lieu en général en automne et le temps de gestation est d'environ cinq mois. Chez certaines races, les brebis peuvent élever facilement deux à trois petits qui seront allaités pendant quatre mois.

L'élevage de moutons, comme tout élevage, évolue au fil du temps selon l'évolution des sociétés et doit s'adapter aux attentes sociétales de son époque. Après la seconde guerre mondiale, l'intensification de l'élevage a engendré un questionnement sociétal sur la condition animale en élevage.

Récemment, la place de l'animal dans la société a fortement évolué et aujourd'hui, le respect du bien-être animal (BEA) est au centre des préoccupations du consommateur. En effet, comme l'indique Fraser (1983), l'élevage étant un milieu restreint et appauvri en comparaison du milieu naturel, les animaux peuvent être privés de l'expression de certains comportements naturels. Ce facteur de stress et de frustration peut donc être une source de mal être pour les animaux. C'est alors sans surprise que l'IFOP a relevé que, en 2022, 85% des français sont favorables à l'interdiction de l'élevage intensif. Il devient donc fondamental pour les filières de prendre en compte l'avis des consommateurs et d'améliorer les conditions de vie des animaux en élevage.

Ce travail a plusieurs objectifs : le premier est de cataloguer et de décrire les comportements normaux et anormaux des ovins (donc d'établir un éthogramme) ; le deuxième est d'explorer des films tournés en élevage lors de la mise en place d'un protocole d'évaluation du bien-être animal (EBBEL – évaluation du bien-être des brebis en élevage laitier) (Jolly, 2020) afin de vérifier les comportements observables en bergerie sur une courte période d'observation compatible avec une évaluation du BEA et d'en déterminer leur fréquence. Ce travail permettra de générer la première grille de référence, adaptée aux observations réalisées en bergerie dans des élevages ovins laitiers semi-intensifs ou intensifs. Elle permettra de savoir quels comportements peuvent être observés sur une courte durée, compatible avec une évaluation du BEA dans ces types d'élevage. Elle fournira donc des éléments palpables aux éleveurs et aux vétérinaires afin de mieux interpréter les

comportements qu'ils observent dans leur pratique. Enfin, le quatrième objectif de cette thèse a une visée pédagogique. En effet, nous réaliserons une vidéo pédagogique destinée aux étudiants et professionnels éleveurs et vétérinaires permettant d'apprendre à repérer un grand nombre de comportements en bergerie. Les frontières de ce travail sont : la bergerie et les brebis en lactation.

Revue de littérature

1. Qu'est-ce qu'un éthogramme ?

A. Définitions

a. *Le bien-être animal*

Le bien-être des animaux d'élevage est souvent traduit par le principe fondamental des 5 libertés individuelles publiées pour la première fois en 1965 dans un rapport de Brambell par le *Farm Animal Welfare Council* (FAWC), à savoir :

- Absence de faim, de soif et de malnutrition : L'animal doit avoir accès à l'eau et à une nourriture en quantité appropriée et correspondant aux besoins de son espèce ;
- Absence de peur et de détresse : Les conditions d'élevage ne doivent pas lui induire de souffrances psychiques ;
- Absence de stress physique et/ou thermique : L'animal doit disposer d'un certain confort physique ;
- Absence de douleur, de lésions et de maladie : L'animal ne doit pas subir de mauvais traitements pouvant lui faire mal ou le blesser et il doit être soigné en cas de maladie ;
- Liberté d'expression d'un comportement normal de son espèce : Son environnement doit être adapté à son espèce (il doit être en groupe si c'est une espèce sociale par exemple).

Ces cinq libertés sont reconnues depuis 2005 de façon internationale par l'Organisation mondiale de la santé animale (OMSA) qui reprend ce concept en tant que principe directeur afin de faire ressortir les besoins fondamentaux indispensables pour le bien-être d'un animal (OIE, 2019).

L'expression de comportements naturels (ou normaux) est donc une des cinq libertés du bien-être animal en élevage et c'est précisément celle qui va nous intéresser. Cependant, si à l'heure actuelle nous connaissons les grandes lignes du comportement ovin, il manque un grand nombre de détails qui pourrait permettre, à l'avenir, de faire des évaluations plus objectives du comportement ovin notamment grâce à une description plus précise de ce que l'on doit (ou ce qu'on peut) observer dans le cadre de l'évaluation du BEA en élevage. Les connaissances sont encore plus lacunaires lorsque les animaux sont en bâtiment, un environnement appauvri par rapport au milieu extérieur. De plus, il n'existe pas encore d'outil pédagogique permettant à un débutant de comprendre et de reconnaître rapidement un comportement exprimé par un ovin.

b. Éthologie et éthogramme

Selon Villemin (1975), l'éthologie correspond à « l'étude des mœurs et du comportement individuel et social des animaux domestiques et sauvages ». Elle s'intéresse à l'ensemble des facteurs qui vont conduire un individu à exprimer un comportement en particulier, mais également à la façon dont les comportements ont changé au cours de l'évolution, de manière innée ou acquise.

D'après l'ONG Objectif Sciences International (2011), les méthodes utilisées en éthologie sont basées sur l'observation et la description la plus fidèle possible des événements. L'important étant de rester le plus objectif possible en appréhendant chaque objet d'étude comme quelque chose d'inconnu. Pour cela, il faut rester descriptif sans faire d'interprétation directe et déterminer les unités comportementales à observer (ce que l'on observe, ce que l'on quantifie).

L'éthogramme constitue la base de la recherche en éthologie et représente l'inventaire des comportements exprimés par une espèce donnée. Ces comportements sont donc observés et décrits de la manière la plus objective possible et en rendant compte de chaque détail de l'action. Il existe deux types d'observation selon l'environnement dans lequel l'espèce est observée :

- L'observation naturaliste : elle est réalisée dans le milieu naturel de l'espèce et permet d'établir l'inventaire des comportements naturels de l'espèce ;
- L'observation expérimentale : elle est réalisée en milieu captif (laboratoire, élevage). Les conditions sont donc différentes du milieu naturel et des paramètres peuvent être modifiées et générer des changements dans l'expression de certains comportements, voire générer l'apparition de nouveaux comportements anormaux comme des stéréotypies.

Dans le cadre de notre travail, l'objectif est d'établir, grâce à une revue de littérature, un éthogramme sur la base de l'observation naturaliste réalisée autant que possible chez des animaux sauvages proches voire ancêtres des ovins domestiques comme le mouflon corse (*Ovis musimon*). Cette base théorique servira de base ensuite pour comparer aux comportements des ovins observés en élevage (observation expérimentale) pour évaluer la proportion de comportements similaires conservés ainsi que l'apparition de nouveaux comportements anormaux.

B. Élaboration d'un éthogramme

Comme dit précédemment, l'éthogramme est un inventaire des différents comportements exprimés par une espèce donnée. Il n'est pas forcément exhaustif et doit s'adapter en fonction du contexte d'observation et au cours du temps.

Un éthogramme complet décrit, pour chaque comportement, le contexte social ou environnemental en précisant la fréquence et le moment d'apparitions de celui-ci. L'ensemble de ces comportements est ensuite trié et réparti selon différentes catégories fonctionnelles définies par l'auteur. Par exemple, Fraser (1983) propose la classification suivante :

- Comportements de maintien de l'espèce : la réactivité, l'alimentation, l'exploration, la kinésie, les associations, les soins corporels, le territorialisme, le repos et le sommeil.
- Déficits comportementaux et comportements anormaux.

a. Étapes de l'élaboration d'un éthogramme

En résumé, la réalisation d'un éthogramme se divise en plusieurs étapes (Braude et al., 2002) qui permettent d'ordonner les différents comportements observables de façon lisible comme exposé chez le chien domestique dans l'Annexe 1 :

1. Établir la **liste des comportements observables** (bibliographie, observation naïve) et leur donner un nom à chacun ;
2. Organiser les différents comportements en **catégories** fonctionnelles ;
3. **Décrire** chaque comportement (en incluant des images et des diagrammes) ;
4. Calculer la **fréquence** et la **durée** d'apparition des comportements ;

b. Étude du comportement et observations préliminaires

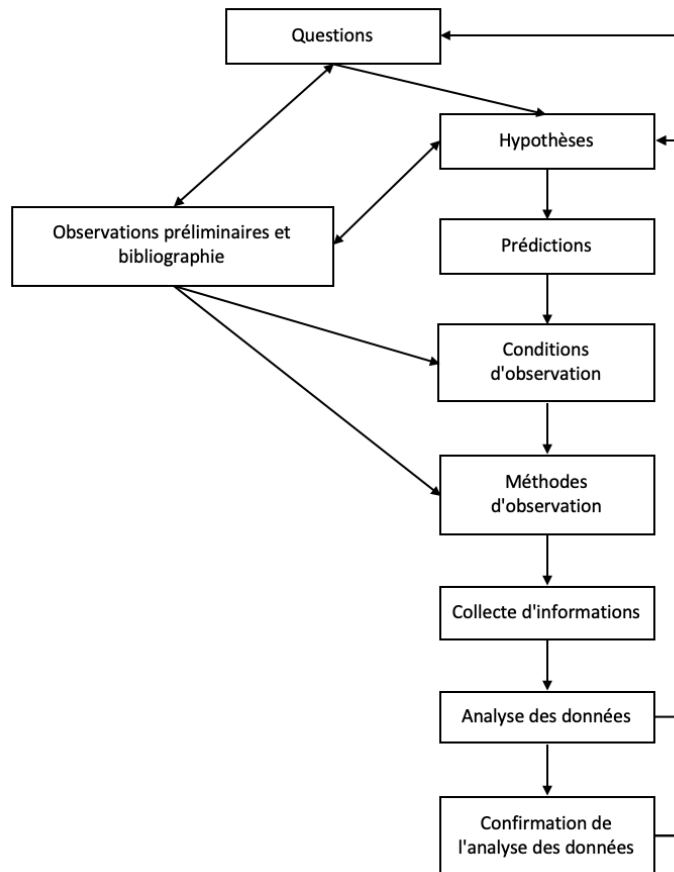
Afin de rester le plus objectif possible lors de l'étude des comportements de l'espèce et dans la conception d'un éthogramme, une phase d'observation préliminaire dite « naïve » est nécessaire et permet d'obtenir une liste non exhaustive de comportements observables tout en s'aidant de la littérature. L'étude bibliographique, bien que nécessaire, n'est pas suffisante à elle seule pour réaliser des observations pertinentes (Martin *et al.*, 1993).

Avant de pouvoir construire un éthogramme, il faut apprendre à étudier les comportements afin de mieux les comprendre et de pouvoir les interpréter. Les différentes étapes permettant l'étude des comportements sont les suivantes (Bateson et Martin, 2021) (Figure 1) :

1. **Poser une question** : toutes les études scientifiques doivent commencer par une question claire ;
2. **Formuler des hypothèses** : elles permettent d'apporter des explications probables aux phénomènes observés ;
3. **Faire des prédictions** : une hypothèse claire met en avant une ou plusieurs prédictions qui peuvent être testées empiriquement ;
4. **Paramétrer les conditions d'observation** : elles doivent être clairement définies et sans ambiguïté avant de collecter des données et elles peuvent être adaptées en fonction des observations préliminaires ;
5. **Choisir les méthodes d'observation** : elles vont dépendre du type de comportement à observer et de l'équipement disponible ;
6. **Créer l'étude** : observation naturelle ou expérimentale, choix du sujet à observer et leur nombre. Il est très important d'être rigoureux pour que les données soient interprétables ;
7. **Conduire des études préliminaires** : elles permettent de tester et de valider les conditions et les méthodes d'observation choisies ;
8. **Collecter des informations** : les conditions et les méthodes d'observation doivent rester les mêmes pendant toute l'étude. Le mieux étant que l'étude soit conduite « à l'aveugle » pour ne pas se laisser influencer par les hypothèses émises ;

9. **Analyser et interpréter les données** : la compréhension et l'organisation des données doit se faire grâce à la création de graphiques ou de tableaux (plus lisibles) afin de confirmer ou non les hypothèses émises. Cette analyse peut parfois générer de nouvelles questions.

Figure 1 : Procédure utilisée dans l'étude des comportements (adapté de Martin et al., 1993)



Lors de l'étude des comportements, il y a quatre notions importantes à retenir et à appliquer correctement (Berman, 2018) :

- La cohérence : les résultats obtenus doivent être reproductibles ;
- La fidélité : le système d'étude (conditions et méthodes d'observation) doit être décrit de manière aussi précise et complète que possible ;
- L'interprétabilité : il faut pouvoir relier facilement les données trouvées à leurs fondements biologiques ;
- L'évolutivité : l'annotation doit être simple et facile à faire évoluer, tout en restant assez précise pour éviter toute confusion.

Si la cohérence et l'évolutivité peuvent théoriquement être obtenues indépendamment l'une de l'autre, la fidélité et l'interprétabilité sont, par définition, en opposition. En effet, les mesures sont généralement plus compréhensibles mais moins précises à mesure que l'on supprime des détails.

Pour étudier au mieux le comportement, l'objectif est donc de trouver des représentations descriptives de ces processus multi-échelles qui soient aussi parcimonieuses que possible (Berman, 2018).

c. Conditions d'observation

En premier lieu, avant même de choisir la méthode d'observation, il faut décider du moment où l'on va réaliser les observations : le moment de l'année et de la journée ainsi que la durée d'observation. Pour que les conditions expérimentales restent les mêmes, il est préférable de garder ces paramètres constants car le comportement de l'animal peut varier en fonction du temps.

d. Méthodes d'observation

Lorsque les comportements possiblement observables ont été recueillis durant la phase d'observation dite « naïve », il est nécessaire de déterminer les méthodes d'observation utilisées au cours de l'étude, c'est-à-dire le type d'observation (en présentiel, à travers une vitre sans tain, par vidéo) et le type d'échantillonnage choisis pour étudier l'expression des comportements de l'espèce. Ce choix dépend du type de recherche, des questions posées, du type de comportements étudiés mais aussi du matériel utilisé et donc de la visibilité des animaux (Genty, 2011).

En ce qui concerne le type d'observation, l'observateur peut décider de ne pas être visible en utilisant un miroir sans tain ou une caméra afin de ne pas influencer le comportement des animaux. Chaque type d'observation a ses avantages et ses inconvénients, il est donc important de les signaler lors de la rédaction du rapport de l'étude. Par exemple, si l'on observe les animaux en présentiel, la qualité de l'observation (vue, audition) est la meilleure mais cela peut perturber les animaux qui ne vont alors pas exprimer des comportements habituels. Si l'on enregistre une vidéo, cela perturbe moins les animaux et on peut la regarder autant de fois que l'on veut pour récupérer le plus d'informations possible. Cependant, la qualité d'enregistrement (image, son) est moins bonne que lorsqu'on observe en présentiel. Dans les deux cas, il faudra une phase d'adaptation pour que les animaux finissent par « oublier » la présence de l'observateur ou de la caméra. Le tout est de pouvoir extraire l'information voulue et qu'elle soit la moins biaisée possible (Genty, 2011).

Il faut ensuite choisir la méthode d'échantillonnage utilisée, c'est-à-dire la façon de compter les comportements observés. Il existe de nombreuses méthodes différentes, mais les plus répandues sont les suivantes (Genty, 2011) :

- *Échantillonnage ad libitum* (« à volonté »)

L'observateur note tout ce qu'il peut voir. C'est une méthode utile lors d'études où la visibilité des animaux est mauvaise et les individus mal connus par l'observateur.

- *Échantillonnage par animal*

Lorsque de nombreux individus sont observés simultanément, comme dans un élevage, il est impossible de noter tous les comportements exprimés en même temps. Un sujet est alors sélectionné et tous ses comportements (dont ses interactions avec d'autres individus) sont enregistrés pendant une durée de temps déterminée à l'avance.

Si l'observation se fait sur la base d'une vidéo enregistrée, il est possible de visionner la même vidéo à plusieurs reprises en se concentrant sur un animal différent à chaque fois. C'est la méthode la plus rigoureuse mais également la plus chronophage.

- *Échantillonnage par comportement*

Dans ce type d'échantillonnage, ce n'est pas un sujet qui est sélectionné, mais un comportement qui est enregistré à chaque fois qu'il apparaît. Cette méthode est particulièrement indiquée si le comportement étudié n'est pas fréquemment observé.

- *Échantillonnage instantané*

L'observateur note ici les comportements à intervalles réguliers. Cette méthode permet d'obtenir une estimation de la durée des activités. Elle peut être utilisée pour un seul ou pour plusieurs individus. Dans ce dernier cas, le regard de l'observateur balaie le groupe observé et il enregistre leurs comportements à des intervalles de temps déterminés à l'avance.

C'est la méthode la plus adaptée lorsqu'il s'agit de mesurer la distribution spatiale d'un groupe d'individus, les uns par rapport aux autres.

- *Échantillonnage un-zéro*

L'observateur note si un comportement est exprimé ou non durant un intervalle de temps donné. On le note alors « un » s'il est exprimé et « zéro » s'il ne l'est pas. La fréquence d'apparition du comportement n'a aucune importance, que le comportement soit exprimé une ou plusieurs fois pendant la période d'observation, il est toujours noté « un ».

L'avantage de cette méthode est sa simplicité : elle peut être utilisée par un observateur inexpérimenté, ou quand il est difficile de définir le début et la fin d'un comportement. Le défaut de cette méthode est la perte d'information concernant la fréquence et la durée du comportement.

e. Outils de mesure des comportements

En pratique, lors de l'établissement d'un éthogramme, il est d'abord nécessaire d'avoir en tête les outils d'échantillonnage des comportements. Selon Bateson et Martin (2021), il existe quatre outils de mesure de base qui sont la latence, la fréquence, la durée et l'intensité.

La latence (mesurée en unités de temps) est le temps écoulé entre l'expression de deux comportements (qu'ils soient identiques ou différents). Par exemple, si un animal s'abreuve puis va

se coucher 10 min plus tard, le temps de latence est de 10 min. Pour obtenir une valeur de latence représentative, il faut une période d'observation suffisamment longue, afin de pouvoir réaliser une moyenne des valeurs obtenues.

La fréquence (mesurée en unités de temps inverses) est le nombre d'occurrence d'un même comportement par unité de temps. Par exemple, si un animal vient 3 fois à une mangeoire de 7h à 19h, soit une période de 12 heures, la fréquence de prise alimentaire est de 0,25/h en période diurne.

La durée (mesurée en unités de temps) est le temps pendant lequel l'animal exprime une unique occurrence d'un comportement. Par exemple, si un animal commence à téter sa mère et s'arrête 5 minutes plus tard, la durée de la tétée est de 5 minutes. Ce paramètre peut également être étudié sous forme de durée totale en additionnant la durée de toutes les occurrences d'un même comportement sur une période donnée. De la même manière que pour la latence, la durée doit être étudiée plusieurs fois par animal afin d'obtenir une moyenne représentative de la durée du comportement observé. Pour éviter toute ambiguïté, la durée peut être exprimée en pourcentage du temps accordé à ce comportement sur le temps total d'observation.

L'intensité permet de quantifier l'ampleur d'un comportement. Elle n'a pas de définition universelle et dépend du comportement étudié. Ce dernier doit donc être défini correctement et précisément afin de mesurer son intensité. L'intensité peut être définie comme une durée (un temps de toilettage par exemple) ou une quantité physique (un volume d'eau ou de nourriture ingéré par exemple). Elle permet d'analyser au mieux la cause d'un comportement (une baisse d'ingestion peut par exemple suggérer une maladie).

f. Description des comportements

Pour décrire un comportement qui a été observé, il est possible de procéder de manière formelle ou fonctionnelle. La description formelle décrit le comportement sans aucune interprétation sur la fonction du comportement, elle décrit une posture ou un mouvement et permet de rester totalement objectif. La description fonctionnelle donne une fonction à un comportement observé et donc l'objectif ou la conséquence de l'expression de ce comportement (Genty, 2011).

Certains comportements s'avèrent difficiles à définir et/ou à décrire. En effet, lorsque l'on attribue une fonction à un comportement, on établit une hypothèse qui devra être vérifiée par la suite. Le nom donné au comportement est également très important car il faut choisir entre une description formelle ou une description fonctionnelle. Par exemple, pour une même posture, on peut dire que l'animal « est couché » ou « se repose ». Si l'on choisit de dire que l'animal « est couché », alors on décrit seulement ce qu'il fait ; lorsque l'on dit que l'animal « se repose », on décrit la raison pour laquelle il exprime ce comportement. Beaucoup d'animaux peuvent se coucher pour d'autres raisons que pour se reposer comme pour se soumettre, chasser ou encore se cacher. Un comportement peut donc avoir plusieurs fonctions selon le contexte (Braude et al., 2002).

g. Quantification des comportements

Lorsqu'une description précise du comportement a été réalisée, il faut ensuite le quantifier en répondant à différentes questions (Genty, 2011) :

- « Où » : composante spatiale du comportement (lieu, position des individus les uns par rapport aux autres) ;
- « Quand » : composante temporelle du comportement (moment de l'année, de la journée, stade physiologique de l'animal) ;
- « Comment » : composante motrice du comportement et analyse des *stimuli* provoquant ce dernier ;
- « Pourquoi » : composante fonctionnelle du comportement et analyse des causes de l'expression de ce dernier.

Afin que l'éthogramme soit un bon outil d'étude des comportements d'une espèce, il ne doit présenter aucune ambiguïté et décrire de façon claire et précise les différents comportements. Les informations sont plus compréhensibles lorsqu'elles sont présentées sous forme de graphiques ou de tableaux. Il est également possible d'intégrer des photos, des dessins ou des vidéos de l'animal dans l'éthogramme pour que le lecteur comprenne exactement de quel comportement l'on parle (Braude et al., 2002).

2. L'expression de comportements normaux dans le cadre du bien-être animal

A. L'étude du comportement animal

L'étude du comportement animal est l'étude scientifique de tout ce que font les animaux. Les animaux peuvent être des organismes unicellulaires, des invertébrés, des poissons, des amphibiens, des reptiles, des oiseaux, des humains ou encore des mammifères. Le comportement animal implique l'étude de la relation qu'ont les animaux avec leur environnement physique ainsi qu'avec d'autres organismes. Cela comprend la manière dont les animaux trouvent et défendent leurs ressources, évitent les prédateurs, choisissent leurs partenaires, se reproduisent et s'occupent de leurs petits (Braude *et al.*, 2002).

L'exemple le plus célèbre de ce type d'analyse est l'hypothèse de Tinbergen selon laquelle les pulsions comportementales des animaux peuvent être expliquées par un ensemble hiérarchisé d'impulsions concurrentes, sur la base d'observations et d'idées concernant l'optimalité et l'évolutivité (Berman, 2018). Les personnes qui étudient le comportement animal tentent donc généralement de répondre à une ou plusieurs des questions suivantes appelées « les quatre questions de Tinbergen » sur le comportement animal (Tinbergen, 1951) :

- Quelle est la cause de l'expression de ce comportement ? Quel est le mécanisme sous-jacent ? Qu'est-ce qui l'a "déclenché" ? Les réponses à ces questions peuvent inclure à la fois les stimuli externes qui affectent le comportement et les mécanismes hormonaux et neuronaux internes qui contrôlent le comportement ;
- Comment ce comportement s'est-il développé au cours de la vie de l'individu ? Cette question permet aux scientifiques d'apprendre comment le comportement évolue au cours de la vie de l'animal et comment ces changements sont influencés par les gènes (l'inné) et l'expérience (l'acquis) ;

- Quelle est ou quelles sont les fonctions de ce comportement ? Cela permet de déterminer l'effet du comportement sur l'animal et sa valeur pour aider l'animal à survivre ou à se reproduire dans un environnement particulier ;
- Comment ce comportement a-t-il évolué au cours du temps ? Cette question permet de déterminer l'origine des modèles de comportements et leur évolution au fil des générations.

B. Pourquoi étudie-t-on le comportement des animaux ?

Les scientifiques étudient depuis longtemps le comportement des animaux afin de mieux les comprendre. Des anthropologues qui étudient les humains aux biologistes qui observent les animaux dans la nature, en passant par les zoologistes qui tentent d'aider les animaux à s'adapter à la vie en captivité, le comportement est une source de connaissances et de preuves pour les scientifiques.

Les parcs zoologiques tout comme les élevages nous permettent d'observer les animaux de beaucoup plus près. En acquérant cette compréhension des animaux en captivité, les scientifiques peuvent ensuite rechercher ces comportements dans la nature, tester des théories et répondre à des questions sur les organismes. En outre, l'étude du comportement des animaux aide les scientifiques à prévoir comment les actions humaines affecteront les animaux et leur environnement à l'avenir. Les humains ont la responsabilité d'étudier le comportement des animaux afin de déterminer les besoins du règne animal et de savoir quand certaines espèces sont menacées. La survie de l'homme, tout comme celle des animaux, dépend de populations saines d'espèces diverses (Braude *et al.*, 2002).

On peut également souhaiter étudier le comportement des animaux sauvages pour connaître leur palette de comportements normalement exprimés afin d'améliorer au mieux le bien-être de ceux vivant en captivité. C'est ce que l'on essaye de faire dans le cadre de notre travail, en étudiant les comportements normaux exprimés dans la nature par des espèces proches de l'ovin domestique afin d'établir un éthogramme et de pouvoir évaluer la part d'expression de comportements normaux en élevage. Cela permettra ensuite d'évaluer une des cinq libertés du BEA en élevage pour pouvoir, à terme, améliorer les conditions de vie des ovins en élevage.

C. L'importance de l'expression de comportements normaux chez les animaux d'élevage

Un comportement est dit fondamental lorsqu'il permet de remplir au moins une des trois fonctions suivantes (McFarland, 1993) :

- Favoriser la viabilité biologique individuelle (capacité des animaux à survivre jusqu'à pouvoir se reproduire) et la viabilité biologique inclusive (capacité des animaux à assurer la survie de leurs descendants) ;
- Se défendre des prédateurs ;
- Assurer un accès facile et suffisant à l'eau et à l'alimentation.

L'expression de comportements normaux permet la survie et la reproduction de l'espèce, que ce soit à l'état sauvage ou en captivité. Comme nous l'avons énoncé précédemment, c'est une des cinq libertés du bien-être animal (Brambell, 1965). Ce n'est pas la liberté la plus mise en avant actuellement et pourtant elle est indissociable du BEA car un animal ne peut par exemple pas correctement s'alimenter (correspondant à la liberté absence de faim, de soif et de malnutrition) si ses conditions de vie ne lui permettent pas d'exprimer des comportements normaux liés à l'espèce. De plus, un animal ne pouvant pas se comporter normalement sera davantage exposé au stress et donc aux maladies (correspondant à la liberté absence de douleur, de lésions et de maladie). Les différentes libertés du BEA sont finalement intimement liées les unes aux autres.

De plus, l'opinion publique accorde une grande importance à la possibilité d'exprimer des comportements naturels pour les animaux. Par exemple, l'élevage de poules en batterie ou encore de truies gardées en cages pour ne pas écraser leurs petits est très critiqué (Grannec, 2017).

Les stéréotypies chez les moutons sont peu fréquentes, mais des stéréotypies orales (léchage compulsif, mastication des clôtures) et locomotrices (déplacements répétitifs sans but) ont été reportés chez des moutons confinés (Richmond *et al.*, 2017). Cependant, il est important de préciser que le BEA ne repose pas que sur la libre expression de comportements naturels. En effet, les animaux en élevage extensif peuvent quand même souffrir de faim, de soif, d'inconfort face au climat, de maladie ou encore de peur et de stress. Webster (1994) donne l'exemple d'un élevage extensif de brebis passant l'hiver dans une pâture mal drainée, avec peu d'abris, sous-nourris, forcés à rester sous la pluie ou à se coucher dans la boue. Ces animaux ont la liberté d'exprimer des comportements naturels – dominés par des comportements de peur et de fuite –, mais ils peuvent difficilement montrer l'exemple en termes de bien-être animal (Dwyer et Lawrence, 2008).

D. Altérations comportementales en élevage

L'élevage a inévitablement engendré des altérations comportementales depuis le début de la domestication et surtout avec son intensification. En effet, les animaux d'élevage tels que les bovins, les porcins ou les ovins étaient encore sauvages lors de leur domestication et ont subi un stress chronique dû aux contacts récurrents avec l'Homme ainsi que l'augmentation de la proximité avec leurs congénères voire avec d'autres espèces (en particulier les chiens qui peuvent être considérés comme des prédateurs pour les animaux d'élevage (Dwyer, 2004)).

Ce stress chronique peut induire des modifications des schémas comportementaux tels que l'activité (les animaux se déplacent beaucoup moins), l'alimentation (dépendante de l'Homme, surtout en bâtiment) et les comportements liés au rythme circadien (Dwyer, 2004).

Selon les travaux de Vigne *et al.* (2011), les animaux ont également été sélectionnés pour être moins agressifs et plus maniables, c'est-à-dire essentiellement les femelles et les mâles de petite taille et dociles. Cette sélection est faite au détriment de l'expression de caractères sexuels et du dimorphisme sexuel. Or, ce dernier influe sur la structure sociale et la stratégie de survie de l'espèce (habitudes alimentaires, reproduction) qui sont alors altérées.

On peut aussi observer des altérations de comportements chez les mères allaitantes. En effet, chez les animaux où une forte prolificité a été sélectionnée (comme chez certaines races ovines par exemple), on observe un affaiblissement de la mère après la mise-bas ce qui amoindrit ses comportements maternels et engendre alors un plus grand risque de mortalité chez les petits.

A l'inverse, la vie en captivité, en particulier avec l'intensification de l'élevage et l'augmentation de la densité des animaux dans les bâtiments, peut amplifier certains comportements voire en créer de nouveaux que l'on ne retrouve pas à l'état sauvage. En effet, on peut retrouver une compétition pour les ressources qui peut augmenter l'agressivité des animaux entre eux. L'environnement simple et restreint peut également entraîner l'apparition de stéréotypies (comportements répétitifs sans objectif ou fonction claire). Ces comportements marquent le manque d'adéquation entre l'environnement et les besoins comportementaux des animaux (Reis, 2021).

De plus, même si un élevage est extensif, il ne pourra jamais reconstruire un habitat comme ceux retrouvés dans la nature, ce qui ne permet pas aux animaux en captivité d'exprimer les mêmes comportements que les animaux sauvages. Par exemple, les brebis vont chercher à s'isoler lors de l'agnelage mais ne pourront pas toujours le faire correctement en élevage, même en habitat extérieur (Dwyer, 2009).

E. Protocoles d'évaluation du bien-être animal chez les ovins

Il existe différents protocoles d'évaluation du bien-être animal chez les ovins. Les plus aboutis à ce jour sont le protocole européen AWIN (« Animal Welfare INdicators ») (Dwyer *et al.*, 2015), un protocole développé en France par l'institut de l'élevage IDELE (Gautier, 2015), un autre protocole français, le protocole EBBEL, développé pour les brebis laitières dans la région Roquefort (Jolly, 2020) et un protocole développé par des chercheurs australiens (Munoz *et al.*, 2019).

a. Le protocole AWIN

Le protocole AWIN pour les ovins a été publié en 2015 (Dwyer *et al.*, 2015). Il existe des protocoles de ce type pour d'autres espèces comme les bovins ou les caprins. Il se base sur le principe des 5 libertés (voir Figure 1, Brambell, 1965) et inclut 23 indicateurs différents dont 5 en lien avec l'expression de comportements.

- *Indicateurs en lien avec l'expression de comportements*

- L'isolement social

Si les ovins s'isolent ou qu'ils ne sont pas alertes et ne répondent pas aux perturbations de leur environnement, cela est considéré comme un comportement anormal pour cette espèce (Figure 2).

Pour évaluer ce critère, l'observateur reste 20 min devant le troupeau et compte le nombre d'animaux présentant des signes d'isolement social.

Figure 2 : Comportement social normal chez les ovins (à gauche) et isolement social (à droite) (d'après Dwyer *et al.*, 2015)



□ L'expression de stéréotypies

Les stéréotypies sont des comportements répétitifs qui ne sont pas censés être retrouvés chez une espèce. Elles sont assez rares chez les ovins mais sont observables en bâtiment avec notamment des animaux qui font les cent pas en marchant en cercle ou en faisant des allers-retours, qui semblent regarder les étoiles, qui s'arrachent la laine ou celle des autres brebis, ou encore qui font des mouvements de tête répétitifs.

De la même façon, pour évaluer ce critère, les animaux sont observés pendant 20 minutes et le nombre d'animaux présentant des signes de stéréotypie est compté.

□ La démangeaison excessive

Il est possible d'observer des animaux qui se démangent de façon excessive en se frottant contre une barrière, avec leurs sabots ou encore en retournant leur tête pour essayer de se gratter avec leurs cornes (Figure 3). Ces comportements, lorsqu'ils sont observés de manière répétée, suggèrent aussi la présence d'ectoparasites et un diagnostic différentiel s'impose.

Pour évaluer ce critère, l'observateur note le nombre d'animaux qui se démangent pendant plus de 5 minutes sur 20 minutes d'observation.

Figure 3 : Comportement de démangeaison (d'après Dwyer *et al.*, 2015)



□ L'évaluation de l'état émotionnel par la méthode du QBA

La méthode du QBA (« Qualitative Behaviour Assessment ») (Wemelsfelder, 2008) est une méthode d'appréciation qualitative du comportement des animaux. Elle permet de donner une connotation émotionnelle aux comportements observés en utilisant des termes comme « calme », « sur la défensive » ou encore « agressif ».

La reproductibilité et la répétabilité de ce test reflètent donc la standardisation de la perception des animaux par l'Homme en supposant que nos interprétations de leur comportement reflètent réellement leur état mental.

Pour réaliser cette méthode, il faut choisir différents points d'observation (entre 4 et 8 en fonction du type d'élevage). Ensuite, il est nécessaire d'attendre que les animaux ne fassent plus attention à l'évaluateur pour commencer l'observation sur 2.5 à 10 minutes par point en fonction du nombre de points choisi (Tableau 1).

Tableau 1 : Temps d'observation nécessaire par point lors de la réalisation de la méthode QBA (d'après Dwyer *et al.*, 2015)

Nombre de points d'observation	1	2	3	4	5	6	7	8
Temps d'observation par point	10	10	6.5	5	4	3.5	3	2.5

La notation se fait après les périodes d'observation en utilisant les 21 adjectifs décrivant les différents états émotionnels des animaux définis dans l'annexe 2. Pour chaque adjectif, l'observateur place un curseur entre un « minimum » et un « maximum ». Il sera placé sur « minimum » si le comportement n'a pas du tout été observé et sur « maximum » si celui-ci est dominant dans le troupeau. Puis, le curseur sera ajusté entre les deux extrêmes en fonction du nombre d'animaux présentant ce comportement, de l'intensité de celui-ci et des interactions avec le reste du troupeau.

Une critique faite à cette méthode est la difficulté de distinguer certains adjectifs proposés (par exemple « méfiant » et « sur la défensive »). Par conséquent, d'autres auteurs tels que Phythian *et al.* (2013) ou encore Diaz-Lundahl *et al.* (2019) ont proposé un test respectivement à 12 et à 14 adjectifs, où l'observation s'effectuait sur la base d'enregistrements vidéo.

□ Le test d'approche humaine familière (« Familiar human approach test »)

Ce test permet d'évaluer la qualité de la relation entre l'Homme et les brebis. En effet, la perception des humains par les brebis peut engendrer des comportements de peur et de fuite. Les éleveurs auront donc plus de mal à repérer les maladies et les blessures et les animaux peuvent se blesser lors de mouvements de panique.

Afin de réaliser ce test, l'éleveur s'approche de ses animaux de la même manière dont il en a l'habitude, comme s'il allait les inspecter (Figure 4). L'évaluateur reste alors à distance pour ne pas perturber les brebis et note jusqu'à quelle distance l'éleveur peut s'en approcher avant qu'elles ne fuient. Le score sera de 0 mètre si elles ne fuient pas et il faut noter tout mouvement d'approche de leur part.

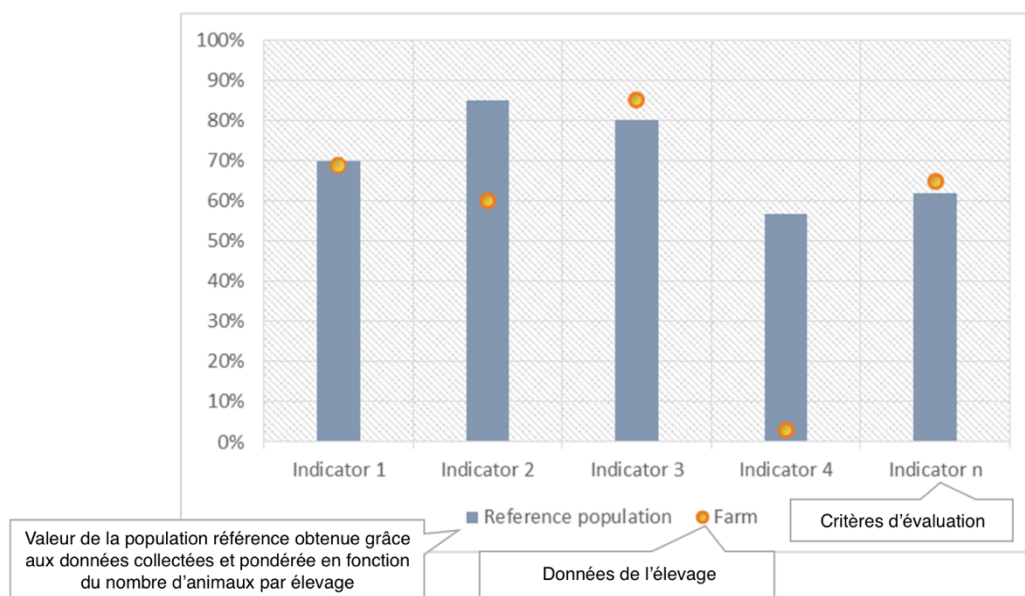
Figure 4 : Test d'approche humaine familière. A gauche, les brebis fuient l'éleveur. A droite, les brebis s'approchent et cherchent le contact de l'éleveur (d'après Dwyer et al., 2015)



- *Résultats du protocole AWIN*

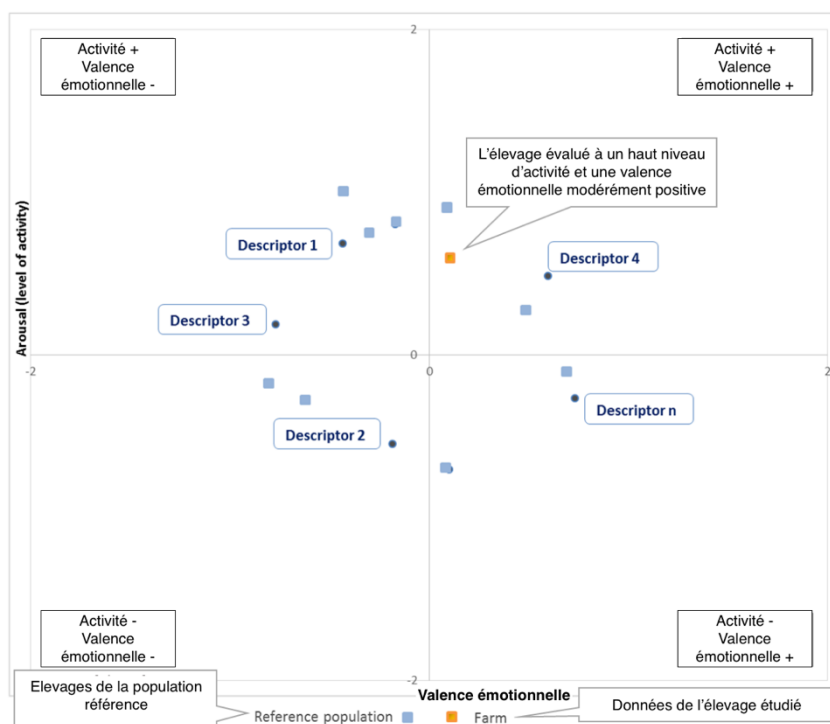
Après avoir évalué chaque critère, les résultats sont entrés dans une base de données qui les compare avec des valeurs de références prises sur différents types d'élevages (allaitant/laitier ; extensif/intensif). Cela permet d'obtenir un diagramme (Figure 5) et de savoir quels sont les points à améliorer dans l'élevage.

Figure 5 : Exemple de résultats obtenus avec le protocole AWIN (adapté de Dwyer et al., 2015)



Le seul critère qu'il n'est pas possible d'inclure dans ce diagramme est le QBA qui est alors considéré comme un indicateur supplémentaire permettant de refléter l'état émotionnel des animaux de l'élevage. Il est également possible de créer un nuage de points (Figure 6), toujours en rentrant les résultats dans une base de données afin de comparer l'élevage observé à la population référence.

Figure 6 : Exemple de résultats de la méthode QBA obtenus grâce au protocole AWIN (adapté de Dwyer *et al.*, 2015)



L'avantage de ce protocole est qu'il a été testé pour des brebis laitières et allaitantes, en bâtiment et en extérieur. Ce protocole permet surtout de repérer des comportements anormaux (stéréotypies), ceux montrant un état de stress (test d'approche humaine familière, QBA) et ceux exprimés de façon excessive (démangeaisons). Cependant, il ne permet pas de savoir si les comportements observés dans la nature sont retrouvés en élevage ou non.

b. Le protocole IDELE

Le protocole IDELE a été développé par l'Institut de l'élevage dans le but d'évaluer le bien-être des ovins allaitants pendant l'hiver (Gautier, 2015). Il a été testé dans 45 élevages d'ovins de race Romane. Il a été testé à la fois sur des lots hivernants au pâturage (19 élevages) et des lots hivernants en bâtiment (26 élevages), afin de comparer leur niveau de bien-être respectif. Il inclut 12 indicateurs différents dont 3 concernant la libre expression de comportements.

- *Indicateurs permettant d'évaluer la libre expression de comportements*
 - L'évaluation de l'état émotionnel par la méthode du QBA

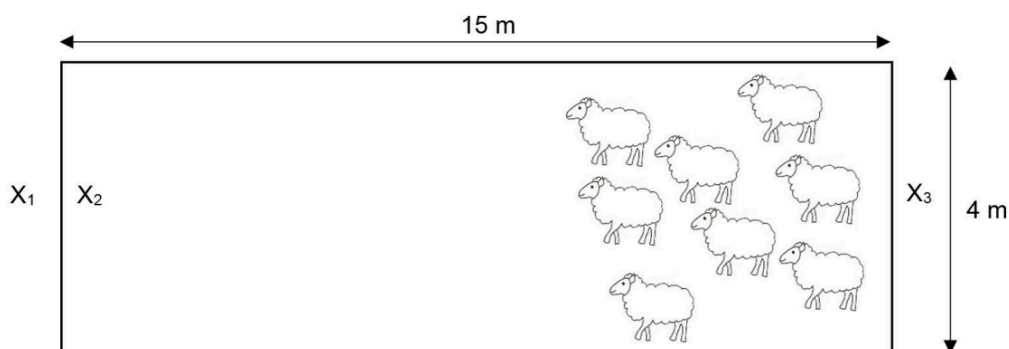
De la même façon que dans le protocole AWIN, celui d'IDELE utilise la méthode du QBA. La différence étant que seulement deux lots de 15 brebis étaient observés pendant 10 minutes chacun. L'observateur évalue ensuite les 21 adjectifs en plaçant un curseur de la même manière qu'expliqué précédemment.

Ensuite, un deuxième test est effectué après la préparation des animaux pour le test à l'Homme (Figure 7) en observant les animaux pendant seulement 3 minutes cette fois-ci et en remplissant une nouvelle grille. Cela permet d'observer l'état immédiat des animaux après une manipulation.

□ Le test à l'Homme

L'idée de ce test est la même que dans le protocole AWIN mais la méthode est beaucoup plus complexe. Les animaux sont placés dans un couloir d'une dimension bien précise (4x15m), l'évaluateur se place en X1 (Figure 7) et attend 5 min pendant lequel il réalise le deuxième QBA.

Figure 7 : Mise en place du test à l'Homme (d'après Gautier, 2015)



Ensuite, l'observateur avance lentement vers le troupeau et calcule non seulement la distance à laquelle il peut s'approcher avant qu'une première brebis fuit, mais aussi le temps écoulé avant que tout le troupeau ne rejoigne cette dernière. Ce protocole est réalisé sur deux lots et répété deux fois.

□ Réactivité au couloir de contention

Le but est de bloquer les brebis et de les attraper chacune leur tour par la ganache. L'évaluateur attribue ensuite une note en fonction de la réaction de chaque brebis (Tableau 2).

Tableau 2 : Notation de la réactivité au couloir (d'après Gautier, 2015)

Mesures	Réactivité	
Description	Saisie facile, aucune résistance de la part de l'animal	La brebis ne se laisse pas saisir ; elle baisse la tête ou présente un mouvement de recul
Notation	0	1

• *Résultats du protocole IDELE*

D'après les résultats obtenus pour les critères de la catégorie « comportements appropriés », les animaux en pâturage semblent plus sensibles aux perturbations que les animaux en bâtiment. De plus, ces résultats obtenus permettent de créer des valeurs de références auxquelles il est possible

de comparer des résultats obtenus dans un autre élevage, tout en différenciant les animaux vivant en pâture de ceux vivant en bâtiment.

Cependant, tout comme dans le protocole AWIN, ce protocole ne permet pas réellement de savoir si les comportements retrouvés dans la nature sont observables en élevage. Il permet plutôt de savoir si l'animal est bien acclimaté à l'Homme et s'il n'en a pas trop peur. De plus, il permet de comparer l'élevage en intérieur et celui en extérieur mais ne repose que sur des observations en élevage allaitant.

c. *Le protocole australien*

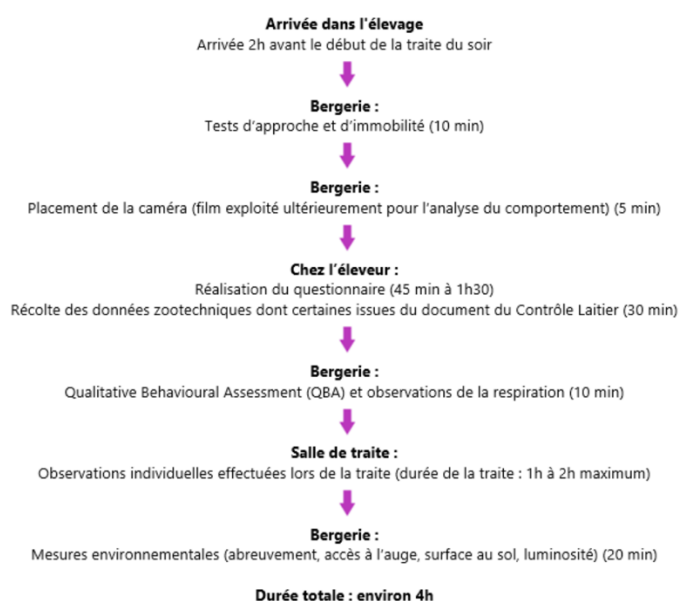
Le protocole australien a été développé afin d'évaluer le bien-être des ovins utilisés pour la production de viande ou de laine, élevés en élevage extensif (Munoz et al., 2019). Il n'inclut que six indicateurs différents portant sur deux libertés du BEA, qui sont l'alimentation et la santé.

Ce protocole est donc relativement peu précis et ne permet pas d'évaluer la libre expression de comportements naturels en élevage.

d. *Le protocole EBBEL*

Le protocole EBBEL (évaluation du bien-être animal des brebis en élevage laitier) a été développé par Pierre-Alexandre Jolly dans sa thèse en 2020 et est spécifiquement adapté aux brebis laitières. Cette première étape a été développée dans la région du Roquefort. En matière de comportement, il se compose des tests à l'Homme et du QBA. Dans sa première phase de développement (Jolly, 2020) le protocole comptait aussi une analyse du comportement social via des observations des animaux par vidéo. La Figure 8 décrit l'ensemble des étapes du protocole tel qu'initialement proposé.

Figure 8 : Étapes de la réalisation du protocole EBBEL (Jolly, 2020)



e. Discussion sur la qualité de l'évaluation comportementale dans les protocoles

Il n'existe pas de « *gold standard* » en matière de protocole d'évaluation du bien-être des ovins à l'heure actuelle, et encore moins une adaptation de celui-ci en fonction du type d'élevage (laitier/allaitant, intensif/extensif). Les critères utilisés concernant l'expression de comportements normaux ne sont également pas très développés (voire pas du tout dans le protocole australien) avec quelques critères d'évaluation, sans étudier si la palette de comportements observables dans la nature est retrouvée en élevage.

Plus récemment, en mars 2022, un protocole a également été publié par Marcone et al. (2022), des chercheurs européens. Le but était de simplifier les protocoles déjà existant afin qu'ils soient réalisables plus facilement par l'éleveur. Il est adapté aux élevages de brebis laitières et aux élevages mixtes. Ce protocole ne compte que 8 critères et aucun ne permet d'évaluer l'expression de comportements naturels chez les brebis. Ce choix est justifié par les auteurs par la difficulté d'évaluer ces critères.

De plus, aucun de ces protocoles n'utilise l'éthogramme comme base pour observer les comportements des brebis en élevage. Il paraît donc intéressant d'en définir un afin de l'utiliser comme outil de l'évaluation du BEA.

Première partie : Description de l'éthogramme ovin

1. Introduction

L'objectif de cette partie est de décrire un éthogramme de l'espèce ovine à l'aide de bibliographie déjà existante. Le but est d'identifier les comportements des ovins décrits dans la nature comme faisant partie de leur budget temps et de voir si ces comportements existent en élevage et comment ils y sont exprimés, afin de pouvoir collecter une palette de comportements observables.

Cette partie sera présentée sous la forme d'un article en anglais à publier dans un journal international à comité de lecture comme le Small Ruminant Research. Le journal ciblé sera un journal publiant des articles de recherche sur les caprins, les ovins, les camélidés ou encore les cervidés.

2. Article

The ethogram of the sheep: an illustrated review

A. Introduction

The place of animals in society has deeply changed. Nowadays, respect of animal welfare is a central concern for consumers. Indeed, as mentioned by Fraser (1983), a farm is a restricted and impoverished environment compared to the natural one. Hence, animals may be deprived of the expression of certain natural behaviours. These stressing and frustrating factors can become a source of discomfort for animals. Therefore, it is becoming essential for the industry to consider the opinion of consumers and to improve the living conditions of animals in farms, including behavioural considerations.

Farm animal welfare is often translated into the fundamental principle of the 5 individual freedoms firstly described by the Farm Animal Welfare Council (FAWC, 1965) and recently adopted by the World Organisation for Animal Health (WOAH, 2005) to embed the guiding principle highlighting the basic needs essential for the animal welfare: freedom from hunger and thirst and it is provided by ready access to fresh water and diet to maintain health and vigor; freedom from discomfort by providing an appropriate environment including shelter and a comfortable resting area; freedom from pain, injury or disease by prevention or rapid diagnosis and treatment; freedom to express normal behavior by providing sufficient space, proper facilities and company of the animal's own kind; and freedom from fear and distress by ensuring conditions and treatment which avoid mental suffering.

Therefore, the expression of natural - or normal - behaviour is the subject of this review. Indeed, while there are broad descriptions of sheep behaviour (Fraser, 1983; Lynch *et al.*, 1992), detailed information is scarce and fragmented preventing further valorisation in objective assessments in

farms. This lag is even more evident in intensive or semi-intensive systems where the animals are kept in a building.

The aim of this review was to describe the time budget of the ovine and its influencing factors and to propose a formal illustrated ethogram of the sheep mainly based on two founding studies about sheep behaviour (Fraser, 1983; Lynch *et al.*, 1992). For this second objective, each behaviour and its function were described as precisely as possible using literature and videos recorded on dairy sheep farms in the Roquefort region in France were used to illustrate them. The normal behaviours were classified within seven categories: sensorial activity, social behaviours, ingestion, exploration, kinesis, body care and rest and sleep. The abnormal behaviours were reunited in one category: stereotypical behaviours.

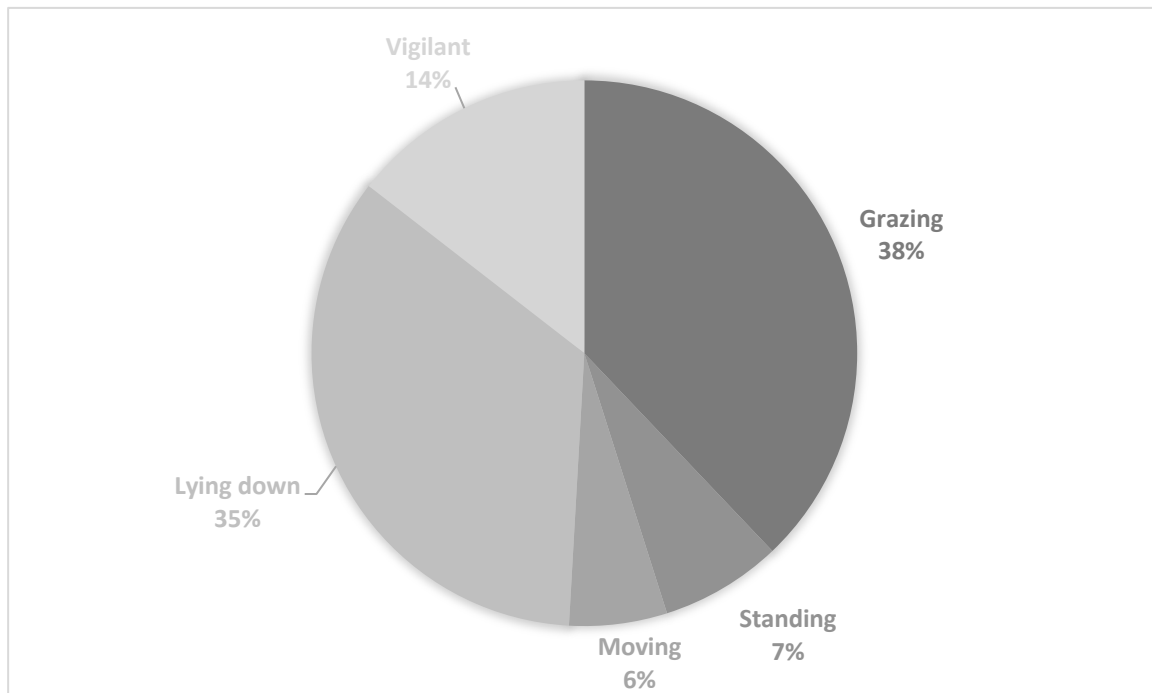
B. Sheep's time budget

In order to understand sheep's behaviour, it is important to know their time budget: the activities performed in a day and their proportions. We will compare the literature on the time budget between wild and domestic species, as well as variations due to intrinsic factors (male or female, for example) or extrinsic factors (such as the size of the pasture).

Mooring *et al.* (2003) studied sexual segregation in desert bighorn sheep (*Ovis canadensis* ssp. *Mexicana*). They made observations during the summer of 1999 and 2000 in the Chihuahuan desert which is located on the territory of Mexico and the United States of America. They compared rams and ewes' time budget, by observing them in the morning when the animals were more active. Indeed, desert bighorns spend most of the afternoon lying down in shade during the hot summer months (Simmons, 1980). To perform their observations, they focused on an individual by observing it for 10 minutes and recording its activity (grazing, moving, standing, lying down or vigilant).

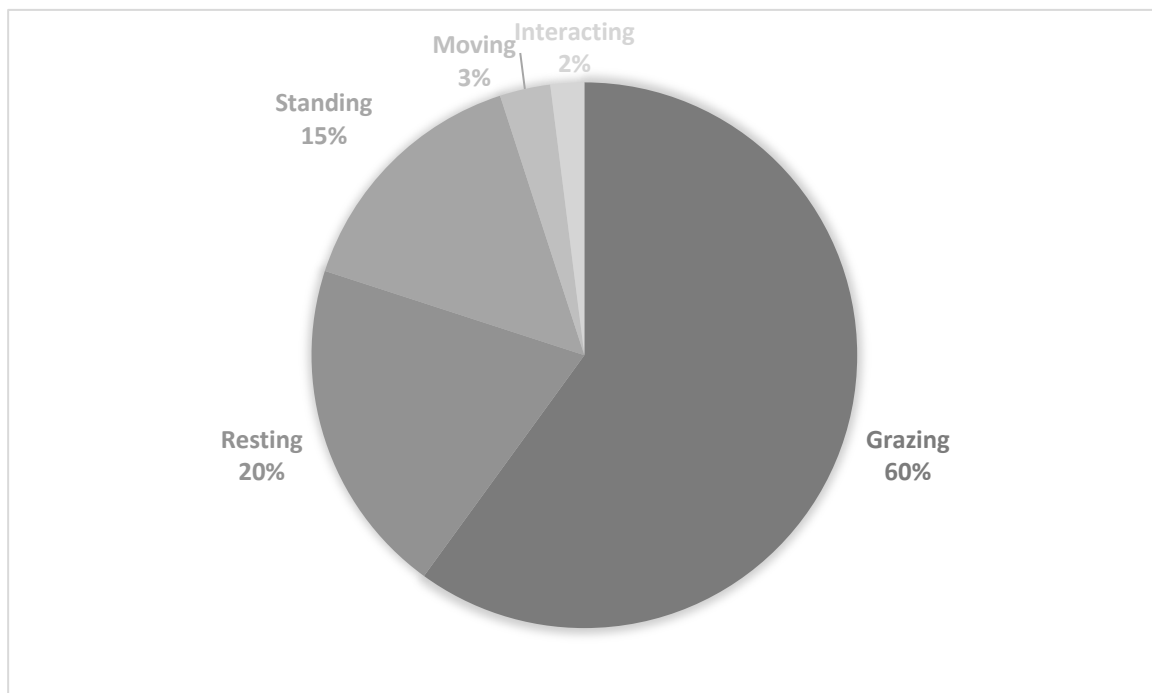
According to their observations, ewes spent most of their time grazing (mean of 37.9%) or lying down (mean of 34.6%), but a significant proportion of their time was taken up by vigilance behaviours (mean of 14.6%), as they are wild animals subject to predation (Figure 1). Moreover, they spent 47.4% of their time ruminating.

Figure 1 : Desert bighorn ewes' time budget observed in 2000 in the Chihuahuan desert (adapted from Mooring *et al.*, 2003)



Michelena *et al.* (2006) determined the time budget of domesticated merino sheep in pasture. Groups of different sizes of ewes, rams and mixed groups were formed for the experiment. Preliminary video recordings allowed the identification of different behavioural events like grazing, standing, resting, moving or interactions. The authors chose the period from 10 a.m. to 4 p.m. because this is the period where the sheep's activities are most varied as it is a diurnal animal (Piccione *et al.*, 2008). Globally, between 10 a.m. and 4 p.m., Michelena *et al.* (2006) reported that the animals spent about 50-75% of their time eating, 15-30% resting, 8-25% standing, 2-4.5% moving and 0-2% interacting with others (Figure 2). Arnold (1984) also noted a peak in sheep activity in the morning and afternoon.

Figure 2 : Merino sheep's average time budget in pasture between 10 a.m. and 4 p.m. (adapted from Michelena et al., 2006)



The comparison of the time budgets described by Mooring *et al.* (2003) and Michelena *et al.* (2006) suggests that domestic sheep spent on average twice as much time grazing (60% vs 38%) and standing still (15% vs 7%) and half as much time moving around (3% vs 6%) than wild sheep. In the case of wild sheep's study (Mooring *et al.*, 2003), a significant amount of time is spent being vigilant to protect themselves from predators. However, in their domestic sheep's study, Michelena *et al.* (2006), found that sheep spent less time standing as the number of their conspecifics increased, perhaps because the need to be constantly vigilant is less important in a larger group of animals (Michelena *et al.*, 2006).

It should be noted, however, that several factors can influence the activity of a group of sheep. For example, in the study of Michelena *et al.* (2006), adult males and females did not differ in the time allocated to feeding, while females spent more time standing and less time interacting (sometimes close to 0% during the day) than males. The same results were found for wild sheep, except for the first year of observation where rams spent a lot of time standing because of a "heavy pre-rut activity" (Mooring *et al.*, 2003).

However, Ruckstuhl (1998) observed greater differences between males and females in bighorn sheep. Adult ewes spent significantly more time grazing and less time lying down than adult rams (53% vs 38% and 39% vs 53%, respectively). Wang *et al.* (2018) also observed that ewes spent more time grazing than rams in bighorn sheep. According to Ruckstuhl (1998), the time-budget difference between males and females could explain the sexual segregation observed in these sheep in the wild. However, this hypothesis is the subject of much debate (Neuhaus et Ruckstuhl, 2004) and some authors like Mooring *et al.*, (2003) believe it to be false. Mooring *et al.* (2003) found many similarities between time-budgets of the two sexes and therefore do not believe that the remaining differences are sufficient to explain the sexual segregation in bighorn sheep. They believe

in the “reproductive strategy-predation risk”, meaning that it may best be seen as the result of a compromise between optimal foraging and predator avoidance. As Bleich *et al.* (1997) suggested: during the summer months, desert bighorn females appeared to minimize the risks of predation to themselves and their offspring by restricting their movements to areas with access to adequate food and water for lactation. On the other hand, males fed in forage-rich habitats that enhanced their body condition and probability of mating success.

Moreover, Michelena *et al.* (2006) observed differences in time budget as the size of the group changes. Males in groups of more than 2 individuals spent more time interacting (approximately 2% of their time budget). As the group size increased (from 2 to 8), males showed a slight tendency to reduce the time spent standing and to increase time spent walking and grazing without increasing their food intake. The standing position being a sign of surveillance of the environment, these results suggest that bigger groups can positively impact the animals as they can spend less time for surveillance.

Space allowance is also a factor of influence. Sibbald *et al.* (2000), showed that ewes spent more time grazing as their space allowance increased from 50 m² to 200 m² per sheep without evidence of an effect of space allowance on herbage intake or digestibility or biting rate. The authors concluded that the relationship between grazing time and space allowance may reflect the extra activity required to maintain group cohesion as space allowance increases.

Finally, the season, the quality of the grass, the nature of the terrain or even the mix of males and females in groups could all influence the sheep's activities (Hopewell *et al.*, 2005; Michelena *et al.*, 2006; Pokorná *et al.*, 2013; Wang *et al.*, 2018). The time budgets presented are therefore not unique truths but they are useful to understand how, in general, sheep spend their time.

C. Sheep's ethogram

Fraser (1983) described behaviour in intensive husbandry of cattle, sheep and pigs. He proposed to classify behaviours into eight categories of “maintenance behaviours”: Reactivity, Ingestion, Exploration, Kinesis, Association, Body care, Territorialism and Rest and sleep. The author also described behavioural deficits and anomalies. However, these behaviours were only succinctly described. From our point of view this foundation work deserves to be completed with a precise description of the sheep behaviour. We observed the behaviour of sheep on 21 dairy ewe farms in the Roquefort region in France in order to describe specifically the behaviours noted by Fraser (1983). When necessary, more recent literature can be introduced to complete the discussions.

Based on the foundation literature (Fraser 1983) and our observations, we described the sheep behaviours into 8 functional categories including 38 different behaviours. Fraser (1983) described 8 categories, including territorialism. However, he was working on livestock in general, not just sheep. In the literature, territorial behaviour in sheep is described as absent (Owen-Smith, 1977). We have therefore excluded this category from the sheep ethogram proposed. For each behaviour, a video describing the ovine ethogram visible on a dairy farm was produced to illustrate our comments.

Complete Video link: <https://youtu.be/kFgi82tOFQo>

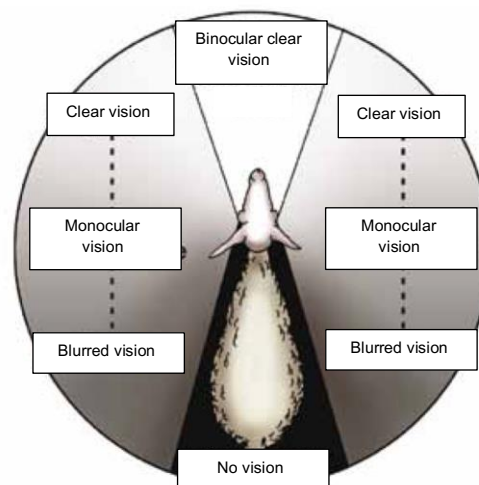
a. **Sensorial reactivity**

The sensorial reactivity category gathers the behaviours allowing the sheep to process the information from their environment and to act accordingly. Indeed, reflexes often represent the first line of defense of the animal. Reflex behaviour is used by the animal to escape from a potentially harmful situation. These behaviours involve the five senses and specially sight and hearing in the case of the sheep.

Sheep have laterally placed eyes which allow them to have monocular vision at 300° and binocular vision at 40-60° forward, apart from an approximately one-inch blind spot in front of the muzzle (Figure 3). They can see colours and have a good night vision (Ekesbo and Gunnarsson, 2018). Jacobs *et al.* (1998), showed that sheep have a dichromatic vision (unlike humans, who have trichromatic vision), meaning their eyes have two types of light-sensitive cells with different spectral sensitivity. Indeed, they identified two cone types in sheep with spectral peaks of 445 and 552 nm (corresponding to blue and yellow).

However, sheep have difficulties accommodating, estimating distances and apprehending areas with high light contrast (Pugh et Baird, 2011). Their sight allows them to recognise themselves individually, to determine the breed or sex of another individual as well as to recognise the emotions of other sheep or humans (Kendrick et Baldwin, 1987; Tate *et al.*, 2006).

Figure 3 : Sheep's field of vision (adapted from Boularand *et al.*, 2013)



Hearing is the second most important sense used by sheep. It has a wide frequency spectrum from 125 to 42 000 Hz (Kendrick, 2008), with optimal hearing at 10 000 Hz (Ekesbo and Gunnarsson, 2018). For comparison, the human audible spectrum ranges from 20 to 20 000 Hz. Therefore, the sheep's auditive spectrum is wider, especially in the high frequencies. Thus, sheep can produce and identify many different sounds, sometimes inaudible to humans. They make specific sounds depending on the situation (stress, fear) and their fellow sheep can potentially differentiate them (Kendrick, 2008). Hearing is also particularly valued for the recognition between mother and offspring. However, these voice communications decrease as the lamb grows (Hague *et al.*, 1982).

Smell is also developed in sheep and is involved in recognising individuals by the smell of their secretions. Their touch compensates for the blind spot in front of their muzzle (Ekesbo and Gunnarsson, 2018).

The different sheep behaviours corresponding to the sensorial reactivity category are listed and developed in the Table 1. These behaviours are specific to a prey living in group.

Table 1 : Sheep's sensorial reactivity behaviours (adapted from Fraser, 1983)

Behaviour	Description
Diurnal and seasonal patterns	<p>Sheep are diurnal animals, meaning they are active during the day. In addition, they are seasonal animals with variations in their activities depending on the season and climate, such as breeding, maintenance, or interactions between individuals (Piccione <i>et al.</i>, 2008; Wang <i>et al.</i>, 2018).</p> <p>Non-observed</p>
Careful orientation	<p>Sheep can perceive a noise, a touch, a smell, a visual element, which triggers a reflex and the sheep turns either its head or its entire body towards the disturbing element in order to better observe.</p> <p>Video link: https://youtu.be/rL-QVjg-g4Q</p>
Vocalisations	<p>Vocalisations are sounds made at specific pitches, volumes or repetitions to signal something and communicate information. Increased vocalisations are observed as individual responses to isolation during a distress situation.</p> <p>Video link: https://youtu.be/rL-QVjg-g4Q</p>
Locomotor reflexes in response to surprise	<p>When the sheep is surprised by a stimulus caught by one of the senses, she will flee in the opposite direction. If she is lying down when the disturbing stimulus appears, she will suddenly get up.</p> <p>In case of surprise, careful orientation can take place after the locomotor reflex in order to estimate the danger. Indeed, the sheep will move when surprised and then evaluate the disturbing element.</p> <p>Video link: https://youtu.be/igm1uLvNztY</p>
Response to invasion of individual space	<p>An intrusion into the individual sphere of a sheep is perceived as an aggression. If the sheep does not perceive this as a threat or is too submissive, it will give up its place and move to another one. On the other hand, if the intrusion is perceived as a threat, the sheep may flee, display a threat, or attack the intruder.</p> <p>Each individual has a vital space necessary for its safety. It is important for its survival and psychic balance. This space is variable between individuals and represents the minimum distance beyond which others cannot approach.</p> <p>Video link: https://youtu.be/6p-UaEGY_h8</p>

Note: For some of the behaviours, the observation was incompatible with the observation period in our study (15 minutes).

b. Social behaviours

Fraser (1983) considered agonistic and associative behaviours as two different subcategories of sensorial reactivity because it can be seen as reactions to perceived social conditions. However, he did not mention reproductive behaviours.

From our point of view, agonistic or affiliative (association) reactions are social interactions that deserve a specific place in an ethogram, especially in the perspective of further appreciation of animal welfare. Reproductive interactions are also social interactions and we propose to include them in this category.

- *Affiliative behaviours*

Sheep, as a gregarious species, engage various forms of affiliative behaviours with each other. As a result, they develop social patterns act according to dominance hierarchies and also leadership.

Stable social relationships depend on recognition between individuals, established social positions and memory of social encounters allowing to establish social status (Fraser, 1983).

- Dominance and social status

The establishment of the social hierarchy depends on the sex, age and stature (including weight, height and horn size) of the animal. Dominance offers priority access to resources over others and without contest. Social priorities are territory, reproduction or access to food, water and shelter. Sheep act according to hierarchy but dominance is not linear and can differ from day to day (Lynch *et al.*, 1992).

Moreover, among closely confined animals, social behaviours are dependent upon the system of husbandry and the number of animals associated together in one group (Fraser, 1983). The maximum number for a stable group of sheep is not known and groups of up to 200 animals can be seen in stable groups.

- Social stability and individual recognition

Social stability requires recognition between individual animals, established social positions and the memory of social encounters that establish social status (Fraser, 1983).

Close social interactions under stress can lead to increased conflict depending on the position of the animals in the dominance order. Thus, the introduction of a new individual into an established group can be dangerous for that individual because of potential aggressive encounters with several members of the group (Lynch *et al.*, 1992).

In order to recognise each other, sheep use all their senses, in particular for the ewe-lamb bonding. Indeed, the ewe stimulates the offspring's learning processes through olfactory, visual and acoustic cues and actively rejects alien newborns. Likewise, newborn lambs develop a preference for their mothers in less than one day. This preference is regulated by the difference between the acceptance behaviour manifested by the lamb's own mother and the aggressive rejecting behaviour shown by alien ewes. At around one week of age, lambs learn to develop the sensory cues allowing

them to recognize their mother. This recognition ensures that newborns will be fed and cared for by their own mother, which satisfies some of the requirements for their survival and welfare (Mora-Medina *et al.*, 2016). This bond between mother and offspring lasts until natural or forced weaning but gradually weakens as weaning approaches.

Sheep also use sight to communicate and recognize themselves. Bellegarde *et al.* (2017) showed that, after learning, the sheep is able to distinguish between pictures of conspecific faces taken in an emotionally neutral or negative situation (social isolation or threatening posture).

Touch and physical contact between sheep can be means of conveying information such as agonistic or association reactions. However, touch is of minor importance in sheep as well as the use of hearing for individual recognition between adult sheep. Hearing is mostly used for recognition between the ewe and its lamb (Dwyer, 2008).

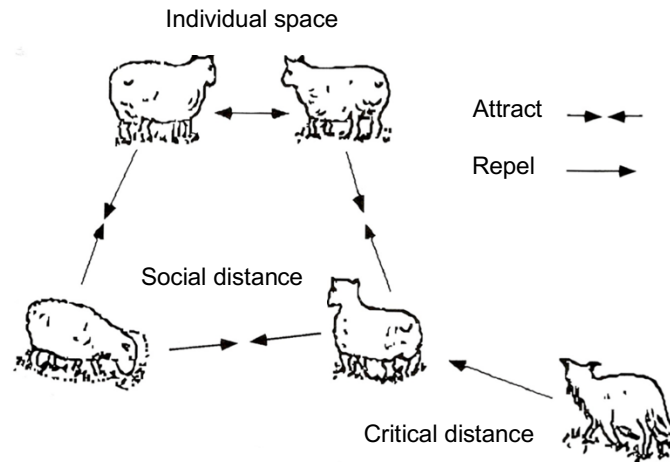
Moreover, sheep can distinguish each other via wool, faeces, urine, saliva and infra-orbital secretions (Lynch *et al.*, 1992).

□ Cohort spirit and cohesion

Sheep cohorts usually consist of conspecific individuals in the same location. Two groups can be distinguished: open and closed groups. In an open group, different individuals are joining and leaving it, leading to instability in its composition. A closed group has a stable composition and size. The following definitions of the spaces between sheep will help explain the spatial distribution of the cohort's members (Figure 4):

- Individual space refers to the minimum distance at which animals would approach each other. It is the very small space that each individual has around itself and that allows it to be comfortable with the conspecifics of its cohort. The concept of the "personal field" was defined by McBride in 1971. The author suggested that this distance is greater around the head and therefore used the term to define an area around an animal rather than a distance between animals.
- Social distance is the maximum distance between individuals for a given environment. It is a cohesion action in a group in order to maintain social contact and exchange. When grazing, it can be quite large but sheep keep each other in sight and therefore move together, even at a distance. The social distance can be reduced if they are exploring a new territory or following the presence of an intruder for example.
- Critical distance is the distance used to describe spatial behaviour in the presence of an intruder. It is the distance at which this disturbing element can approach before the animals run away or form a group, depending on the initial social dispersal or the nature of the intruder for example.

Figure 4 : Spatial measures used to describe social organisation in sheep (Lynch *et al.*, 1992)



The balance between individual space and social distance determines the structure of social groups. Sheep are a gregarious species that have short individual spaces, rather small social distances (within sight) and can form large groups. Therefore, in buildings, animals are capable of greater tolerance with smaller social distances and individual spaces (Lynch *et al.*, 1992).

Sheep form social groups of variable size (from 5 animals to 200 or more) and settle on a flexible home range. A sexual segregation occurs for most of the year, with males and females separating as adults. The males join the females during the breeding season. Adult males form closed groups and females form open groups, with a progressive dissociation of mother and young (Lynch *et al.*, 1992). This description of social organisation is close to what is identified in studies of wild sheep and mouflon (Mooring *et al.*, 2003).

□ Leadership

Sheep have a strong allelomimetic behaviour allowing them to follow the activities they observe around them, especially when moving. The phenomenon of leadership, a pillar of cohort behaviour, is created by leaders who should not be confused with dominants (Fraser, 1983). A leader is a more curious and courageous individual that leads the way, and is sometimes described as less gregarious. Leaders often seem to be the older, more cautious and experienced animals (Table 2). When moving, sheep instinctively follow the leader (Arnold et Maller, 1974; Lynch *et al.*, 1992).

Table 2 : Frequency of leadership by age in sheep (Arnold and Maller, 1974)

Age (years)	Percentage of leaders
1	0.7 %
2	12.5 %
3	22.9 %
4	38.2 %
7	27.1 %

Note: Results in Table 2 are based on an experiment carried out on a flock of 30 male Merino castrated male sheep comprising six sheep each of 1, 2, 3, 4 and 7 years. Observations were made over a 6-week period and the percentages described correspond to the percentage of leaders in each age category.

Sheep tend to flock together and form a united block. This behaviour occurs when there is an intrusion into the home range of the cohort or when there is a climatic disturbance such as rain or cold (Lynch *et al.*, 1992).

Group cohesion is also achieved through spatial distribution. Indeed, during grazing activities, the sheep are oriented in such a way that at least two others are visible.

Sheep within a cohort show sympathetic agreements in pairs or by three. Compared to the rest of the cohort, they perform the majority of their actions simultaneously with their peers (Michelena *et al.*, 2006). Siblings seem to associate and group preferentially and this association may also continue after weaning (Lynch *et al.*, 1992).

Play interactions can occur between youngsters but also between adults. For example, adult sheep can exhibit seemingly unnecessary behaviours such as trotting, galloping and head tipping. In groups of adult animals, it appears to be most prevalent in presence of positive energy balance, meaning that more energy is ingested than consumed. However, the majority of play behaviour occurs between lambs aged from a few days to ten weeks (Lynch *et al.*, 1992).

The different sheep behaviours corresponding to the affiliative category are listed and described in Table 3.

Table 3 : Sheep's affiliative behaviours (adapted from Fraser, 1983)

Behaviour	Description
Social organization	The dominant sheep have more access to resources and will more likely use agonistic behaviours while others will show submissive behaviours (Lynch <i>et al.</i> , 1992). Non-observed
Followership	A rather curious and adventurous member leads the way and the rest of the cohort is attracted by allelomimetism. This means they mimic its behaviours. It allows them to all follow the same path and direction when they change places together (Lynch <i>et al.</i> , 1992). Non-observed
Maternal bond	The mother is followed by its lamb and spends more time with it than with other members of the herd. They recognise each other by scent and vocalisation or less often visually (Lynch <i>et al.</i> , 1992). Video link: https://youtu.be/zOS6PULZoTU
Social exchanges	Sheep can perform affiliative grooming, meaning it rubs its horns, face, muzzle or neck on another animal. They can also show nose-to-nose greetings (personal observation). Playful behaviours can also be observed, especially between lambs (Lynch <i>et al.</i> , 1992). Video link: https://youtu.be/ZbYz-Z7u2nQ
Group formation	Sheep move in cohorts, they tend to stay together. They will flock together and form a united block when they feel threatened (Michelena <i>et al.</i> , 2006). Video link: https://youtu.be/QIbEpHMQbfM

Note: For some of the behaviours, the observation was incompatible with the observation period in our study (15 minutes).

- *Agonistic behaviours*

According to Scott and Fredericson (1951), a behaviour is agonistic when it makes possible to appropriate a resource (territory, food, etc.) or to establish a dominance hierarchy in a social group, by avoiding a fight that would cost energy and time or cause injuries for both individuals.

Agonistic activities are common among animals when they associate with each other. They are basically involved in the determination of social hierarchy. According to McGlone (1986) they can be classified into two categories: “aggression and threats”: behaviours that cause or threaten to cause physical harm; and “submission and flight”: behaviours to avoid physical injury.

In socially stable cohorts, aggressive and submissive postures and responses are adopted appropriately (Fraser, 1983). Overt aggression between the extremes of a hierarchy is rare, most of them occur between animals of similar rank (Stephens, 1974). In most cases, threatening or submissive responses replace aggression (Lynch *et al.*, 1992).

Aggressive acts are most evident when the aggression of one individual is countered with the aggression of another animal of similar social rank. When a social agonistic exchange takes place between animals of widely separated ranks, it is common for the animal of lower rank to show some form of submission without a challenge to the initial threat (Fraser, 1983).

Threats refer to species-specific body postures, vocalisations, odours or facial movements that signal the intention to show aggression. In stable social groups, immediate signs of submission are observed in response of these threats. However, if the social rank is close, a return threat or even an aggressive behaviour may be observed. These observations are very limited, often subtle to the human observer and difficult to measure objectively.

Domestic sheep are often viewed as non-aggressive, gregarious animals. While sheep may not show the highest frequency of agonistic encounters observed in animals, they do show measurable levels of agonistic behaviours including pushing with shoulders and running together and butting. Most fighting between males happens during the fall breeding season (McGlone, 1986).

Aggressive behaviours can be observed between two different species or within the same species. Interspecific aggression occurs for maternal defence, territory defence or predation (which is aberrant in sheep). Intraspecific aggression can be promiscuous aggression in order to defend individual space, fighting between males for reproduction and hierarchy or defence of resources. These behaviours are shown after the mixing of unfamiliar animals and last until a period of social stability is reached, where only occasional threats or attacks are necessary to maintain dominance.

Submissive behaviour is usually exhibited following either a threat or an aggressive interaction to avoid conflict (McGlone, 1986). Therefore, while showing submission, the submissive animal is stressed. Submission includes species-specific behaviours, vocalisations and odours that signal non-aggressiveness and reduce further attack by conspecifics. Most submissive behaviours are learned behaviours associated with flight from an attack).

The different behaviours corresponding to agonistic behaviours are listed and described in Table 4.

Table 4 : Sheep's agonistic behaviours (adapted from Fraser, 1983 and McGlone, 1986)

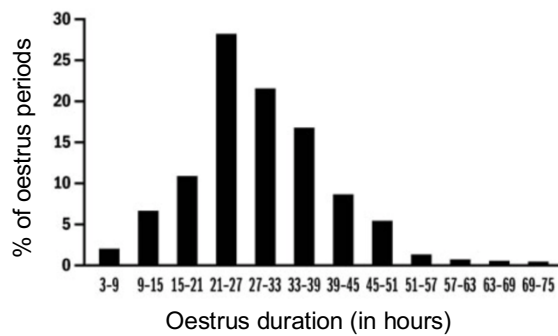
Behaviour	Description
Aggression	<p><u>Butting</u>: it is the most common aggressive behaviour in sheep. The aggressor sheep lowers its head and then makes a short charge propelled by the hind legs. The sheep may remain supported on all legs or take off from the ground with only the hind legs touching the ground. Sometimes, there may be a butting duel, meaning two ewes stand face to face, then both individuals charge each other initiating a duel, consisting of one to several headbutts. Their ears can sometimes contract and stretch to the sides. The butting duel is very often preceded by a mutual threat or may start with an offensive headbutt directly (personal observations).</p> <p><u>Kick</u>: The sheep gives a series of repeated kicks with its front paws to another sheep until it gives way (personal observations).</p> <p>Video link: https://youtu.be/NLpkRVlwQGo</p>
Submission	<p><u>Prostration</u>: The sheep stands facing another and lowers its head and neck below its shoulders. This is a common form of submission, especially seen in the context of withdrawal from an aggressive encounter (Lynch <i>et al.</i>, 1992).</p> <p><u>Submission</u>: The sheep stands facing another and turns its neck outstretched and its head to the side horizontally, or it can just run away (Fraser et Rushen, 1987).</p> <p>Video link: https://youtu.be/NLpkRVlwQGo</p>

- *Reproduction*

Sexual maturity is reached between 6 and 9 months in ewes (Hafez and Hafez, 2013). Each year, sheep have a natural breeding season and an anoestrus period. In the autumn, when daylight decreases, the ewes enter in breeding season. During the winter, when the days start to get shorter, the ewes are pregnant. They lamb in the spring after 5 months of pregnancy, when the days start to be longer, the weather is better and the pastures are rich. Then, in the summer, they are sexually inactive. This cycle is repeated every year. Moreover, breeds from areas closer to the equator generally have longer breeding seasons than those further north (Kennedy, 2012).

Most ewes are in heat for 21-33 hours but young ewes last less time in heat than adult ewes (Figure 5). When the ewe is in heat, it wags its tail, bleats frequently, has a redder and more swollen vulva, urinates often. They also look for a ram and let themselves be smelled by standing still. On average, the oestrous cycle (between 2 ovulations) lasts 17 days (Kennedy, 2012).

Figure 5 : Statistical distribution of oestrus duration in ewes (American Sheep Industry Association, Inc., 2015)



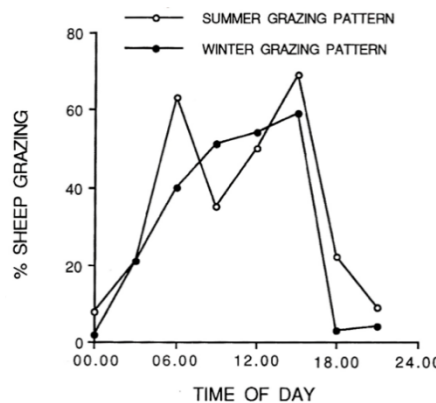
c. Ingestion

- *Feeding and rumination*

Ingestion behaviour represents an essential category of behaviour involved in both maintenance and self-determination. Food intake and rumination are major features of ingestion in sheep (Fraser, 1983). Grazing is, under natural conditions, the main occupation of sheep in terms of time budget.

This activity is mainly confined to the day time, although some night grazing occurs (Figure 6). Most of the daylight hours are occupied with grazing periods but there is diminished grazing during the midday period. According to Fraser (1983), sheep normally spend 4 to 9 hours grazing during a 24 hours period, when in loose-housing they spend about 5 hours each day eating. Their rumination time is also reduced. Although sheep in feedlots are in a very unnatural environment they still show diurnal rhythms similar to those in natural grazing.

Figure 6 : Percentage of sheep grazing according to time of day (Lynch *et al.*, 1992).



Rumination is a major feature of ingestion in sheep. It is usually performed with the animal resting on the sternum. During a 24 hours cycle, rumination takes place 15 to 20 times, but the duration of each period may differ from 2 minutes up to 1 hour or even more. The peak period for rumination is shortly after nightfall. Thereafter, it declines steadily until shortly before dawn when grazing begins. The time spent ruminating is equivalent to 75 % of the time spent grazing (Fraser, 1983).

- *Drinking*

Ingestion behaviour also includes watering. In extensive grazing areas, if access to water is remote, sheep have physiological mechanisms that allow them to have long periods without drinking water. In their study, Squires et Wilson (1971) showed that when the distance to water increased, sheep reduced the number of travels to the water source. However, the total amount of water drunk during the day remained the same compared with other sheep with close access to water. Al-Ramamneh *et al.* (2012) had the same result regarding water intake but in their study, it was the access duration to the drinking trough that was limited.

The nature of the diet plays a major role in sheep's hydration. If the grass is rich in water, it may be sufficient for sheep to drink once every two or three days. However, as soon as the grass is drier, the animals are fed with fodder, the heat increases or the feed is rich in salt, sheep will increase the frequency of trips to the water to drink once or twice a day. In a sheep pen or on small pastures, the time needed to go from the feeding area to the water trough and back is very short. In this case, sheep drink when they want and in a more fragmented way (Lynch *et al.*, 1992).

It is common for dairy sheep to pasture during the day without water because in the wild sheep do not drink often. However, these animals produce a large amount of milk and are therefore dehydrated in the evening when they return to the building and there may be competition for water if there are not enough troughs. In addition, the most subordinate animals can still not have access to water (Lynch *et al.*, 1992). Moreover, during pregnancy, ewes tend to drink more (Kennedy, 2012).

The different sheep behaviours corresponding to the ingestion category are listed and described in Table 5.

Table 5 : Sheep's ingestion behaviours (adapted from Fraser, 1983)

Behaviour	Description
Eating	<p><u>Grazing activities:</u> The sheep while walking or standing lower its head to search the herbage, gathers and manipulate the herbage with their lips, grips it between its incisors and tears it from the sward (biting) often with a jerk of the head (vertical movement). The herbage is then chewed, formed into a bolus and finally swallowed (Champion <i>et al.</i>, 2004).</p> <p><u>Feeding in the sheep pen:</u> The sheep lower its head into the feeder or through the feed fence and opens its mouth to eat (personal observations).</p> <p><u>Selectivity and specific appetites:</u> Sheep may make longer trips to graze a plant they particularly like. In the pen, this behaviour is observed when sheep move from station to station in the feeding station to select what they want to eat (personal observations).</p> <p>Video link: https://youtu.be/LzyLRFz4uJE</p>
Rumination	<p>The sheep chews its food bolus continuously. When ruminating, the sheep makes regular movements of its head and jaw related to regurgitation, chewing and swallowing of boluses (Giovanetti <i>et al.</i>, 2017). When regurgitating its food bolus, slight contractions appear at the level of the sternum. Then, a movement similar to swallowing is made in the esophagus before the cheeks swell. It is a sign of the ruminal contents rising. It is a background activity. While doing it, sheep are standing on their legs, moving or lying down (Bae <i>et al.</i>, 1979; Fraser, 1983).</p> <p>Video link: https://youtu.be/L7dRXYR6BaE</p>
Drinking	<p>The sheep moves towards a water source and opens its mouth to swallow water from the surface. In the case of a bowl drinker, the animal has to push the control with its head to get the water before swallowing it (personal observations).</p> <p>Video link: https://youtu.be/OL5HVwhaG5M</p>
Cationic balance	<p>Physiologically, the sheep seeks a source that allows it to reach a balance in mineral salts. In livestock farming, sheep come to the salt stone to lick or bite it. In extensive systems, sheep select and seek out salt-rich vegetation (Digby <i>et al.</i>, 2011).</p> <p>Video link: https://youtu.be/EtCpGW8goIU</p>
Milk feeding	<p>The lamb moves to its mother in an upright position and comes to drink milk through suckling by the dam several times during the day. The interval between feedings varies between one and three hours. This interval becomes longer as the lamb replaces the mother's milk with pasture or other sources of forage in the farm (Ricordeau <i>et al.</i>, 1960).</p> <p>Non-observed</p>

Note: For some of the behaviours, the observation was incompatible with the observation period in our study (15 minutes).

d. Exploration

All animals show a strong motivation to explore and investigate their environments. The senses of sight, hearing, smell, taste and touch meet the perceptual needs of the animal. Sheep are gregarious animals and prey. It therefore uses the sum of its senses to understand its environment, to communicate with its cohort but also to protect itself from attack.

These needs are translated into essential exploratory drives and evolve through several phases (Fraser, 1983). First, the need for perception of environmental factors is really intense, driving the animal to actively explore the new environment. Then, the exploration reduces as a result of sensory need being satisfied. Finally, the animal returns to a basal level of readiness with knowledge of the prior events in memory. Thus, exploratory behaviour is reduced when the environment has become very familiar to the sheep, but it reappears whenever there is a change in their environment.

Exploratory activities vary according to the age of the animal, its previous experiences and its environment. In wild animals, continuous behavioural adjustment to the environment is a major activity and can be considered mandatory for self-maintenance. However, in intensive farms, exploratory behaviours are reduced and the drive to explore is much lower. Sometimes, it can result in the apparition of repetitive activities characteristic of stereotyped behaviour. Moreover, when a sheep is depressed, it can completely stop any exploratory behaviour (Fraser, 1983).

Sheep have highly developed visual abilities and memory. Their visual information intake allows them to memorise the location of favourite foods and watering places on pasture and to optimise movements. In their studies, Lynch *et al.* (1992) showed that sheep have a memory of the success of previous expeditions. In their study, initially, the sheep travelled further to graze alfalfa, which they particularly liked, but within a few days they reduced the distance travelled by optimising their route.

The different sheep behaviours corresponding to the exploratory category are listed and described in Table 6.

Table 6 : Sheep's exploratory behaviours (adapted from Fraser, 1983)

Behaviour	Description
Focusing senses	<p><u>Attentive posture</u>: Sheep adopts attentive posture to sense their environment. It positions itself straight in the direction of the element of interest (visual or sound) with its ears pointing forward (personal observations).</p> <p><u>Alert posture</u>: The sheep stretches its ears horizontally and pulls them backwards with the auricles pointing towards the ground and tending towards the rear. When fully extended, the ears are at an angle of up to 90°. The sheep adopts this posture when exposed to noise of an unknown nature or from an unknown source. It is also adopted in stressful situations such as flight or social or visual isolation (Bellegarde <i>et al.</i>, 2017).</p> <p><u>Flehmen response</u>: When it senses the presence of an odorous substance of particular interest such as sex pheromones, the sheep erects its head with the neck stretched upwards, curls its upper lip revealing its incisors, allowing the vomeronasal organ to pick up a specific odour. It can maintain this position for several seconds and sometimes while rocking its head from side to side (Ambrosi <i>et al.</i>, 2018; personal observations).</p> <p>Video link: https://youtu.be/miieJ9r31fc</p>
Physical exploration of environment	<p>Once in a new environment, sheep will gradually move over the maximum number of surfaces repeatedly until they are used to it.</p> <p>Sheep will seek out stimuli in the environment. If the item of interest is reachable, smelly, or highly stimulating, the sheep may show more interest by adopting an attentive posture. Constant elements lose their stimulus value over time due to habituation (Fraser, 1983).</p> <p>Video link: https://youtu.be/t0U7gCdrmzg</p>

e. Kinesis

In all ages, movements allow sheep to carry out many activities. Kinesis serves as a subcategory for many behaviours and is recognised as a basic behavioural requirement. Sheep are instinctively programmed to walk considerable distances daily in search for food.

Movement is vital, even outside of pastoral life, for the physical and psychological balance of animals. There is always a basic need for the expression of a kinetic behaviour that justifies them to walk or to exercise their different gaits. That is why sheep need movement to exercise and maintain healthy conditions of their musculoskeletal, nervous and psychological systems, even in buildings. Thus, severe kinetic restrictions can be associated with the development of abnormal and stereotyped behaviour. It is therefore necessary to have space for the animals to move around in the sheepfold.

Moreover, some behaviours are difficult to classify. Indeed, stretches are movements of kinesis, even if they are static. Certain behavioural activities - particularly in young animals - appear

to be purely kinetic, but we decided to classify them in other categories. For example, play behaviours between lambs are affiliative behaviours, even if they involve locomotion.

The different sheep behaviours corresponding to the kinetic category are listed and described in Table 7.

Table 7 : Sheep's kinetic behaviours (adapted from Fraser, 1983)

Behaviour	Description
Natural gaits	<p>In order to move, the limbs move synchronously in one pattern. Each pattern is called a gait (Fraser, 1983; personal observations).</p> <p><u>Walk</u>: It is the slowest gait with four separate equal beats.</p> <p><u>Trot</u>: It is a symmetrical, jumping gait with two equal beats. The head swings up and down but the body remains horizontal.</p> <p><u>Canter</u>: It is an asymmetrical gait with three beats followed by a projection period in the air. Canter is the fastest gait.</p> <p>Video link: https://youtu.be/WvHdVYMU50M</p>
Perambulation	<p>The sheep comes out of an activity or a stationary position to walk randomly through space (Fraser, 1983).</p> <p>Video link: https://youtu.be/tJ14_EjP9Fw</p>
Travel	<p>The sheep uses specific routes to reach a known location by walking (Fraser, 1983).</p> <p>Video link: https://youtu.be/nbdIDu4EbuY</p>
Natural postures	<p>They are the set of positions in which the sheep stands in space (personal observations).</p> <p><u>Standing</u>: The sheep stands on all four legs.</p> <p><u>Sternal decubitus</u>: The sheep lies on its sternum with its pelvis resting on the ground and keeps its head up. The animal often keeps its front legs flexed inwards but may extend one or both in front of it. If the animal is resting, it can also bend its head to rest on its belly.</p> <p><u>Lateral decubitus</u>: the sheep lies on its side, with one flank, its neck and its head on the ground.</p> <p>Video link: https://youtu.be/LX-v5lxRqzw</p>
Change of posture	<p>This is a change between natural postures (Pallares, 2020; personal observations).</p> <p><u>Lie down</u>: The sheep stands on its four legs, flexes one front leg placing its metacarpal on the ground, then does the same with the second. Then it flexes its hind legs to fall on the ground.</p> <p><u>Standing up</u>: The lying sheep stands up on the metacarpals, then pushes and extends both hind legs fully. Finally, it flexes one front leg to put a hoof on the ground and does the same with the second to straighten up.</p> <p>Video link: https://youtu.be/GBOjUnT7LIs https://youtu.be/Aphoat6ntbw</p>

Stretching	<p>The sheep is standing and stretching by simultaneous extension of the four limbs and the neck. Hind legs are usually outstretched one after the other. The body then leans slightly forward (personal observations).</p> <p>This behaviour is more commonly seen soon after the animal has risen after a period of resting (Fraser, 1983).</p> <p>Video link: https://youtu.be/czrP1e-LO1c</p>
-------------------	--

f. Body care

Animals seek physical comfort and ensure that it is maintained. The motivation for these behaviours clearly indicates the existence of a general need relating to body care. They are used to fight discomfort in the environment, for thermal regulation and for body mechanisms like evacuation (Fraser, 1983).

In order to maintain comfort, sheep are able to rub, scratch and lick themselves (individually or in groups). Scratching of the head region with the hind foot and licking accessible body parts are grooming behaviours common to most species. When those behavioural patterns cease, it is often related to the first signs of clinical or sub-clinical disease or stress (Fraser, 1983).

The different sheep behaviours corresponding to the kinetic category are listed and described in Table 8.

Table 8 : Sheep's body care behaviour (adapted from Fraser, 1983)

Behaviour	Description
Scratching	<p>The sheep rubs its head or flank on the uprights of walls, fences, trees or other natural features. In a standing position, it can also rise a hind leg to scratch a part of its body (personal observations).</p> <p>Video link: https://youtu.be/XR_Oy7tCsXc</p>
Grooming	<p>While standing or lying down, the animal cleans a leg or flank with its mouth, helped by its teeth and lips (personal observations).</p> <p>Sometimes, sheep groom each other. This is called allogrooming.</p> <p>Video link: https://youtu.be/We1EaCwRRnE</p>
Shaking	<p>The animal shakes its body, head, ears or tail in order to remove material or insects from its body surface (Fraser, 1983).</p> <p>Video link: https://youtu.be/al2-r2GdRNq</p>
Thermoregulation	<p>Sheep huddle together to seek warmth. They are also capable of shivering in extreme cold. In windy conditions, sheep protect their heads and turn away from the wind gusts. Sheep also gather under a shelter in search of shade or to avoid rain. They can also slide their heads under each other's bellies in bright sunlight when they have no shelter (NFACC, 2013; Al-Ramamneh, 2023).</p> <p>Non-observed</p>
Evacuation	<p><u>Defecation</u>: The sheep raises its tail above the vertebral axis and relaxes its anal sphincter to evacuate the excrements. This can be done while walking (personal observations).</p> <p><u>Urination</u>: The ewe raises its tail above the vertebral axis and tilts its pelvis forward. To do this, she lowers her hindquarters and then urinates in a few seconds (personal observations).</p> <p>Video link: https://youtu.be/fiexMcsSHpE</p>
Comfort-seeking contact	<p>Sheep wanting to rest can scratch the ground with its foreleg in search of a comfortable place to lie down. Resting sheep like to lie along walls and close to each other. They can lie down in a long line one behind the other or in pairs back to back with their heads in different directions (personal observations).</p> <p>Video link: https://youtu.be/BwoAbcq4aP0</p>

Note: For some of the behaviours, the observation was incompatible with the observation period in our study (15 minutes).

g. Territorialism

As Noble (1939) stated: a territory is simply any defended area. Therefore, territorialism is the behaviour that consists of defending its territory. Animals' territory is where they feed, find shelter, rest, drink water, exercise or evacuate.

There is little literature on territorialism in sheep. In his researches about ungulates, Owen-Smith (1977) found that territorialism is generally absent in sheep. However, Fraser (1983) mentions territorialism in sheep. He writes that sheep prefer density but they require extensive territorial facilities for the total flock strategy. However, he adds that one of the major deficiencies with husbandry methods in sheep is territorial activity.

Furthermore, in our videos, no territorial behaviour was visible. In fact, the aggressive behaviour observed is mainly linked to hierarchy. This category has therefore not been included in the sheep ethogram.

h. Rest and sleep

Rest and sleep allow metabolic recoveries to take place and save body energy. These behaviours occupy a large part of the animal's total life span and are governed by the "internal biological clock" that exists in the nervous system to measure time. As in many diurnal animals, the sun is the most important factor in the perception of time for sheep and influences the various systems of the body (Fraser, 1983).

In cold climates, sheep rest mostly at night, on the highest site and near where grazing takes place. In warm climates, sheep also elevate and rest for up to 10 hours a day, either in the shade of trees or near water. If there is no shade and no water supply, sheep can be seen with their heads under each other's bellies (Lynch *et al.*, 1992).

Sheep rest in numerous sleepy phases throughout the day. These periods may precede or follow true sleep. Sleep occurs in two forms (Fraser, 1983):

- Slow wave sleep is characterised by a light and a deep phase, with slow brain waves. The electrical discharge of the brain shows a low level of activity and for this reason it is sometimes called brain sleep.
- Paradoxical sleep: the body is flaccid and the electrical activity in the brain is typical of the awake state with the presence of rapid eye movements (REM). For this reason, it is sometimes called body sleep. Paradoxical sleep appears to be the critical and essential component of sleep as its deprivation leads to behavioural abnormalities such as incongruous responses

Rest is polyphasic in sheep (Munro, 1957; Tobler, 1995). It is composed of numerous phases of rest and sleepiness of varying duration spread over the day. Sleep is rather distributed at night and most of the resting time is composed of drowsiness.

Fraser then described two types of resting: stationary resting (idling or standing) and drowsing (standing or lying in a sternal decubitus position with head suspended). He also described two types of sleep: slow wave sleep (sternal sleeping phase with head resting) and paradoxical sleep (resting in lateral decubitus position with rapid eye movements).

However, it can be difficult to differentiate between the different stages of a sheep's sleep or resting simply by observing it from a distance. For practical reasons, we have therefore chosen to simplify the rest and sleep behaviours described by Fraser (1983) in order to describe two types of rest (standing and lying down) and one type of sleep (lying down with eyes closed).

The different sheep behaviours corresponding to the rest and sleep category are listed and described in

Table 9.

Table 9 : Sheep's rest and sleep behaviours (adapted from Fraser, 1983)

Behaviour	Description
Standing rest	The sheep stands on its legs. It can be associated with passive, slowed-down activity such as ruminating (personal observations). Video link: https://youtu.be/CMZVRZ744oQ
Lying rest	The sheep lies in a sternal decubitus position with its head suspended and sometimes its eyes closed (personal observations). Video link: https://youtu.be/CMZVRZ744oQ
Sleep	The sheep lies in a sternal or lateral decubitus position with its eyes closed and its head resting against a wall, on the ground, on its belly or on the back of another sheep (personal observations). Video link: https://youtu.be/pc7P XUoyyJE

i. Behavioural deficits and stereotyped behaviours

Substantial freedom of movement, use of environment and association with others are clearly required for an animal to produce the range of behavioural items included in the ethogram. Under the conditions of constraint - which characterize all intensive husbandry systems - some of these behaviours cannot be reproduced and ethograms of maintenance in these circumstances show certain deficits.

In his study, Fraser (1983) proposed an ethogram of 43 normal sheep behaviours. In intensive farms considered as stressful environments, he estimated a deficit in the expression of 13 of them, i.e. 30 %. Fraser thus established that the percentage of deficiencies in the total ethogram of behaviour can be taken as an index of behavioural deprivation. Above this percentage, it can be stated that the farming conditions are unsuitable.

In general, territorial activity in sheep in mainly indoor housing is severely impaired or absent. Moreover, certain aspects of ingestion (grazing, selectivity) were inevitably inhibited in animals genetically programmed to graze and to forage (Fraser, 1983).

Behaviour may be altered as animals respond to the invasion of their personal field. Reducing space allowance can lead to increase in aggressive interactions and is considered to be highly important for optimum welfare and production (Gougoulis *et al.*, 2010).

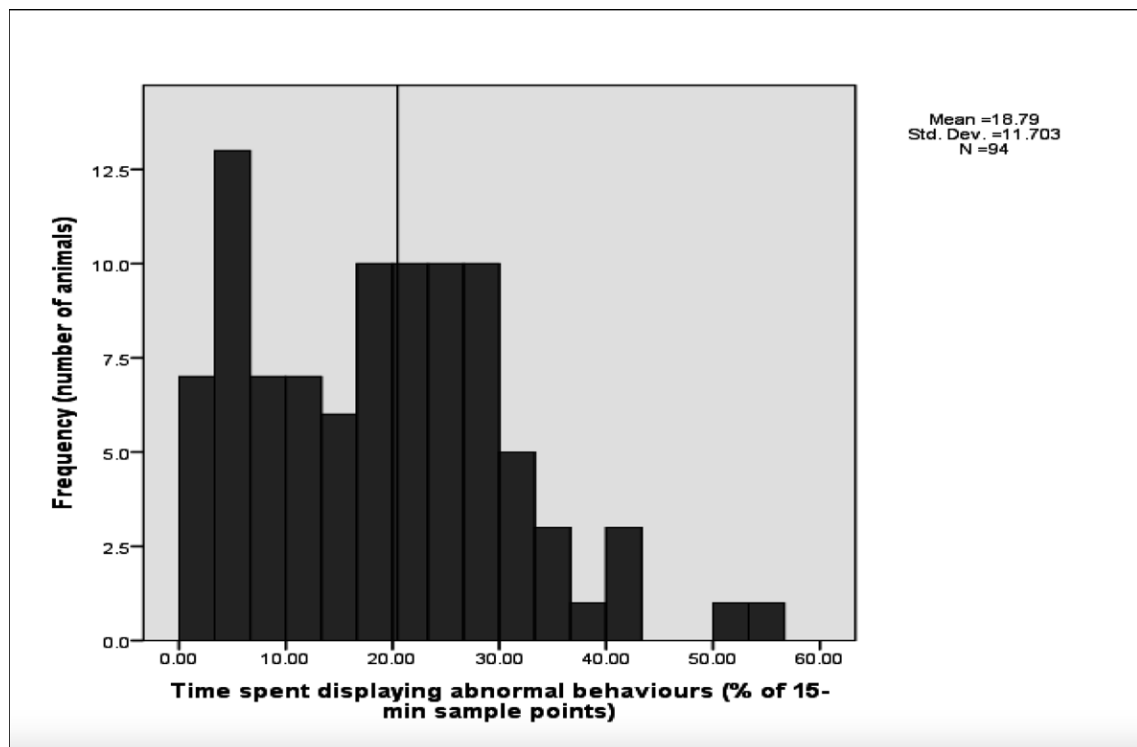
In addition to the behavioural deficits observed by Fraser, stereotypies may develop. Stereotypies or stereotypic behaviours are a set of uncontrollable and repetitive behaviours with no apparent purpose. Social pressures or lack of sensory stimulation can cause stress or even physiological disturbances that lead to these abnormal behaviours (Fraser, 1983).

Considered as an aspect of the behaviour of an animal, these abnormal behaviours are frequently defined as atypical for the species, outside the normal behaviour pattern that has evolved in the natural habitats of the species or outside the range usually observed in the species in non-captive situations (Keeling and Jensen, 2009).

Wool biting in sheep is the most common stereotyped behaviour. It is thought to occur in animals chronically confined to small pens. They express an intense dominance system by pulling wool from subordinate animals. The wool strands are introduced into the mouth of the dominant sheep and torn from the fleece. In these pens, the most dominant animal usually has its entire fleece intact, while the dominated ones have large bare areas. In the most severe cases, the entire fleece may be torn off, as if shorn. Moreover, among rams kept in large numbers in small paddocks, homosexual activities become common, notably following puberty (Fraser, 1983).

More recently, in a study of 96 individually housed sheep in the same farm in Australia, Lauber *et al.* (2012) showed that almost three quarters of them displayed one or more of the abnormal behaviours of pacing, and chewing and nosing pen fixtures for more than 10 % of the day (see Figure 7). However, we did not observe any stereotypical behaviour in our videos.

Figure 7 : Time spent displaying abnormal behaviours by individually housed by sheep (Lauber *et al.*, 2012).



The different stereotypical behaviours in sheep are listed and described in the Table 10.

Table 10 : Stereotypical behaviours in sheep (adapted from Fraser, 1983 and Lauber *et al.*, 2012)

Behaviour	Description
Wool biting	A sheep opens its mouth and grabs the fleece of another sheep. It chews or plucks the wool of a fellow sheep (Fraser, 1983). Non-observed
Mouthing	The animal opens its mouth to pick up equipment between its jaws or lick fences or other equipment (Lauber <i>et al.</i> , 2012). Non-observed
Mounting in ram groups	When kept away from ewes, rams may mount each other. It occurs especially in young rams (Fraser, 1983). Non-observed
Pacing	A sheep walks in a distinct pattern, such as frequent walking back and forth, weaving or moving in circles (Lauber <i>et al.</i> , 2012). Non-observed

3. Conclusion

To conclude, according to literature, 38 different behaviours are described in sheep. Fraser (1983) stated that a depletion of up to 30 % of natural behaviours can be observed in housed sheep because of the reduced space and the absence of dangers to which the animals are exposed in the wild. A depletion superior to 30 % of the ethogram described in this chapter must be considered as unsuitable farming conditions. Such deficits can trigger abnormal or stereotypical behaviours, such as wool biting, mouthing, mounting (in ram groups) and pacing, especially in individually housed sheep. In such conditions, up to 70 % of the animals can express a stereotype (for approximately 2 to 5 minutes).

In our 15 minutes observations, we only observed 30 of the described behaviours. But it is not necessarily sign of behavioural depletion. Indeed, the not observed behaviours were: social organisation and followership, thermoregulation and stereotypes. The first were not observed because of the short time of observation (15 minutes) while this behavior demands a fine knowledge of the flock. The second was not observed because the animals were indoors and benefited of an appropriate temperature. The non-observation of stereotypical behavior is rather positive and should not be considered as a sign of behavioural depletion.

Deuxième partie : Évaluation du comportement de brebis laitières dans le cadre d'une évaluation du BEA

1. Introduction

Sheep can express a wide range of behaviours which can be classified into 8 different categories in an ethogram. Fraser (1983) estimated at about 30 % the deficit of the expression of normal behaviours in indoor sheep compared to outdoor life because of a lack of space, the absence of exposure to stimulating factors like predators (which can be considered positive) and other natural environment components. In extreme cases, the deficit of expression of fundamental behaviours for a species can trigger the development of abnormal or stereotypical behaviours. For example, Lauber *et al.* (2012) observed that sheep spent on average 14 % of their time pacing during the morning (between 8:15 and 11:45 a.m.) in an individually housed farm of 96 Merino sheep in Australia. Pacing is an abnormal behaviour where the sheep walks in a distinct pattern, such as frequent walking back and forth, weaving or moving in circles with no clear aim.

The existing protocols (Dwyer *et al.*, 2015; Gautier, 2015; Munoz *et al.*, 2019) of assessment of sheep welfare lack of reference data to analyse the behavioural observations included in it. Indeed, the ethogram of the sheep was described by Fraser in 1983 and since then, studies have been developed to describe the time budget of the sheep (Arnold, 1984; Mooring *et al.*, 2003; Michelena *et al.*, 2006). However, at our knowledge only the study of Jolly (2020) built a reference of some behaviours observable in sheep during a short period of observation (15 minutes), more adapted to an assessment of animal welfare than the analysis of the time budget of a full day.

The aim of this work was to establish the complete repertoire of behaviours that can be observed in sheep in buildings (semi-intensive or intensive systems) and their frequency of expression during a short duration of observation (15 minutes) in order to create a protocol for assessing the behavioural aspects of animal welfare.

This work can serve as a reference to determine the observable behaviours during an animal behaviour assessment compatible with a welfare assessment. It was based on filmography and consisted in four phases: Phase one: a method of observation was established. Phase two: a list of behaviours was proposed, based on the ethogram of production animals (Fraser, 1983). Phase three: a collection of 21 films of 15 minutes recorded in sheepfolds of commercial farms was observed to identify the behaviours present or absent in these farms using the technique of binary behaviour study (Pallares, 2020). Phase four, the same films were observed a second time to count the number of occurrences of the present behaviours. The level of difficulty of observation and the certainty of identification of each behaviour was estimated. The detailed description of each behaviour described in the first part of this thesis was fundamental to perform this work.

2. Materials and methods

A. Movie recording

The movies were recorded between January and February 2019 in one pen of 21 farms in the Roquefort Region. The movies were recorded after the morning milking or before the afternoon milking. One camera was installed outside the pen, allowing the view over the full pen. The assessor left the building during the recording. Only routine activities (performed by known humans) were allowed during the observations. Each movie lasted 40 minutes.

B. Observation of the movies

The first step was to eliminate the first 25 minutes of each movie to limit the influence of curiousness of the animals on the behavioural assessment. Then, the assessor observed the following 15 minutes.

a. Identification of present or absent behaviours: binary behaviour study

To perform this work, a table of behaviours was built based on the ethogram of the sheep described by Fraser (1983) and by ourselves in the first part of this thesis (Table 1). Then, a first naïve observation of the movies was performed to identify which of these 38 behaviours were observable during this short-term observation. If a behaviour was observed, at least once, it was noted 1 in a chart, if not, 0 (Table 1). However, the behaviours determining diurnal and seasonal patterns were not included in our observations because incompatibility with the short time of observation. Also, male stereotypical behaviour “mounting in rams” was not included because only lactating females were observed in this study.

Table 1: Observation chart used in the binary behaviour study. The Frequency column represents the frequency of presence of the behaviour within the farms.

Category	Behaviour	Farm number																				Total	Frequency
		3	4	5	6	7	8	9	11	12	13	14	15	16	17	18	19	20	21				
Sensorial reactivity	Careful orientation																						
	Vocalisation																						
	Locomotor reflexes in response to surprise																						
	Response to invasion of individual space																						
Social behaviours	Aggression																						
	Submission																						
	Social organisation																						
	Followership																						
	Maternal bond																						
	Social exchanges																						
	Group formation																						
Ingestion	Eating																						
	Rumination																						
	Drinking																						
	Cationic balance																						
	Milk feeding																						
Exploration	Focusing senses																						
	Physical exploration of environment																						
Kinesis	Natural gaits																						
	Perambulation																						
	Travel																						
	Natural postures																						
	Change of posture																						
	Stretching																						
Body care	Scratching																						
	Grooming																						
	Shaking																						
	Thermoregulation																						
	Evacuation																						
	Comfort-seeking contact																						
Rest and sleep	Standing rest																						
	Lying rest																						
	Sleep																						
Stereotypical behaviours	Wool pulling																						
	Mouthing																						
	Pacing																						

N.B. The films from farms 1 and 2 could not be recovered and the film from farm 11 was too dark to be analysed.

b. Defining the frequency of observation of the behaviours

Once the observable behaviours were identified, the films were watched a second time to define the frequency of observation. An observation chart was created to record our observations in each film (Table 2). In this table, the results are presented in terms of the observed number of occurrences of each behaviour. Then a second table gives the frequency of occurrence by calculating the number of occurrences per 100 animals (Table 4).

Table 2: Observation chart used in the behaviour frequency study.

Categories of behaviours	Behaviours	Farm number (up) & head count (below)																			
		3	4	5	6	7	8	9	11	12	13	14	15	16	17	18	19	20	21		
Sensorial reactivity	Careful orientation																				
	Vocalisation																				
	Locomotor reflexes in response to surprise																				
	Response to invasion of individual space																				
Social behaviours	Aggression																				
	Submission																				
	Social organisation																				
	Followership																				
	Maternal bond																				
	Social exchanges																				
Ingestion	Group formation																				
	Eating																				
	Rumination																				
	Drinking																				
	Cationic balance																				
Exploration	Milk feeding																				
	Focusing senses																				
Kinesis	Physical exploration of environment																				
	Natural gaits																				
	Perambulation																				
	Travel																				
	Natural postures																				
	Change of posture																				
Body care	Stretching																				
	Scratching																				
	Grooming																				
	Shaking																				
	Thermoregulation																				
	Evacuation																				
Rest and sleep	Comfort-seeking contact																				
	Standing rest																				
	Lying rest																				
Stereotypical behaviours	Sleep																				
	Wool pulling																				
	Mouthing																				
	Pacing																				

N.B. The films from farms 1 and 2 could not be recovered and the film from farm 11 was too dark to interpret.

Behaviours that show a rather long duration (i.e. feeding, ruminating, rest and sleep) were counted only once at the video to give an idea of the proportion of animals expressing these behaviours. The number of animals eating, ruminating, resting or sleeping at the moment of observation (i.e.: at 8 minutes - out of a total observation of 15 minutes) was counted and the frequency of observation was calculated as follows:

$$Fb = \frac{n}{N} \times 100$$

With F being the frequency of observation of the given behaviour b , n being the number of animals presenting the behaviour and N the number of animals present in the pen.

The frequency of the behaviours of shorter duration, was calculated by observing all the ewes throughout the 15 minutes. Each individual observation of a given behaviour was noted on the chart. The final result of the farm was the addition of the events observed for each behaviour.

Exception was made for some overly frequent behaviours. They were not counted:

- Vocalisations were not counted, but an overall assessment was made of whether or not the farm was noisy. A graduation of – to +++ was given to the farms. The farms rated – are the quietest ones with almost no vocalisations. In those rated +, vocalisations can be heard for less than half the observation time. In those rated ++, vocalisations can be heard for more than half the observation time. Finally, in farms rated +++, vocalisations were heard almost constantly.
- Careful orientation, focusing senses, physical exploration of environment, natural gaits, perambulation, travel and natural postures were not counted as they were observable at all times and they occurred too many times to be counted,
- Response to invasion of individual space and group formation because they could be confused with agonistic behaviour and locomotor response in response to surprise respectively.

As the number of animals present in the different movies were not similar, after calculating the number of occurrences of each behaviour on the farm, we adjusted these results to the number of occurrences per 100 animals. This allowed us to obtain comparable results between the different farms and to calculate standard deviations and 95 % confidence intervals. The formulas used were:

- Number of occurrences of a behaviour per 100 animals: $X_i = \frac{x_i}{n_i} \times 100$,
- Mean of number of occurrences of a behaviour: $\bar{X} = \frac{\sum_{i=1}^N X_i}{N}$,
- Standard deviation: $\sigma(X) = \sqrt{\frac{\sum_{i=1}^N (X_i - \bar{X})^2}{N}}$,
- 95 % confidence interval: $CI_{95\%} = [\bar{X} - 2 \times \frac{\sigma(X)}{\sqrt{N}} ; \bar{X} + 2 \times \frac{\sigma(X)}{\sqrt{N}}]$,

With X the behaviour, i the farm number, x_i the number of occurrences of the behaviour in farm number i, n_i the number of animals in farm number i and N the number of farms.

These confidence intervals give an idea of the expected number of occurrences for each behaviour when an indoor dairy sheep farm is observed for 15 minutes.

Finally, an observation table was proposed for anyone wishing to observe a farm to determine whether the behavioural observation is normal or not.

3. Results

The results are presented in two parts: the binary behaviour observation (Table 3) and the study of the adjusted frequency of observation of each behaviour (

The frequency of observation of each of these behaviours in each farm adjusted to 100 animals was summarised in Table 4. Exception made for the following behaviours:

- Eating, ruminating, standing rest, lying rest and sleep which were counted only once, at 8 minutes of observation as described in the Material and Methods because they are rather long behaviours and it would be too laborious for the observer to follow these behaviours over 15 minutes,
- Careful orientation, focusing senses, physical exploration of environment, natural gaits, perambulation, travel and natural postures because they occur too many times to be counted,
- Response to invasion of individual space and group formation because they could be confused with agonistic behaviour and locomotor response in response to surprise respectively.
- Vocalisation were estimated with a notation from - to +++ according to their frequency of appearance, because in most cases they were too numerous to count precisely.

Table 4). From these results it was possible to establish 95 % confidential intervals (Table 5).

The crowd and the low light in some buildings were complicating elements because of the difficulty of counting the animals. Despite these difficulties, it is possible to use video recording to study the behaviour in the building.

The observations should be initially performed on 21 farms, but for technical problems, the films from farms 1 and 2 were lost and the film from farm number 10 was too dark to observe the animals. The final sample retained in the results consisted on 18 farms.

The results of the binary behaviour observation were described in Table 3.

Table 3: Binary behaviour observation (Present (1) or absent (0)) in the 18 sheep dairy farms before or after milking.

Category	Behaviour	Farm number																		Total	Frequency
		3	4	5	6	7	8	9	11	12	13	14	15	16	17	18	19	20	21		
Sensorial reactivity	Careful orientation	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	17	94%
	Vocalisation	1	1	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	14	78%
	Locomotor reflexes in response to surprise	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	3	17%
	Response to invasion of individual space	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	16	89%
Social behaviours	Aggression	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	0	1	15	83%	
	Submission	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	6	33%
	Social organisation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	Followership	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	Maternal bond	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	11%
	Social exchanges	1	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	5	28%
Group formation	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	3	17%	
Ingestion	Eating	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Rumination	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Drinking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	6%
	Cationic balance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	6%
	Milk feeding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Exploration	Focusing senses	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Physical exploration of environment	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
Kinesis	Natural gaits	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Perambulation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Travel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Natural postures	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Change of posture	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Stretching	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	11%
Body care	Scratching	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Grooming	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	17	94%
	Shaking	1	0	0	0	0	1	1	1	1	1	0	0	1	1	1	1	1	1	12	67%
	Thermoregulation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	Evacuation	1	1	1	0	0	1	1	0	0	1	0	1	0	1	1	1	1	1	12	67%
	Comfort-seeking contact	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17	94%
Rest and sleep	Standing rest	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Lying rest	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	17	94%
	Sleep	0	1	1	1	0	1	0	1	1	0	0	0	0	0	0	1	1	1	10	56%
Stereotypical behaviours	Wool pulling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	Mouthing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	Pacing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%

N.B. The films from farms 1 and 2 could not be recovered and the film from farm 11 was too dark to interpret.

The behaviours can be grouped according to the likelihood of presence (observation) within the farms studied as follows:

- Observed in all the farms (100 % of the farms): eating, rumination, focusing senses, physical exploration of environment, natural gaits, perambulation, travel, natural postures, change of postures, scratching, standing rest.
- Observed in the majority of the farms (more than 80 % of the farms): careful orientation (94 %), grooming (94 %), comfort-seeking contact (94 %), lying rest (94 %), response to invasion of individual space (89 %) and aggression (83 %).
- Observed in more than 50% of the farms: vocalisation (78 %), shaking (67 %), evacuation (67 %), sleep (56 %)
- Observed in less than 50% of the farms: submission (33 %), social exchanges (28 %), locomotor reflexes in response to surprise (17 %), group formation (17 %), maternal bond (11 %), stretching (11 %), drinking (6 %), cationic balance seeking (6 %)
- Non-observable behaviours (0 farms): social organisation, followership, milk feeding, thermoregulation, wool pulling, mouthing, pacing.

The frequency of observation of each of these behaviours in each farm adjusted to 100 animals was summarised in Table 4. Exception made for the following behaviours:

- Eating, ruminating, standing rest, lying rest and sleep which were counted only once, at 8 minutes of observation as described in the Material and Methods because they are rather long behaviours and it would be too laborious for the observer to follow these behaviours over 15 minutes,
- Careful orientation, focusing senses, physical exploration of environment, natural gaits, perambulation, travel and natural postures because they occur too many times to be counted,
- Response to invasion of individual space and group formation because they could be confused with agonistic behaviour and locomotor response in response to surprise respectively.
- Vocalisation were estimated with a notation from - to +++ according to their frequency of appearance, because in most cases they were too numerous to count precisely.

Table 4: Number of occurrences per 100 animals of each behaviour in the 18 sheep dairy farms before or after milking. The column Mean/100 animals corresponds to the mean of the frequencies of the different farms.

Categories of behaviours	Behaviours	Farm number																			Mean / 100 animals
		3	4	5	6	7	8	9	11	12	13	14	15	16	17	18	19	20	21		
Sensorial reactivity	Careful orientation	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Vocalisation	+++	++	-	+++	+	+	+	+	+	+	-	-	+	+	++	+	++	-	NR	
	Locomotor reflexes in response to surprise	100	0	0	0	0	0	0	0	0	0	0	6,2	0	0	20	0	0	0	0	7,0
	Response to invasion of individual space	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Social behaviours	Aggression	7	20	2	1,4	1,4	3,1	0	5,3	1,7	5	0	2,9	2,7	3,1	1,1	6	3,3	3,3	3,9	
	Submission	0	2	0	0	0	1,5	0	0	0	0	0	2,9	1,3	1,5	0	2	0	3,3	0,8	
	Social organisation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Followership	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Maternal bond	3	0	0	0	0	0	0	0	0	0	0	4,6	0	0	0	0	0	0	0,4	
	Social exchanges	1	2	0	0	1,4	1,5	0	0	0	0	0	0	1,3	0	0	0	0	0	0,4	
	Group formation	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Ingestion	Eating	15	16	14	1,4	3,3	12	37	4	5	5	15	20	45	35	62	54	6,7	8,3	22	
	Rumination	20	20	26	64	39	58	14	21	42	25	20	29	15	15	11	10	20	33	27	
	Drinking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0,6	
	Cationic balance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0,2	
	Milk feeding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Exploration	Focusing senses	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Physical exploration of environment	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Kinesis	Natural gaits	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Perambulation	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Travel	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Natural postures	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Change of posture	1	6	16	4,3	13	25	8,6	20	10	23	23	17	16	12	1,1	10	17	20	13	
	Stretching	0	0	0	0	0	0	0	0	0	0	0	0	1,3	0	0	0	0	1,7	0,2	
Body care	Scratching	2	2	4	2,9	4,3	9,2	2,9	2,7	1,7	7,5	4,6	11	13	9,2	2,2	6	6,7	3,3	5,3	
	Grooming	1	0	2	0	0	3,1	2,9	2,7	3,3	13	4,6	5,7	12	4,6	1,1	6	10	8,3	4,4	
	Shaking	1	0	0	0	0	3,1	0	1,3	3,3	2,5	0	0	2,7	9,2	3,3	2	0	1,7	1,7	
	Thermoregulation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Evacuation	1	2	2	0	0	1,5	0	0	0	2,5	0	2,9	0	3,1	2,2	8	3,3	8,3	2,0	
	Comfort-seeking contact	0	2	0	1,4	1,4	6,2	1,4	1,3	1,7	2,5	9,2	2,9	1,3	3,1	0	4	13	3,3	3,1	
Rest and sleep	Standing rest	51	30	34	4,3	34	9,2	19	17	6,7	43	32	0	9,3	18	37	14	27	15	22	
	Lying rest	0	30	38	74	10	72	21	67	67	38	29	74	43	35	4,4	44	43	58	42	
	Sleep	0	4	4	2,9	0	1,5	0	1,3	6,7	2,5	0	0	0	0	10	10	3,3	2,6		
Stereotypical behaviours	Wool pulling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Mouthing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Pacing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

NR = Not rated

N.B. The films from farms 1 and 2 could not be recovered and the film from farm 11 was too dark to interpret.

For the vocalisations, the farms rated – are the quietest ones with almost no vocalisations. In those rated +, vocalisations can be heard for less than half the observation time. In those rated ++, vocalisations can be heard for more than half the observation time. Finally, in farms rated +++, vocalisations were heard almost constantly. The rate of vocalisations varied greatly between farms, but 5 of them were moderately (rated ++) or very noisy (rated +++).

□ Sensorial reactivity

In this category of behaviours, careful orientation, vocalisation and response to invasion of individual space were not rated as explained in the Material and Methods. The locomotion reflexes in response to surprise was observed in only three farms (3, 14 and 17) and concerned 6, 20 and 100 animals per 100 animals respectively, suggesting a high level of allelomimetism.

□ Social behaviours

We were not able to observe the social organisation and followership behaviours. Social exchanges were rather low (0.4 occurrences per 100 animals in average) and present in only five farms (3, 4, 7, 8, 16). Aggression, mostly represented by butting and kicking, was the more frequently observed social behaviour, present in 15 of the 18 farms and with an average frequency of 3.9 occurrences per 100 animals. Despite a rather low level of aggressive contacts in the majority of farms, the farm 4 presented exceptional high level of expression (20 aggressions per 100 animals). We were not able to observe any evident relation between the frequency of aggressions and submissions. Indeed, the expression of submission behaviours was lower (0.8 occurrences per 100 animals in average) than the aggressive behaviours (3.9 occurrences per 100 animals) and could be expressed after each aggressive behaviour (farms 15 and 21) but also not expressed at all (12 farms out of 18), independently of the level of aggressive behaviours. These observations showed that the aggression was not always concluded with a submissive behaviour.

Maternal bond is another behaviour of this category. These behavioural observations were performed in lactating dairy sheep (in production). It explains the low level of maternal bond observed in this study (0.4 occurrences per 100 animals in average). Despite that, a small number of lambs were still with their mothers in the farms 3 and 14 and in these cases, the maternal bond could be observed.

Group formation was not rated because it was too rare (observed only once in farms 3, 14 and 17) and confusing with locomotor reflexes in response to surprise. Moreover, this is a global behaviour where one occurrence corresponds to many animals, which does not correspond to the notation used for other behaviours.

□ Ingestion

There were animals eating and ruminating in all the farms. Ruminating was the predominant activity with an average of 27 % of the ewes eating at the moment of observation. In only five farms (farm 9, 16, 17, 18 and 19) less than 20 % of the animals were ruminating. The eating behaviour was also highly expressed, in average, by 22 % of the animals of the farms. In 6 farms (n=18) less than 10 % of the ewes eating at the moment of observation.

Taken together these two activities concern 35 % or more of the animals in the majority of the farms suggesting that, at this moment of observation, the animals are highly invested in ingestion behaviours. In only 3 farms (11, 13 and 20) these behaviours concerned less than 35 % of the animals.

The average frequency of animals drinking and seeking for cationic balance was, in average, very low (0,6 and 0,2 % respectively). In the only farm these two behaviours were observed (farm 19) the frequency was of 10 and 4 %, respectively. Some animals use the salt stone and then the drinking trough.

These results suggest a certain level of synchronisation to express these ingestion behaviours.

□ Exploration

Focusing senses and physical exploration of the environment were observed in all farms (Table 4) but were not rated in the frequency study because they were observable at all times and they occurred too many times to be counted.

□ Kinesis

Perambulation, travel and natural postures and natural gaits were present in all the farms of this study (Table 3) but were not rated in the study of the frequency of occurrences because they were observable at all times and they occurred too many times to be counted.

Change of posture was observed in all the farms and represented in average 13 events per 100 animals, showing that these animals are constantly changing of posture. Stretching was the less observed behaviour of the family of kinetic behaviours (expressed in low levels in only 2 farms). It was always observed after a period of sleep or lying down.

□ Body care

These behaviours were observed in low frequencies but in the majority of the farms. Scratching (5.3 occurrences per 100 animals), grooming (4.4 occurrences per 100 animals) and comfort seek (3.1 occurrences per 100 animals) were the more frequently observed. Despite being fundamental, evacuation was observed in only 11 out of 18 farms. The frequency of observation was rather low (2 occurrences per 100 animals in average). In two farms, 19 and 21, the frequency of observations was rather high compared to the other farms. Despite the low frequency of observations of shaking (1.7 occurrences per 100 animals in average), this behaviour was observed in more than 50 % of the farms, meaning that this behaviour is rather present in farms.

□ Rest and sleep

Lying rest (42 % in average) and standing rest (22 % in average) were observed in 17 out of 18 farms at the moment of observation. These behaviours were predominant in the flocks together with eating and ruminating. In addition, farms with high number of animals eating presented low number of animals lying. Sleep was only objectively identifiable in 11 farms, and with a low frequency of observation (2.6 events per 100 animals). However, it is difficult to differentiate well sleeping and rest and this observation can be biased.

□ Stereotypical behaviours

The three stereotypical behaviours searched (wool pooling, mouthing and pacing) were not observed.

After the study of the adjusted frequency of behaviours, it was possible to calculate the 95 % confidence interval (Table 5). The interest was to have a better idea of the expected frequencies in a commercial farm not presenting stereotypies, adjusted in number of occurrences per 100 animals.

Table 5: The 95 % confidence interval for the number of occurrences per 100 animals of each sheep ethogram behaviour in dairy farms, before or after milking.

Categories of behaviours	Behaviours	95%CI
Sensorial reactivity	Diurnal and seasonal patterns	[0 ; 0]
	Careful orientation	NR
	Vocalisation	NR
	Locomotor reflexes in response to surprise	[0 ; 18,2]
	Response to invasion of individual space	NR
Social behaviours	Aggression	[1,74 ; 5,96]
	Submission	[0,28 ; 1,35]
	Social organisation	[0 ; 0]
	Followership	[0 ; 0]
	Maternal bond	[0 ; 1,02]
	Social exchanges	[0,08 ; 0,73]
	Group formation	NR
Ingestion	Eating	[13 ; 30,3]
	Rumination	[19,6 ; 34]
	Drinking	[0 ; 1,67]
	Cationic balance	[0 ; 0,67]
	Milk feeding	[0 ; 0]
Exploration	Focusing senses	NR
	Physical exploration of environment	NR
Kinesis	Natural gaits	NR
	Perambulation	NR
	Travel	NR
	Natural postures	NR
	Change of posture	[9,99 ; 16,9]
	Stretching	[0 ; 0,65]
Body care	Scratching	[3,67 ; 6,99]
	Grooming	[2,56 ; 6,31]
	Shaking	[0,59 ; 2,76]
	Thermoregulation	[0 ; 0]
	Evacuation	[0,85 ; 3,24]
	Comfort-seeking contact	[1,45 ; 4,68]
Rest and sleep	Standing rest	[15,5 ; 31,8]
	Lying rest	[30,4 ; 52,7]
	Sleep	[1 ; 4,13]
Stereotypical behaviours	Wool pulling	[0 ; 0]
	Mouthing	[0 ; 0]
	Pacing	[0 ; 0]

95%CI = 95% confidence interval

NR = Not rated

From Table 5, we can observe that this short period of observation (15 minutes) is not adapted to clearly identify behaviours such as: diurnal and seasonal patterns, social organisation and followership (except in case of response to a surprise). Also, in normal farms with adapted building, thermoregulation behaviours and stereotypical behaviours should not be observed. In addition, in a dairy sheep farm, when observing animals during the lactating period, it is rather normal to not observe milk feeding of the descendant.

Concerning careful orientation, vocalisation, physical exploration of the environment, natural gaits, perambulation, travel, natural postures: despite their presence in most farms during the 15 minutes of observation, it was very difficult to rate their exact frequency as they occur very frequently. Concerning response to invasion of individual space and group formation, they were quite rare but confusing with other behaviours and therefore difficult to evaluate. These behaviours should be analysed only in a binary study but not their frequency of occurrence.

Within the behaviours that can be rated, the triad eating – ruminating – rest should be predominant.

4. Discussion

A. Methodology

The goals of these observations were partially achieved. Firstly, it was rather simple to carry out the binary observation. Indeed, once a behaviour had been observed in a farm, we no longer needed to focus on it and we could focus on the expression of other behaviours.

However, the calculation of occurrences of each behaviour was much more laborious because of the need of concentration on some dozens of animals at each time to catch all the behaviours, even the rare ones (submission, maternal bond, social exchanges, stretching and evacuation). On the other hand, very frequent behaviours like changes of posture were also difficult to count because of the high frequency of observation. We will discuss the results of each category in detail.

The methodology seems suitable for frequent and easily identifiable behaviours like scratching or sleeping behaviours. However, certain variables, such as the time at which the animals were fed before the recording should be considered to improve analysis. For example, it influences the number of ewes eating or resting.

In addition, some behaviours, such as vocalisations have found to be unquantifiable. In the case of vocalisation, for example, a sound level meter could be used in order to better assess this aspect, like Bishop *et al.* (2017) did in their study. Indeed, in our study the assessment was very subjective and was carried out by comparing one farm with another. These results are therefore not repeatable by different observers.

Furthermore, observation using cameras means that the animals are disturbed to a lesser extent and the same footage can be viewed several times. However, it does not necessarily mean that the observer can see all the animals in the same field of observation. Similarly, in many of the movies the drinking trough or the salt stone were not visible, which can include some bias in these results.

Nevertheless, this methodology is easy for a breeder or his advisor and is not too time demanding. Indeed, it would take approximatively 45 minutes altogether: 15 minutes for the naïve observation, 15 minutes for the binary observation and 15 minutes for the frequency observation in which it can be useful to stop the video now and then. It allows us to observe a wide range of behaviours and to get an overall idea of animal behaviour on the farm. The movie can be stoped several times to better count or analyse some behaviours.

B. Discussion of the results

a. Observable behaviours

All the behaviours observed in our films were expected to be seen in a dairy sheep farm.

- *Sensorial reactivity*

Sensorial reactivity was biased by the presence of the camera and the presence of routine activity in 4 farms (farm number 3, 7, 13 and 18). Indeed, despite the fact that we had considered a 25 minutes delay between the beginning of the film and the beginning of the observations, the ewes were still clearly looking at the camera quite regularly. In the other hand, it also showed that the sheep conserved this natural behaviour of using its senses to monitor the environment. Therefore, the slightest stimulus leads sheep to check the environment.

In the farms where routine activities were running during the movie recording (mainly people walking and talking next to the pen), we observed higher frequency of vocalisations. In quiet, undisturbed environments, there were only a few or even no vocalisations over the whole fifteen minutes. Indeed, in the farms 5, 14, 15 and 21 (4/18, 22 % of the farms) any vocalisation was heard. The presence of lambs in the farms 3 and 14 could be at the origin of a moderate level of vocalisations.

Locomotor reflexes in response to surprise were rare but also very dependent on the environment. The disturbing elements identified in the movie were human activity, opening of fences, conversation or even an airplane flying over the building.

Knowing that the ewes conserved these behaviours, it is important to keep the environment of the ewes as calm as possible. Sart *et al.* (2004); Murray *et al.* (2009); Dodd *et al.* (2012) have demonstrated that a calm, unstressed ewe takes better care of her lambs and produces milk with more protein than a nervous one.

- *Social behaviours*

Aggressive and/or submissive behaviours, social exchanges and maternal bonds were observed demonstrating that sheep can show social behaviours in buildings.

The aggressive behaviours were observed in 15 farms (n=18, 83 %) although in the majority of the farms, the frequency of observation was low (<4 events per 100 animals in 15 minutes of observation). The calculated confidence interval suggests that in 95 % of the farms, we can see less than 6 aggressive behaviours per 100 animals. Thus, 6 or more aggressive behaviours per 100 animals observed over 15 minutes on a farm could be considered abnormal. In only two farms we observed higher occurrences (7 and 20 events per 100 animals). We were not able to identify the source of aggressiveness in these two farms, but, according to Stephens (1974), aggressive behaviours between animals within a group are frequent while the group is developing its hierarchy. After that, the group becomes stable and there is less aggressive behaviour. According to Nowak *et al.* (2008), aggressive behaviours can be related to competition for resources or space where the animals are often forced to compete over inadequate sources of food, such as small troughs. Moreover, Squires (1975) stated that the restrictions of movement coupled with relatively uniform physical environments often result in increased aggression. It is important to monitor the level of

aggressiveness in farms because unnatural competition can lead to potential problems such as weight loss in dominated ewes, which itself leads to fertility problems and reduced lactation (Adams, 2001).

Despite the observation of maternal bounds in this sample of farms, it is important to emphasise that this behaviour was observed only in 2 farms where one or two lambs were still present with the females. Despite the fact that this is a normal behaviour, it was an exception in our study because the farms observed were dairy farms where the lambs are removed before the beginning of the milking routine.

Group formation was also not frequently observed in our videos (four farms). Indeed, in a building they are less exposed to danger than outside. According to our observations, the ewes formed groups when a sudden and unusual noise (surprise) was heard by the ewes.

- *Ingestion*

Eating was one of the most expressed behaviours throughout the videos and was present in all the farms. Indeed, it was rare to observe a video where just a few sheep were eating. It confirms that feeding is one of the most important activities of sheep and that it is necessary for them to have food at will and in sufficient quantity to avoid aggression (Adams, 2001).

Rumination is a behaviour associated with eating (Bae *et al.*, 1979). It was therefore normal to observe rumination in all farms and in a high frequency (in average, 27 % of the ewes were ruminating in all the farms).

The physiological chronological sequence of these two behaviours is marked by eating followed by ruminating (Chai *et al.*, 1988). The fact that we observed some animals eating and some animals ruminating in the same farm does not challenge the concept of synchronously feeding behaviour, but rather shows that some animals can stop eating before others and engage rumination.

On the other hand, although drinking is an essential activity for the survival of ewes, we could only observe this behaviour in one farm. It could be explained by the fact that, as described by Fraser (1983) the drinking behaviour is infrequent and of short duration. In addition, the water troughs were generally not visible in the videos, which could have introduced a bias in our observation.

- *Exploration*

Sheep are prey animals and are therefore very aware of their environment. They rely on their senses to protect themselves. It was difficult to count the exact number of these behaviours because they were expressed by several animals at the same time, almost continuously. We also observed a high number of sensorial explorations of their environment.

Wang *et al.* (2023) showed that when exposed to predator odour, sheep increased their exploratory, moving, and watching behaviours. In their study, sheep spent up to 6 times more time exploring when exposed to predator scent (leopard) than another sheep scent. Moreover, sheep spent 1,6 times more time moving and 2,5 times more time watching when exposed to the leopard scent compared to the sheep scent. This shows that prey animals modify their behaviour and physiology in the presence of predators.

- *Kinesis*

The animals of this study did not use another gait than walking or trotting. It could be due to the restricted environment with no special stimulation and/or due to the physiological status. Indeed, all animals observed were adult lactating females, while young animals are more prone to play (Dwyer, 2008).

Moreover, travels were observed even without a distinguishable target on the arrival point. Perambulation and travel were sometimes confusing because it can be difficult to distinguish a sheep travelling with a purpose and one just perambulating to go from point A to B. The travels were rather short. This result suggests that the small space available in a building could limit the distance travelled in once. However, it is important to emphasise the importance to let the ewes free of movement in the building to allow them to perform travels throughout the day. It could be interesting to enhance their environment with enrichment elements to give a purpose for the travels performed during the day.

- *Body care*

Scratching, grooming and shaking are normal behaviours expressed by animals to groom themselves or to get rid of discomfort. Nevertheless, when the frequency of expression of these behaviours increase, it can highlight health problems. For example, sheep can increase the scratching behaviour when they have external parasites such as lice (James *et al.*, 2001). The results of our study suggest that it should be considered as abnormal when more than 7 animals are scratching, 7 are grooming or 3 are shaking per 100 animals.

Evacuation is constitutive of the physiology of a sheep. Although, it is short-lived and only occurs a few times a day, as for the drinking behaviour, this result suggests that it could be normal to not observe evacuation in a 15 minutes observation at the level of the flock (6 farms / 18 in our study). However, a very high frequency of this behaviour could be considered pathological (signs of diarrhoea or a urinary tract infection for example). In the same way, based on this sample of farms, we could consider that there is a problem if we see more than 4 evacuation behaviours for 100 animals in 15 minutes, especially if it concerns the same animal.

- *Rest and sleep*

In all the videos, we could observe ewes resting but the extent was variable among farms. On farms where the environment was calm, most ewes could be seen resting standing or lying down, whereas in noisy environments only a few ewes could be seen resting and they were standing. This phenomenon was studied by Gautrais *et al.* (2007) and was attributed to allelomimetism. When a sheep is disturbed, it will stand up and be alert. The others will then copy this behaviour and will not rest.

Fraser (1983) described several different types of sleep: stationary resting, drowsing, slow wave sleep and paradoxical sleep. However, in practice, in our study, it was quite difficult to differentiate the types of sleep because they can be very similar and impossible to differentiate in a movie, especially if the animal is in the background. For this reason, we have simplified the different types of sleep into resting standing up, resting lying down and sleeping. When resting lying down,

the animal's head was in an upright position while when sleeping, its head was resting on its side, on a fence, on the ground or on a fellow animal.

b. Non- observable behaviours

Fraser (1983) states that there is an impoverishment of behaviours in farms. We were able to determine whether the behaviours listed in the sheep ethogram were missing in our videos or not. However, we must question if a non-observable behaviour was really absent or just not observed because of the duration of observation.

- *Unobservable behaviour in intensive dairy farming*

According to Fraser (1983) up to 30 % of the natural behaviours are not observable in intensive farming.

Our study showed the importance of the methodology of observation on the observability of the behaviours. For example, with a short observation of 15 minutes, it is impossible to observe diurnal and seasonal pattern behaviours, social organisation and followership because these behaviours are not one behaviour in itself but a set of dynamic elements that can be better observed in everyday life.

In addition, the absence of some behaviours does not necessarily indicate a negative life condition. For example, the fact that no thermoregulatory effort was not observed in our study suggests that the buildings provided suitable thermal conditions. Indeed, sheep are homeothermic animals and must make efforts to maintain the internal temperature if the conditions are not suitable (Bøe, 1990).

Finally, no stereotypical behaviours were observed in this study. This is consistent with the literature stating that stereotypic behaviour is infrequent in sheep, although it has been reported in individually housed sheep (Done-Currie *et al.*, 1984; Richmond *et al.*, 2017). According to the literature, it can become common if the environment is extremely unsuitable to the animals. Lauber *et al.* (2012) observed a high number of stereotypical behaviours on individually housed sheep suggesting that the social environment is fundamental for the behaviour of sheep. Squires (1975) stated that the restrictions of movement indoors coupled with relatively uniform physical environments often result in stereotyped patterns of movement. Nevertheless, due to the short-term observation we cannot affirm that the stereotypical behaviours were completely absent in these farms. However, we can affirm that, if present, they were in a frequency low enough to not be observed during the 15-minutes observations. The fact that in all the farms the ewes were raised in groups, had food available and were able to rest, move and express behaviours of the eight behavioural categories, could explain the absence of observation of stereotypes in the present study.

- *Behaviours normally observable in intensive dairy farming*

Some behaviours are observable in intensive dairy farming but were not observed in the present study. The first of them is the milk feeding of lambs. Indeed, the period chosen for the observations corresponded to the lactation period (where the lambs are not present anymore with the ewes). Despite the presence of two lambs in Farm 3 and one lamb in Farm 14, this behaviour was not

observed. It is not surprising because the number of lamb present was low and the interval between milk feeding in lambs can last 1 to 3 hours, which can overlap the duration of the observed recording (10 minutes). Allogrooming is also theoretically an observable behaviour but it was not seen in the videos of this study.

C. Creation of an animal behaviour assessment protocol

In the previous parts, we identified the behaviours observable in 15 minutes in dairy sheep farms and determined how often they occur in order to supply farmers and their advisors a list of observable behaviours on the farm. If these behaviours are observed in normal frequencies, then the farmer can assume that the behavioural part of animal welfare is being respected. The aim in this part is to propose a chart of behavioural observations for farmers and advisors (including veterinarians).

We will present a summary of how to make the film correctly and the observation method. This will then enable the observer to fill in a table, which will be described later.

a. Making the film

The farm observed must be a dairy sheep farm. The animals observed must be of adult age and all female. The pen observed should contain at least thirty animals in order to observe as much different behaviours as possible. The film is made before or after milking and some luminosity must be present to obtain good image quality.

Then, a camera with good image quality is placed outside the enclosure on a tripod. It is important to check on the camera that all the animals can be seen in the frame. When everything is set up, the video can be started and the observer must move away from the pen to avoid disturbing the animals (out of the building). The film is recorded for 40 minutes. Then, the film is cut after 25 minutes to give the ewes time to get used to the camera. If the observer does not have a software to cut the videos, the observations must start at 25 minutes of the movie.

b. Observation of sheep behaviour in the film

The standards were created from a detailed video observation, ideally this method (video observation) should be employed by the farmer or his advisor. If the observer observes the animals directly (without a movie), there is a high risk of underestimation of the behaviours because of the lack of details which are observable with a movie (reward and stop functions).

The first step is to carry out a naive observation. This means watching the film attentively for the first time without taking any notes. This allows the observer to become familiar with the behaviours expressed by the animals. The observer then reads the chart (Figure 1A) to be filled in in order to memorise which behaviours to observe and count.

For the second step, the observer advances the video to 8 minutes (or 33 minutes if it was not cut as previously explained) in order to collect the information about the predominant behaviours. First, the observer counts how many animals are eating or ruminating (the observation must be done over one minute to better spot the animals that are ruminating by observing the regurgitation reflex). Then, they count how many animals are resting or sleeping according to the different categories listed in the chart (Figure 1A).

For the last step, the observer watches the entire film and notes the behaviours listed in the second part of the observation table (Figure 1A) each time they appear. At the end of the film, the observer must assess whether the farm is noisy or calm, i.e. whether vocalisations are audible most of the observation time or if it is rather quiet.

Figure 1A: Behavioural observation chart and expected standards using video recording.

Observations 8 minutes into the film : Number of animals in the pen =

Categories of behaviours	Behaviours	Number of animals	Percentage	Standards
Ingestion	Eating			[13% ; 30%]
	Ruminating			[20% ; 34%]
Rest and sleep	Standing rest			[15% ; 32%]
	Lying rest			[30% ; 53%]
	Sleep			[1% ; 4%]

Observations over a 15-minute period :

Categories of behaviours	Behaviours	Number of occurrences	Number of occurrences per 100 animals	Standards
Sensorial reactivity	Vocalisation	Calm / Noisy		Calm
	Locomotor reflexes in response to surprise			[0 ; 18,2]
Social behaviours	Aggression			[1,74 ; 5,96]
	Submission			[0,28 ; 1,35]
	Social exchanges			[0,08 ; 0,73]
Kinesis	Change of posture			[9,99 ; 16,9]
Body care	Scratching			[3,67 ; 6,99]
	Grooming			[2,56 ; 6,31]
	Shaking			[0,59 ; 2,76]
	Evacuation			[0,85 ; 3,24]
	Comfort-seeking contact			[1,45 ; 4,68]
Stereotypical behaviours	Wool pulling			[0 ; 0]
	Mouthing			[0 ; 0]
	Pacing			[0 ; 0]

c. Completing the observation table

Initially the observer fills in the box corresponding to the number of animals present in the pen i.e. the number of animals visible in the camera field. Then, he/she fills in the number of animals and the number of occurrences columns according to the observations.

After that, the percentage or number of occurrences per 100 animals' columns are filled in using the following formula:

$$X_i = \frac{x_i}{n} \times 100$$

With i the corresponding behaviour, x the number of animals or the number of occurrences in the observation and n the number of animals in the farm.

Finally, the results obtained should be compared with the reference set out in the chart (Figure 1A). These references are based on results obtained after observing 18 farms using the same method. They correspond to the 95 % confidence intervals of the results.

This chart allows observers (farmers and their advisors) to know which behaviours should or should not be expressed and at which frequency thanks to the reference column. By comparing the results with the standards, the observer can identify certain problems in the farm. To better illustrate the application of the method, an example of one of the farms observed during our study is described in the next section.

d. Example

The observations were made on farm 21 and the observation chart was filled in. The results obtained are shown in Figure 1B.

Figure 1B: Observation chart filled in with the results obtain in Farm 21.

Observations 8 minutes into the film :			Number of animals in the pen = <input type="text" value="60"/>	
Categories of behaviours	Behaviours	Number of animals	Percentage	Standards
Ingestion	Eating	5	8%	[13% ; 30%]
	Ruminating	20	33%	[20% ; 34%]
Rest and sleep	Standing rest	9	15%	[15% ; 32%]
	Lying rest	35	58%	[30% ; 53%]
	Sleep	2	3%	[1% ; 4%]

Observations over a 15-minute period :			Number of occurrences per 100 animals	
Categories of behaviours	Behaviours	Number of occurrences	Number of occurrences per 100 animals	Standards
Sensorial reactivity	Vocalisation	Calm	Calm	Calm
	Locomotor reflexes in response to surprise	0	0,00	[0 ; 18,2]
Social behaviours	Aggression	2	3,33	[1,74 ; 5,96]
	Submission	2	3,33	[0,28 ; 1,35]
	Social exchanges	0	0,00	[0,08 ; 0,73]
Kinesis	Change of posture	12	20,00	[9,99 ; 16,9]
Body care	Scratching	2	3,33	[3,67 ; 6,99]
	Grooming	5	8,33	[2,56 ; 6,31]
	Shaking	1	1,67	[0,59 ; 2,76]
	Evacuation	5	8,33	[0,85 ; 3,24]
	Comfort-seeking contact	2	3,33	[1,45 ; 4,68]
Stereotypical behaviours	Wool pulling	0	0,00	[0 ; 0]
	Mouthing	0	0,00	[0 ; 0]
	Pacing	0	0,00	[0 ; 0]

Acceptable results are shown in green and those requiring further attention are shown in red. The results must be related to each other and to the context at the moment of the movie recording to be interpreted correctly. In this case, in the beginning of the video, a several animals were eating and a few were resting. Then, the animals finished eating and started resting by lying down and ruminating. This explains the low number of animals eating, the high number of animals lying and the large number of changes of posture. The number of aggressions is low, suggesting a fairly well-established hierarchy that avoids aggression and an efficient system of hierarchy building (1 aggression corresponding to 1 submission). Body care behaviours are fairly good with a too high frequency of evacuation and grooming accompanied by a low level of scratching. The high frequency of evacuations could indicate a digestive or urinary problem or a high level of stress. However, we observed in the film that the animals were calm throughout the film and the evacuations were observed in animals that had just finished eating and were evacuating afterwards. Globally, these observations are consistent with the context of the observation (mid-end of the meal) and rather normal despite a high number of evacuations. It would be wise to monitor the herd and, if necessary, carry out urine and/or faecal or food analyses to be sure that the high number of evacuations is not linked to a disease or feeding imbalance.

5. Conclusion

Fraser (1983) stated that there is an impoverishment of behaviours in farms and up to 30 % behavioural deprivation is expected in intensive farms. However, our observations over 15 minutes do not allow us to confirm this. We observed all the behaviours expected in a dairy farm for such a short period of observation. On the other hand, some of the behaviours in the ethogram were not observed, either because of the observation method (not adapted to the observation of diurnal and seasonal patterns, social organisation, followership) or because of the farming system (milk feeding, thermoregulation). Yet, in our observations, 5 out of 34 behaviours described in the ethogram were not visible in our videos, i.e. 15 % of them. However, in order to be sure of these assertions, sheep would have to be observed over longer periods and in different seasons.

Despite these limits of our study, the results confirm the predominance of ingestion (mainly eating and ruminating) and resting behaviours in sheep, even in 15 minutes observations. The ewes also showed a high frequency of exploratory behaviours even in a simple environment as a building, showing that this is a highly conserved behaviour. Indeed, they performed several travels in the building despite an identifiable objective suggesting a major need for them to walk. Social behaviours are mainly represented by aggressive events despite the low frequency. Competition for resources could be at the origin of this pattern. It should be normal to observe scratching in all the farms but in a low frequency. It should not be considered normal if behaviours of thermoregulation would be observed in a building during a 15-minute observation. Despite the vital role of evacuation and drinking, it can be normal to not observe these behaviours. Moreover, these results strongly suggest the influence of the environment (presence of activity, noise or lambs) on the frequency of sensorial reactivity with an augmentation of observation in presence of environmental disturbances. The fact that in all the farms the ewes were raised in groups, had food available and were able to rest and move could explain these results.

In practice, the behaviours that must be observed and counted in all farms during a 15 minutes observation are the following:

- Sensorial reactivity: locomotor reflexes in response to surprise,
- Ingestion: eating and ruminating,
- Social behaviours: aggression, submission and social exchanges,
- Kinesis: change of postures,
- Body care: scratching, grooming, shaking, evacuation and comfort-seeking contact
- Rest and sleep: standing rest, lying rest and sleep.
- Stereotypical behaviours must be included but such events should not be observed.

Vocalisations should be included but it is not necessary to count them, estimating their frequency is enough. The behaviours of stretching, maternal bond, drinking and cationic balance are rarely observed in lactating dairy sheep and should not be included in a behavioural observation of 15 minutes

Conclusion générale

Ce travail nous a permis d'étudier le comportement des moutons en élevage ovin laitier en différentes étapes. Dans un premier temps, un éthogramme du mouton a été réalisé à l'aide de la littérature et de nos observations réalisées en élevage ovin laitier dans la région de Roquefort. Dans cet éthogramme, 38 comportements différents ont été identifiés et divisés en 8 catégories fonctionnelles. Ces comportements ont été décrits précisément et illustrés à l'aide de vidéos réalisées en élevage.

Dans un second temps, nous avons de nouveau utilisé les vidéos réalisées en élevage ovin laitier pour identifier les comportements visibles dans chaque élevage et leur fréquence. Pour cela, nous avons utilisé l'éthogramme réalisé précédemment. Ces observations ne nous ont pas permis de mettre en évidence un déficit comportemental en élevage par rapport au mouflon (état sauvage). Cependant, nous avons pu réaliser un tableau d'évaluation de la partie comportementale du bien-être animal en élevage ovin laitier grâce aux intervalles de confiance à 95 % des fréquences d'observation des différents comportements dans nos films.

A la suite de ce travail, il pourrait être intéressant de tester ce tableau d'observation en élevage ovin laitier afin de voir s'il permet de mettre en lumière des problèmes dans un élevage qui peuvent éventuellement être résolus (comme par exemple une forte agressivité entre les moutons par manque de cornadis). De plus, en l'appliquant à de nombreux élevages, cela permettrait d'obtenir des résultats plus fiables car nos observations ne reposent que sur 18 élevages différents. Il pourrait également être intéressant de réaliser des observations en élevage allaitant afin d'avoir des données sur des comportements tels que le lien maternel ou l'allaitement.

Liste des références bibliographiques

- ADAMS, S. (2001) Analysis of Allelometric Behaviors and Social Organization in Domestic Sheep. Master of science thesis, Kingston, RI, University of Rhode Island. [<https://doi.org/10.23860/thesis-adams-shole-2001>]
- AL-RAMAMNEH, D., RIEK, A., GERKEN, M. (2012) Effect of water restriction on drinking behaviour and water intake in German black-head mutton sheep and Boer goats. *Animal* vol. 6, n° 1, p. 173-178. [<https://doi.org/10.1017/S1751731111001431>]
- AL-RAMAMNEH, D. (2023) Thermoregulation in Sheep and Goats: A Review. *Asian Journal of Biology* vol. 17, n° 1, p. 34-42. [<https://doi.org/10.9734/ajob/2023/v17i1315>]
- AMBROSI, C.P., RUBIO, N., GIMÉNEZ, G., *et al.* (2018) Modeling of behavioral responses for successful selection of easy-to-train rams for semen collection with an artificial vagina. *Animal Reproduction Science* vol. 193, p. 90-97. [<https://doi.org/10.1016/j.anireprosci.2018.04.003>]
- AMERICAN SHEEP INDUSTRY ASSOCIATION, INC. (2015) Sheep Production Handbook, 4^{ème} éd. Englewood, American Sheep Industrie.
- ARNOLD, G.W. (1984) Comparison of the time budgets and circadian patterns of maintenance activities in sheep, cattle and horses grouped together. *Applied Animal Behaviour Science* vol. 13, n° 1, p. 19-30. [[https://doi.org/10.1016/0168-1591\(84\)90048-0](https://doi.org/10.1016/0168-1591(84)90048-0)]
- ARNOLD, G.W., MALLER, R.A. (1974) Some aspects of competition between sheep for supplementary feed. *Animal Science* vol. 19, n° 3, p. 309-319. [<https://doi.org/10.1017/S0003356100022881>]
- BAE, D.H., WELCH, J.G., SMITH, A.M. (1979) Forage Intake and Rumination by Sheep. *Journal of Animal Science* vol. 49, n° 5, p. 1292-1299. [<https://doi.org/10.2527/jas1979.4951292x>]
- BATESON, M., MARTIN, P. (2021) Measuring Behaviour: An Introductory Guide, 4^{ème} éd., Cambridge University Press.
- BELLEGARDE, L.G.A., ERHARD, H.W., WEISS, A., *et al.* (2017) Valence of Facial Cues Influences Sheep Learning in a Visual Discrimination Task. *Frontiers in Veterinary Science* vol. 4, p. 188. [<https://doi.org/10.3389/fvets.2017.00188>]
- BERMAN, G.J. (2018) Measuring behavior across scales. *BMC Biology* vol. 16, n° 1, p. 23. [<https://doi.org/10.1186/s12915-018-0494-7>]
- BISHOP, J.C., FALZON, G., TROTTER, M., *et al.* (2017) Sound analysis and detection, and the potential for precision livestock farming - a sheep vocalization case study. In *Asian-Australasian Conference on Precision Pastures and Livestock Farming, Hamilton, Nouvelle-Zélande, 16-18 octobre*. Monticello, International Society of Precision Agriculture (ISPA), p. 1-7. [<https://doi.org/10.5281/ZENODO.897209>]
- BLEICH, V.C., BOWYER, R.T., WEHAUSEN, J.D. (1997) Sexual Segregation in Mountain Sheep: Resources or Predation? *Wildlife Monographs* n° 134, p. 3-50.

- BØE, K. (1990) Thermoregulatory behaviour of sheep housed in insulated and uninsulated buildings. *Applied Animal Behaviour Science* vol. 27, n° 3, p. 243-252. [[https://doi.org/10.1016/0168-1591\(90\)90059-M](https://doi.org/10.1016/0168-1591(90)90059-M)]
- BOMSEL, M.-C. (1999) Mouton. In *Encyclopædia Universalis*, 4^{ème} éd., Paris, Albin Michel.
- BOULARAND, M., DASSÉ, F., HARDY, A. (2013) Manipulation des ovins. In *MSA*. [<https://ssa.msa.fr/wp-content/uploads/2018/12/Manipulation-des-ovins.pdf>] (consulté le 23/10/2022).
- BRAMBELL, F.W.R. (1965) Report of the Technical Committee to Enquire into the Welfare of Animals kept under Intensive Livestock Husbandry Systems. London, Her Majesty's Stationery Office.
- BRAUDE, S., CREWS, J., STEPHENSON, C., *et al.* (2002) The Ethogram and Animal Behavior Research. Polycopié. St. Louis, Washington University, science curriculum.
- CHAI, K., MILLIGAN, L.P., MATHISON, G.W. (1988) Effect of muzzling on rumination in sheep. *Canadian Journal of Animal Science* vol. 68, n° 2, p. 387-397. [<https://doi.org/10.4141/cjas88-044>]
- CHAMPION, R.A., ORR, R.J., PENNING, P.D., *et al.* (2004) The effect of the spatial scale of heterogeneity of two herbage species on the grazing behaviour of lactating sheep. *Applied Animal Behaviour Science* vol. 88, n° 1, p. 61-76. [<https://doi.org/10.1016/j.applanim.2004.02.011>]
- DIAZ-LUNDAHL, S., HELLESTVEIT, S., STUBSJØEN, S.M., *et al.* (2019) Intra- and Inter-Observer Reliability of Qualitative Behaviour Assessments of Housed Sheep in Norway. *Animals* vol. 9, n° 8, p. 569. [<https://doi.org/10.3390/ani9080569>]
- DIGBY, S.N., CHADWICK, M.A., BLACHE, D. (2011) Salt intake and reproductive function in sheep. *Animal* vol. 5, n° 8, p. 1207-1216. [<https://doi.org/10.1017/S1751731111000152>]
- DODD, C.L., PITCHFORD, W.S., HOCKING EDWARDS, J.E., *et al.* (2012) Measures of behavioural reactivity and their relationships with production traits in sheep: A review. *Applied Animal Behaviour Science* vol. 140, n° 1, p. 1-15. [<https://doi.org/10.1016/j.applanim.2012.03.018>]
- DONE-CURRIE, J.R., HECKER, J.F., WODZICKA-TOMASZEWSKA, M. (1984) Behaviour of sheep transferred from pasture to an animal house. *Applied Animal Behaviour Science* vol. 12, n° 1, p. 121-130. [[https://doi.org/10.1016/0168-1591\(84\)90102-3](https://doi.org/10.1016/0168-1591(84)90102-3)]
- DWYER, C.M. (2004) How has the risk of predation shaped the behavioural responses of sheep to fear and distress? *Animal Welfare* vol. 13, n° 3, p. 269-281. [<https://doi.org/10.1017/S0962728600028384>]
- DWYER, C.M. (2008) The welfare of the neonatal lamb. *Small Ruminant Research*, Special Issue: Current Issues in Sheep Health and Welfare vol. 76, n° 1, p. 31-41. [<https://doi.org/10.1016/j.smallrumres.2007.12.011>]
- DWYER, C.M. (2009) Welfare of sheep: Providing for welfare in an extensive environment. *Small Ruminant Research*, Special Issue: Keynote Lectures of the 7th International Sheep Veterinary Congress vol. 86, n° 1, p. 14-21. [<https://doi.org/10.1016/j.smallrumres.2009.09.010>]
- DWYER, C.M., RUIZ, R., BELTRAN DE HEREDIA, I., *et al.* (2015) AWIN Welfare Assessment Protocol for Sheep. [https://doi.org/10.13130/AWIN_sheep_2015] (consulté le 23/05/2022).

- DWYER, C.M., LAWRENCE, A.B. (2008) Introduction to Animal Welfare and the Sheep. In Dwyer, Cathy M. (Éd.), *The Welfare of Sheep, Animal Welfare*. Dordrecht, Springer Netherlands, p. 1-40. [https://doi.org/10.1007/978-1-4020-8553-6_1]
- EKESBO, I., GUNNARSSON, S. (2018) Farm Animal Behaviour: Characteristics for Assessment of Health and Welfare, 2^{ème} éd. Wallingford, CABI.
- FÉDÉRATION CANADIENNE DU MOUTON (2013) Code de pratiques pour le soin et la manipulation des moutons. In *National Farm Animal Care Council*. [https://www.nfacc.ca/pdfs/codes/mouton_code_de_pratiques.pdf] (consulté le 07/07/2022).
- FONDATION 30 MILLIONS D'AMIS (2022) Les Français et le bien-être des animaux. In *IFOP*. [<https://www.ifop.com/publication/les-francais-et-le-bien-etre-des-animaux-vague-5-2022/>] (consulté le 30/03/2022).
- FRASER, A.F. (1983) The behaviour of maintenance and the intensive husbandry of cattle, sheep and pigs. *Agriculture, Ecosystems & Environment* vol. 9, n° 1, p. 1-23. [[https://doi.org/10.1016/0167-8809\(83\)90002-6](https://doi.org/10.1016/0167-8809(83)90002-6)]
- FRASER, D., RUSHEN, J. (1987) Aggressive Behavior. *Veterinary Clinics of North America: Food Animal Practice* vol. 3, n° 2, p. 285-305. [[https://doi.org/10.1016/S0749-0720\(15\)31153-1](https://doi.org/10.1016/S0749-0720(15)31153-1)]
- GAUTIER, D. (2015) BIENE : protocole d'évaluation du bien-être des brebis en condition de pâturage hivernal, test en exploitations d'élevage 2^{ème} année. In *IDELE*. [https://idele.fr/?eID=cmis_download&oID=workspace://SpacesStore/17bc0ddf-37b0-4928-bc5b-a96d41f21db2] (consulté le 23/05/2022).
- GAUTRAIS, J., MICHELENA, P., SIBBALD, A., *et al.* (2007) Allelomimetic synchronization in Merino sheep. *Animal Behaviour* vol. 74, n° 5, p. 1443-1454. [<https://doi.org/10.1016/j.anbehav.2007.02.020>]
- GENTY, E. (2011) Comment construire un éthogramme. In *Objectif Sciences International*. [<https://www.osi-panthera.org/Comment-construire-un-ethogramme.html>] (consulté le 05/04/2022).
- GIOVANETTI, V., DECANDIA, M., MOLLE, G., *et al.* (2017) Automatic classification system for grazing, ruminating and resting behaviour of dairy sheep using a tri-axial accelerometer. *Livestock Science* vol. 196, p. 42-48. [<https://doi.org/10.1016/j.livsci.2016.12.011>]
- GOUGOULIS, D.A., KYRIAZAKIS, I., FTHENAKIS, G.C. (2010) Diagnostic significance of behaviour changes of sheep: A selected review. *Small Ruminant Research*, Special Issue: Sheep Diagnostic Medicine vol. 92, n° 1, p. 52-56. [<https://doi.org/10.1016/j.smallrumres.2010.04.018>]
- GRANNEC, M.-L. (2017) Enjeu de la perception locale d'élevages bovins, avicoles et porcins dans trois régions. In *IDELE*. [https://idele.fr/rmt-travail/publications/detail-article?tx_atolidelecontenus_publicationdetail%5Baction%5D=showArticle&tx_atolidelecontenus_publicationdetail%5Bcontroller%5D=Detail&tx_atolidelecontenus_publicationdetail%5Bpublication%5D=11003&cHash=7e08466634cd4aac404467512f24a7cb] (consulté le 01/06/2023).
- HAFEZ, E.S.E., HAFEZ, B. (2000) Reproduction in Farm Animals, 7^{ème} éd. Philadelphia, Lippincott Williams & Wilkins.
- HAGUE, P., WALSER, E.S., WALTERS, E. (1982) Vocal Communication Between Ewes and Their Own and Alien Lambs. *Behaviour* vol. 81, n° 2-4, p. 140-150. [<https://doi.org/10.1163/156853982X00120>]

- HOPEWELL, L., ROSSITER, R., BLOWER, E., *et al.* (2005) Grazing and vigilance by Soay sheep on Lundy island: Influence of group size, terrain and the distribution of vegetation. *Behavioural Processes* vol. 70, n° 2, p. 186-193. [<https://doi.org/10.1016/j.beproc.2005.04.009>]
- JACOBS, G.H., DEEGAN, J.F., NEITZ, J. (1998) Photopigment basis for dichromatic color vision in cows, goats, and sheep. *Visual Neuroscience* vol. 15, n° 3, p. 581-584. [<https://doi.org/10.1017/S0952523898153154>]
- JAMES, P.J., MOON, R.D., KARLSSON, L.J.E. (2001) Optimising the sensitivity of sheep inspection for detecting lice. *In National Conference on Flystrike & Lice IPM Control Strategies, Launceston, 25-27 juin*. Hobart, Tasmanie, Queensland Alliance for Agriculture and Food Innovation, p. 331-340.
- JOLLY, P.-A. (2020) Bien-être animal des brebis laitières dans le rayon Roquefort : Mise en place d'un protocole d'évaluation et constitution d'une base de référence en vue de la mise en place d'une charte. Thèse de médecine vétérinaire, École nationale vétérinaire d'Alfort.
- KEELING, L., JENSEN, P. (2009) Abnormal behaviour, stress and welfare. *The Ethology of Domestic Animals: An Introductory Text*, 2^{ème} éd. Wallingford, CABI, p. 85-101. [[10.1079/9781845935368.0085](https://doi.org/10.1079/9781845935368.0085)]
- KENDRICK, K.M., BALDWIN, B.A. (1987) Cells in temporal cortex of conscious sheep can respond preferentially to the sight of faces. *Science (New York, N.Y.)* vol. 236, n° 4800, p. 448-450. [<https://doi.org/10.1126/science.3563521>]
- KENDRICK, K.M. (2008) Sheep Senses, Social Cognition and Capacity for Consciousness. *In* Dwyer, C.M. (Éd.), *The Welfare of Sheep, Animal Welfare*. Dordrecht, Springer Netherlands, p. 135-157. [https://doi.org/10.1007/978-1-4020-8553-6_4]
- KENNEDY, D. (2012) Rudiments de la reproduction et des taux de conception chez les ovins. *In* *Gouvernement de l'Ontario*. [<http://www.ontario.ca/fr/page/rudiments-de-la-reproduction-et-des-taux-de-conception-chez-les-ovins>] (consulté le 03/08/2022).
- LAUBER, M., NASH, J.A., GATT, A., *et al.* (2012) Prevalence and Incidence of Abnormal Behaviours in Individually Housed Sheep. *Animals* vol. 2, n° 1, p. 27-37. [<https://doi.org/10.3390/ani2010027>]
- LYNCH, J.J., HINCH, G.N., ADAMS, D.B. (1992) The behaviour of sheep: biological principles and implications for production. Wallingford, CABI.
- MARCONE, G., CARNOVALE, F., ARNEY, D., *et al.* (2022) A simple method for on-farm evaluation of sheep welfare using animal-based indicators. *Small Ruminant Research* vol. 208, p. 106636. [<https://doi.org/10.1016/j.smallrumres.2022.106636>]
- MARTIN, P., BATESON, P.P.G., BATESON, P. (1993) *Measuring Behaviour: An Introductory Guide*. 3^{ème} éd., Cambridge University Press.
- MCBRIDE, G. (1971) Theories of Animal Spacing: The Role of Flight, Fight and Social Distance. *In* Esser, A.H. (Éd.), *Behavior and Environment: The Use of Space by Animals and Men*. Boston, MA, Springer US, p. 53-68. [https://doi.org/10.1007/978-1-4684-1893-4_6]
- MCFARLAND, D. (1993) *Animal behaviour: Psychobiology, ethology, and evolution*, 2^{ème} éd. Oxford, England, John Wiley & Sons.

- MCCGLONE, J.J. (1986) Agonistic behavior in food animals: review of research and techniques. *Journal of Animal Science* vol. 62, n° 4, p. 1130-1139. [<https://doi.org/10.2527/jas1986.6241130x>]
- MICHELENA, P., NOËL, S., GAUTRAIS, J., *et al.* (2006) Sexual dimorphism, activity budget and synchrony in groups of sheep. *Oecologia* vol. 148, n° 1, p. 170-180. [<https://doi.org/10.1007/s00442-005-0347-2>]
- MOORING, M.S., FITZPATRICK, T.A., BENJAMIN, J.E., *et al.* (2003) Sexual Segregation in Desert Bighorn Sheep (*Ovis canadensis mexicana*). *Behaviour* vol. 140, n° 2, p. 183-207. [<https://doi.org/10.1163/156853903321671497>]
- MORA-MEDINA, P., ORIHUELA-TRUJILLO, A., ARCH-TIRADO, E., *et al.* (2016) Sensory factors involved in mother-young bonding in sheep: a review. *Veterinária Medicina* vol. 61, n° 11, p. 595-611. [<https://doi.org/10.17221/255/2014-VETMED>]
- MUNOZ, C.A., CAMPBELL, A.J.D., HEMSWORTH, P.H., *et al.* (2019) Evaluating the welfare of extensively managed sheep. *PLoS One* vol. 14, n° 6. [<https://doi.org/10.1371/journal.pone.0218603>]
- MUNRO, J. (1957) Sleep in sheep. *Proceedings of the British Society of Animal Production* vol. 1957, p. 71-75. [<https://doi.org/10.1017/S0369852100001810>]
- MURRAY, T.L., BLACHE, D.B., BENCINI, R. (2009) The selection of dairy sheep on calm temperament before milking and its effect on management and milk production. *Small Ruminant Research* vol. 87, n° 1, p. 45-49. [<https://doi.org/10.1016/j.smallrumres.2009.10.005>]
- NEUHAUS, P., RUCKSTUHL, K.E. (2004) Can the activity budget hypothesis explain sexual segregation in desert bighorn sheep? *Behaviour* vol. 141, p. 513-520. [<https://doi.org/10.1163/1568539041166708>]
- NOBLE, G.K. (1939) The Role of dominance in the social life of birds. *The Auk* vol. 56, p. 264-273. [<https://doi.org/10.2307/4079047>]
- NOWAK, R., PORTER, R.H., BLACHE, D., *et al.* (2008) Behaviour and the Welfare of the Sheep. In Dwyer, Cathy M. (Éd.), *The Welfare of Sheep, Animal Welfare*. Dordrecht, Springer Netherlands, p. 81-134. [https://doi.org/10.1007/978-1-4020-8553-6_3]
- ORGANISATION MONDIALE DE LA SANTÉ ANIMALE (2019) Dispositions générales. In *Code sanitaire pour les animaux terrestres*. [https://rr-africa.woah.org/wp-content/uploads/2019/08/fr_csar-vol1-2019.pdf] (consulté le 06/06/2022).
- OWEN-SMITH, N. (1977) On Territoriality in Ungulates and an Evolutionary Model. *The Quarterly Review of Biology* vol. 52, n° 1, p. 1-38. [<https://doi.org/10.1086/409720>]
- PALLARES, V. (2020) Ethologie de l'espèce ovine appliquée à l'élevage. Rapport de stage, AgroParisTech.
- PHYTHIAN, C., MICHALOPOULOU, E., DUNCAN, J., *et al.* (2013) Inter-observer reliability of Qualitative Behavioural Assessments of sheep. *Applied Animal Behaviour Science* vol. 144, n° 1, p. 73-79. [<https://doi.org/10.1016/j.applanim.2012.11.011>]
- PICCIONE, G., GIANNETTO, C., CASELLA, S., *et al.* (2008) Circadian activity rhythm in sheep and goats housed in stable conditions. *Folia Biologica* vol. 56, n° 3-4, p. 133-137. [https://doi.org/10.3409/fb.56_3-4.133-137]

- POKORNÁ, P., HEJCMANOVÁ, P., HEJCMAN, M., *et al.* (2013) Activity time budget patterns of sheep and goats co-grazing on semi-natural species-rich dry grassland. *Czech Journal of Animal Science* vol. 58, n° 5, p. 208-216. [<https://doi.org/10.17221/6749-CJAS>]
- PUGH, D.G., BAIRD, A.N. (2012) *Sheep and Goat Medicine*, 2^{ème} éd., Maryland Heights, Mo, Saunders.
- REIS, A. (2021) Altérations comportementales induites par l'élevage et leurs conséquences zootechniques. In *Journées nationales des GTV, Tours, 20-22 octobre*. Paris, SNGTV, p. 81-84.
- RICHMOND, S.E., WEMELSFELDER, F., DE HEREDIA, I.B., *et al.* (2017) Evaluation of Animal-Based Indicators to Be Used in a Welfare Assessment Protocol for Sheep. *Frontiers in Veterinary Science* vol. 4, p. 210. [<https://doi.org/10.3389/fvets.2017.00210>]
- RICORDEAU, G., BOCCARD, R., DENAMUR, R. (1960) Mesure de la production laitière des brebis pendant la période d'allaitement. *Annales de zootechnie* vol. 9, n° 2, p. 97-120. [<https://doi.org/10.1051/animres:19600201>]
- RUCKSTUHL, K.E. (1998) Foraging behaviour and sexual segregation in bighorn sheep. *Animal Behaviour* vol. 56, n° 1, p. 99-106. [<https://doi.org/10.1006/anbe.1998.0745>]
- SART, S., BENCINI, R., BLACHE, D., *et al.* (2004) Calm ewes produce milk with more protein than nervous ewes. *Animal Production in Australia* vol. 25, p. 307-307.
- SCOTT, J.P., FREDERICSON, E. (1951) The Causes of Fighting in Mice and Rats. *Physiological Zoology* vol. 24, n° 4. [<https://doi.org/10.1086/physzool.24.4.30152137>]
- SIBBALD, A.M., SHELLARD, L.J.F., SMART, T.S. (2000) Effects of space allowance on the grazing behaviour and spacing of sheep. *Applied Animal Behaviour Science* vol. 70, n° 1, p. 49-62. [[https://doi.org/10.1016/S0168-1591\(00\)00145-3](https://doi.org/10.1016/S0168-1591(00)00145-3)]
- SIMMONS, N.M. (1980) Behaviour. In *Manson G., Sumner L., The Desert Bighorn: Its Life History, Ecology, and Management*. Tucson, University of Arizona Press, p. 124-144.
- SMITH, B.P. (2019) The Domestic Dog: Its Evolution, Behavior and Interactions with People, 2^{ème} ed. *Anthrozoös* vol. 32, n° 5, p. 719-722. [<https://doi.org/10.1080/08927936.2019.1645518>]
- SQUIRES, V.R., WILSON, A.D. (1971) Distance between food and water supply and its effect on drinking frequency, and food and water intake of Merino and Border Leicester sheep. *Australian Journal of Agricultural Research* vol. 22, n° 2, p. 283-290. [<https://doi.org/10.1071/ar9710283>]
- SQUIRES, V.R. (1975) Ecology and behaviour of domestic sheep (*Ovis aries*): a review. *Mammal Review* vol. 5, p. 35-57. [<https://doi.org/10.1111/j.1365-2907.1975.tb00186.x>]
- STEPHENS, D.B. (1974) Studies on the effect of social environment on the behaviour and growth rates of artificially-reared British Friesian male calves. *Animal Production* vol. 18, n° 1, p. 23-34. [<https://doi.org/10.1017/S0003356100017219>]
- TATE, A.J., FISCHER, H., LEIGH, A.E., *et al.* (2006) Behavioural and neurophysiological evidence for face identity and face emotion processing in animals. *Philosophical Transactions of the Royal Society B: Biological Sciences* vol. 361, n° 1476, p. 2155-2172. [<https://doi.org/10.1098/rstb.2006.1937>]

- TINBERGEN, N. (1951) *The study of instinct*, Oxford, Clarendon Press.
- TOBLER, I. (1995) Is sleep fundamentally different between mammalian species? *Behavioural Brain Research*, *The Function of Sleep* vol. 69, n° 1, p. 35-41. [[https://doi.org/10.1016/0166-4328\(95\)00025-O](https://doi.org/10.1016/0166-4328(95)00025-O)]
- VIGNE, J.-D., MARIE, B., GOURICHON, L., *et al.* (2011) Etat des connaissances archéozoologiques sur les débuts de l'élevage du mouton dans l'ancien monde. *Ethnozootecnie* vol. 91, p. 11-19.
- VILLEMEN, M. (1975) *Dictionnaire des termes vétérinaires et zootechniques*, 2^{ème} éd. Paris, Vigot frères.
- WANG, M., ALVES, J., TUCKER, M., *et al.* (2018) Effects of intrinsic and extrinsic factors on ruminating, grazing, and bedding time in bighorn sheep (*Ovis canadensis*). *PLoS One* vol. 13, n° 10, p. e0206664. [<https://doi.org/10.1371/journal.pone.0206664>]
- WANG, Z.N., WANG, H., SHEN, Y.Z., *et al.* (2023) Behavioural and physiological responses of Small Tail Han sheep to predators. *Animal* vol. 17, n° 8, p. 100884. [<https://doi.org/10.1016/j.animal.2023.100884>]
- WEBSTER, J. (1994) *Animal Welfare: A Cool Eye Towards Eden*. Oxford, Blackwell Science
- WEMELSFELDER, F. (2008) Qualitative Behaviour Assessment (QBA): a novel method for assessing animal experience. *Proceedings of the British Society of Animal Science*, p. 279-279. [<https://doi.org/10.1017/S1752756200028246>]

Annexe 1 : Exemple de l'éthogramme du chien domestique (d'après Smith, 2019)

a sample ethogram: DOMESTIC DOG

resting behaviors

Rest: lying down with eyes open or closed

Sit: sit on hind legs

Stand: stand on four legs

locomotive behaviors

Walk: ambulatory gait

Trot: trotting gait

Run: running gait

Hind legs: standing on hind legs using forelegs against a wall to support the body

Circle: repetitive circling around pen

Tail chase: repetitive chasing of tail

Pace: repetitive pacing usually along a fence

Social pace: repetitive pacing along fence with a dog on the other side

Jump: repetitive jumping so that hind legs leave the ground

Wall bounce: repetitive jumping at wall, rebounding off it

Flank suck: repetitive and prolonged auto-grooming of flank

social behaviors/dogs

Contact dog: lying in contact with dog

Amicable dog: lick, paw or allogroom dog often with tail wag

Threat dog: snarl, raise hackles to dog

Attack dog: bite, snap, or chase dog often with aggressive vocalizations

Defensive dog: Evade dog, cower, roll over, lick face

Competitive dog: defend object or food from dog

Sniff dog: nose to any area of another dog

Solicit play dog: bow, short charges with bouncing gait, often barking

T-dog: muzzle placed across neck of another dog

Mount dog: hetero/homosexual mounting of another dog

Mounted: focal animal mounted by other dog

social behaviors/humans

Amicable human: lick, paw, allogroom human, often with tail wag

Threat human: snarl, raise hackles to human

Attack human: bite, snap or chase human

Defensive human: evade human, cower, roll over

Competitive human: defend object or food from human

Sniff human: nose to any area of human

Solicit play human: bow, metaplay with human

Play human: bouncing gait, play face, wrestle, play chase

Pat dog: human pat dog

vocal behaviors

Bark: staccato vocalizations

Howl: long drawn out vocalizations

Bark at passers: recorded where object of barking could be seen

solitary behaviors

Autogroom: lick, pull at body/pelage

Dig: dig at ground with forepaws

Urinate squat: urinate in squatting position

Urinate raised leg: urinate with one leg cocked

Kick ground: scratching ground usually following urination or defecation

Sniff ground: Nose to ground

Eat: eating food

Drink: drinking

Coprophagy: eat own or other dog's feces

Chew: chew nonnutritive material

Eat grass: eating grass

Mouth toy: chew toy

from Serpell, J. (ed.). The Domestic Dog: its evolution, behavior, and interactions with people. 1995 Cambridge University Press.

Annexe 2 : Liste des 21 adjectifs utilisés pour évaluer l'état émotionnel de l'animal en utilisant la méthode QBA (d'après Dwyer *et al.*, 2015)

Descriptor	Definition
Alert	Observant and vigilant.
Active	Animal is physically active. Engaged in task e.g. grazing, walking, or fighting.
Relaxed	At ease, free from anxiety, agitation or tension. The animal appears to be unthreatened.
Fearful	Attention is focussed on one specific object/being which is either a real or perceived threat. Animal may also be fleeing.
Content	Satisfied and at peace. The animal's needs are met, or the animal is successfully working towards their completion.
Agitated	Excessive cognitive and/or motor activity due to tension or anxiety. The animal is uneasy and if moving their actions are twitchy.
Sociable	Seeking and interacting with other sheep. The sheep appears to be enjoying/taking comfort from their contact. The sheep is choosing to be part of a flock and not fully isolate themselves.
Aggressive	Hostile and tense. Attacking/ready to attack, usually unprovoked or to compete for resource.
Vigorous	The animal is carrying out task in an energetic or forceful way. If stationary or moving slowly the animal expresses an inner strength and energy. May imply good physical health.
Subdued	Submissive and docile. Often removed from social group and self absorbed.
Physically uncomfortable	Giving impression of pain or other physical discomfort through posture/movement.
Defensive	Ready to potentially defend herself or lamb from harm/perceived threat.
Calm	Placid and sedate. If physically active the animal's movements are smooth and unhurried.
Frustrated	Dissatisfied. Unable to fulfil satisfaction and achieve goal.
Apathetic	Unresponsive and dull.
Wary	Shy, cautious, apprehensive and possibly distrustful.
Tense	Uneasy and/or on-edge. Posture may show physical tension.
Bright	Alert, lively and aware of environment.
Inquisitive	Curious, interested and intrigued by the environment or other animals.
Assertive	Displaying confidence or determination.
Listless	Lack of vigour and energy. Animal appears lacklustre.

Annexe 3 : Résultats d'observations des comportements en élevage avec une notation binaire (0 = comportement non observé ; 1 = comportement observé)

Category	Behaviour	Farm number																		Total	Frequency	
		3	4	5	6	7	8	9	11	12	13	14	15	16	17	18	19	20	21			
Sensorial reactivity	Careful orientation	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	17	94%	
	Vocalisation	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	14	78%
	Locomotor reflexes in response to surprise	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	3	17%	
	Response to invasion of individual space	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	16	89%
Social behaviours	Aggression	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	1	15	83%
	Submission	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	6	33%	
	Social organisation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	Followership	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	Maternal bond	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	11%	
	Social exchanges	1	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	5	28%	
Ingestion	Group formation	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	3	17%	
	Eating	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Rumination	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Drinking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6%	
	Cationic balance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6%	
	Milk feeding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Exploration	Focusing senses	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Physical exploration of environment	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
Kinesis	Natural gaitis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Perambulation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Travel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Natural postures	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Change of posture	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Stretching	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	11%
Body care	Scratching	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Grooming	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17	94%
	Shaking	1	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	12	67%
	Thermoregulation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	Evacuation	1	1	1	0	0	1	1	0	0	1	0	1	0	1	0	1	1	1	1	12	67%
	Comfort-seeking contact	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17	94%
Rest and sleep	Standing rest	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	100%
	Lying rest	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17	94%
	Sleep	0	1	1	1	1	0	1	0	1	1	1	0	0	0	0	1	1	1	1	10	56%
Stereotypical behaviours	Wool pulling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	Mouthing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
	Pacing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%

Annexe 4 : Résultats du nombre d'occurrences des comportements observés en élevage

		Farm number (up) & head count (below)																				
Categories of behaviours	Behaviours	3	4	5	6	7	8	9	11	12	13	14	15	16	17	18	19	20	21	Mean		
		100	50	70	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	62
Sensorial reactivity	Careful orientation	NR	NR	NR	+++	+	+	+	+	+	+	-	-	+	+	++	+	++	NR	+		
	Vocalisation	+++																				
	Locomotor reflexes in response to surprise	100	0	0	0	0	0	0	0	0	0	4	0	0	13	0	0	0	0	0	6,5	
	Response to invasion of individual space	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Social behaviours	Aggression	7	10	1	1	1	2	0	4	1	2	0	1	2	2	1	3	1	2	2,3		
	Submission	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0	1	0	2	0,4		
	Social organisation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Followership	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Maternal bond	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0,3		
	Social exchanges	1	1	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0,3		
	Group formation	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0,2		
Ingestion	Eating	15	8	7	1	23	8	26	3	3	2	10	7	34	23	56	27	2	5	14		
	Rumination	20	10	13	45	27	38	10	16	25	10	13	10	11	10	10	5	6	20	17		
	Drinking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,3		
	Cationic balance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0,1		
	Milk feeding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Focusing senses	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Exploration	Physical exploration of environment	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Natural gaits	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Kinesis	Perambulation	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Travel	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Natural postures	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Change of posture	1	3	8	3	9	16	6	15	6	9	15	6	12	8	1	5	5	12	7,8		
Body care	Stretching	2	1	2	2	3	6	2	2	1	3	3	4	10	6	2	3	2	2	3,1		
	Scratching	1	0	1	0	0	2	2	2	2	5	3	2	9	3	1	3	3	5	2,4		
	Grooming	1	0	0	0	0	2	0	1	2	1	0	0	2	6	3	1	0	1	1,1		
	Shaking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Thermoregulation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Evacuation	1	1	1	0	0	1	0	0	0	1	0	1	0	1	0	2	4	1	5	1,1	
Rest and sleep	Comfort-seeking contact	0	1	0	1	1	4	1	1	1	1	6	1	1	2	0	2	4	2	1,6		
	Standing rest	51	15	17	3	24	6	13	13	4	17	21	0	7	12	33	7	8	9	14		
	Lying rest	0	15	19	52	7	47	15	50	40	15	19	26	32	23	4	22	13	35	24		
	Sleep	0	2	2	2	0	1	0	1	0	1	0	0	0	0	0	0	0	0	1,3		
Stereotypical behaviours	Wool pulling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Mouthing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Pacing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

Annexe 5 : Résultats du nombre d'occurrences des comportements observés en élevage pour 100 animaux ainsi que les intervalles de confiance à 95 % associés

Categories of behaviours	Behaviours	Farm number																				Mean / 100 animals		CI95%	
		3	4	5	6	7	8	9	11	12	13	14	15	16	17	18	19	20	21						
Sensorial reactivity	Careful orientation	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0	0	NR	NR	[0; 18.2]
	Vocalisation	+++	++	-	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	100	0	0	0	7.0
	Locomotor reflexes in response to surprise	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	7	20	2	1.4	[1.74; 5.96]
	Response to invasion of individual space	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0	2	0	0	0.8
Social behaviours	Aggression	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 0]
	Submission	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 0]
	Social organisation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 0]
	Followership	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 0]
	Maternal bond	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 1.02]
	Social exchanges	1	2	0	0	1.4	1.5	0	0	0	0	0	0	0	1.3	0	0	0	0	0	0.4	0.4	NR	NR	[0.08; 0.73]
Ingestion	Group formation	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	[13; 30.3]
	Eating	15	16	14	1.4	33	12	37	4	5	5	15	20	45	35	62	54	6.7	8.3	22	22	27	27	27	[19.6; 34]
	Rumination	20	20	26	64	39	58	14	21	42	25	20	29	15	15	11	10	20	33	27	0	0	0	0	[0; 1.67]
	Drinking	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 0.67]
	Cationic balance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 0]
	Milk feeding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 0]
Exploration	Focusing senses	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Physical exploration of environment	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Natural gait	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Perambulation	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Travel	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Natural postures	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Body care	Change of posture	1	6	16	4.3	13	25	8.6	20	10	23	23	17	16	12	1.1	10	17	20	13	0	0	0	0	[9.99; 16.9]
	Stretching	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 0.65]
	Scratching	2	2	4	2.9	4.3	9.2	2.9	2.7	1.7	7.5	4.6	11	13	9.2	2.2	6	6.7	3.3	5.3	3.67	3.3	5.3	5.3	[3.67; 6.99]
	Grooming	1	0	2	0	0	3.1	2.9	2.7	3.3	13	4.6	5.7	12	4.6	1.1	6	10	8.3	4.4	2.56	6.31	4.4	4.4	[2.56; 6.31]
	Shaking	1	0	0	0	0	3.1	0	1.3	3.3	2.5	0	0	2.7	9.2	3.3	2	0	1.7	1.7	0.59	2.76	1.7	1.7	[0.59; 2.76]
	Thermoregulation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 0]
Rest and sleep	Evacuation	1	2	2	0	0	1.5	0	0	0	2.5	0	2.9	0	0	0	0	0	0	0	0.85	3.24	2.0	2.0	[0.85; 3.24]
	Comfort-seeking contact	0	2	0	1.4	1.4	6.2	1.4	1.3	1.7	2.5	9.2	2.9	1.3	3.1	0	4	13	3.3	3.1	1.45	4.68	3.1	3.1	[1.45; 4.68]
	Standing rest	51	30	34	4.3	34	9.2	19	17	6.7	43	32	0	9.3	18	37	14	27	15	22	15.5	31.8	22	22	[15.5; 31.8]
	Lying rest	0	30	38	74	10	72	21	67	38	29	74	43	35	4.4	44	43	58	42	42	30.4	52.7	42	42	[30.4; 52.7]
Stereotypical behaviours	Sleep	0	4	4	2.9	0	1.5	0	1.3	6.7	2.5	0	0	0	0	0	10	10	3.3	2.6	1.4	13	2.6	2.6	[1; 4.13]
	Wool pulling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 0]
	Mouthing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 0]
	Pacing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[0; 0]

NR = Not rated
CI95% = 95% confidence interval

Annexe 6 : Tableau d'observation à remplir pour évaluer la partie comportementale du BEA en élevage ovin laitier

Number of animals on the farm =

Observations 8 minutes into the film :

Percentage	Standards
	[13% ; 30%]
	[20% ; 34%]
	[15% ; 32%]
	[30% ; 53%]
	[1% ; 4%]

Categories of behaviours	Behaviours	Number of animals
Ingestion	Eating	
	Ruminating	
	Standing rest	
Rest and sleep	Lying rest	
	Sleep	

Observations over a 15-minute period :

Number of occurrences per 100 animals	Standards
	Calm
	[0 ; 18,2]
	[1,74 ; 5,96]
	[0,28 ; 1,35]
	[0,08 ; 0,73]
	[9,99 ; 16,9]
	[3,67 ; 6,99]
	[2,56 ; 6,31]
	[0,59 ; 2,76]
	[0,85 ; 3,24]
	[1,45 ; 4,68]
	[0 ; 0]
	[0 ; 0]
	[0 ; 0]

Categories of behaviours	Behaviours	Number of occurrences
Sensorial reactivity	Vocalisation	Calm / Noisy
	Locomotor reflexes in response to surprise	
Social behaviours	Aggression	
	Submission	
	Social exchanges	
Kinesis	Change of posture	
	Scratching	
	Grooming	
	Shaking	
Body care	Evacuation	
	Comfort-seeking contact	
	Wool pulling	
Stereotypical behaviours	Mouthing	
	Pacing	

DESCRIPTION DE L'ÉTHOGRAMME DES OVINS ET OBSERVATIONS EN ÉLEVAGE DE BREBIS LAITIÈRES

AUTEUR : Léa DELHOM

RÉSUMÉ :

L'étude des comportements exprimés par les ovins sauvages est un point de repère pour l'évaluation du comportement animal en élevage malgré les nombreuses adaptations du mouton domestique à leur milieu d'élevage. En effet, la liberté d'expression d'un comportement normal de son espèce est un des 5 principes du bien-être animal et connaître les comportements exprimés naturellement permet d'analyser la palette de comportements exprimés en élevage.

Ce manuscrit décrit, dans un premier temps, comment construire un éthogramme, c'est-à-dire l'inventaire des comportements exprimés par une espèce donnée. Ensuite, il permet de comprendre pourquoi on étudie le comportement animal qui est présent dans la plupart des protocoles d'évaluation du bien-être animal chez les ovins (protocoles AWIN, IDELE allaitant, et EBBEL). Cependant, malgré la présence des observations du comportement dans les protocoles, il est évident le manque de références chiffrées dans ce domaine.

Ainsi, dans un second temps, l'objectif de cette thèse a été de construire un éthogramme adapté à l'espèce ovine. Cet éthogramme permet de lister les différents comportements observés chez les moutons en élevage et dans la nature. Trente-huit comportements divisés en huit catégories fonctionnelles ont été décrits précisément et illustrés par des vidéos réalisées en élevage ovin laitier dans la région de Roquefort.

Enfin, ces vidéos de 15 minutes réalisées dans 18 élevages différents ont permis d'observer quels comportements décrits dans l'éthogramme étaient présents ou non en élevage. Le nombre d'occurrences des comportements présents a ensuite été compté afin d'établir une référence à l'aide d'intervalles de confiance à 95 %. Ces références ont permis ensuite d'établir un protocole d'évaluation du comportement en élevage ovin laitier, permettant d'enrichir l'analyse de la liberté d'expression de comportements normaux dans les protocoles d'évaluation du bien-être animal. Ce protocole se présente sous la forme d'une fiche pratique contenant une synthèse des étapes à suivre et un tableau d'observation à remplir où certains comportements jugés importants à dénombrer ont été sélectionnés. L'éleveur peut alors comparer le nombre d'occurrences de ces comportements observés en 15 minutes dans son élevage aux références établies par nos soins. Il peut alors ensuite essayer de comprendre pourquoi certains comportements sont présents en trop haute ou trop basse fréquence et améliorer les infrastructures ou le fonctionnement de son élevage en conséquence.

MOTS CLÉS :

BIEN-ÊTRE ANIMAL, BREBIS, COMPORTEMENT, ÉTHOGRAMME, OVINS

JURY :

Président : Pr Karim ADJOU

Directrice de thèse : Dr Alline DE PAULA REIS

Examineur : Pr Yves MILLEMANN

DESCRIPTION OF THE SHEEP ETHOGRAM AND OBSERVATIONS ON DAIRY SHEEP FARMS

AUTHOR: Léa DELHOM

SUMMARY:

The study of behaviours expressed by wild sheep is essential for assessing animal welfare on farms, despite the numerous adaptations of domestic sheep to their breeding environment. Indeed, the freedom to express normal behaviours to its species is one of the 5 principles of animal welfare, and knowing the behaviours expressed naturally allows us to analyse the range of behaviours expressed on farms.

This manuscript first describes how to construct an ethogram, i.e. an inventory of the behaviours expressed by a given species. It then explains why animal behaviour is studied and presents the various existing protocols for assessing animal welfare in sheep (AWIN, IDELE, Australian and EBBEL protocols). However, despite the presence of behavioural observations in the protocols, there is an obvious lack of quantified references in this field.

The second objective of this thesis was therefore to construct an ethogram adapted to the sheep species. This ethogram lists the different behaviours observed in sheep on farms and in the wild. Thirty-eight behaviours divided into eight functional categories were described in detail and illustrated by videos taken on dairy sheep farms in the Roquefort region.

Finally, these 15-minute videos, taken on 18 different farms, were used to observe which of the behaviours described in the ethogram were present on the farm and which were not. The number of occurrences of the behaviours present was then counted in order to establish a reference using 95 % confidence intervals. These references were then used to create a protocol for assessing behaviour on dairy sheep farms, making it possible to enrich the analysis of freedom of expression of normal behaviour in animal welfare assessment protocols. The protocol takes the form of a practical sheet containing a summary of the steps to be followed and an observation table to be filled in, in which certain behaviours deemed important to count have been selected. The farmer can then compare the number of occurrences of these behaviours observed in 15 minutes on his farm with the references established by us. They can then try to understand why certain behaviours occur too frequently or too infrequently, and improve the infrastructure or operation of their farm accordingly.

KEYWORDS:

ANIMAL WELFARE, BEHAVIOUR, ETHOGRAM, EWES, SHEEP

JURY:

Chairperson: Pr Karim ADJOU

Thesis director: Dr Aline DE PAULA REIS

Reviewer: Pr Yves MILLEMANN