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## **On farm welfare monitoring of European fattening lambs**

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### **Highlights**

- Animal welfare is a key factor in lamb production.
- From intensive to shepherded lamb farms, animal welfare requirements are complied with.
- Animals seem to express different positive emotional state depending on rearing system.

### **Abstract**

#### **Introduction**

Lamb meat production systems are highly variable, even if we only consider Europe. They range from animals that are raised only under intensive conditions (they are born, weaned and fed indoors based on concentrates and with forage supplementation) to systems where the animals are raised always outdoor and fed exclusively from mother's milk and grazing. There are systems located from plateau areas where temperatures are high in summer and temperate in winter to mountain areas with particularly harsh winters (Font i Furnols et al., 2009; Morris, 2017). Sheep and the production of lamb meat, has been adapting over millennia to the most varied environmental conditions thanks to a genetic and racial diversity that has allowed a great selection and evolution in recent years (Kijas et al., 2012; Nozieres-Petit and Moulin, 2021).

Given that meat consumption has increased in recent years, there is growing political pressure to regulate it or keep it within certain limits, citing health reasons (Bonnet et al., 2020). At the same time, there is an increase in the number of vegetarian or vegan consumers in developed countries, characterized by greater concern and awareness about suffering and animal welfare (Rosenfeld, 2018). Parallely, this concern is also showed by meat consumers, and it steps up the demand for products obtained from animals raised under high standards of animal welfare (Coleman, 2017; Hempstead et al., 2019). However, there may be a certain dissociation between the opinions expressed by consumers regarding animal welfare and the preferences they show at the time of purchase, which would focus on price (Hempstead et al., 2019). Despite this, there is no doubt that the improvement in animal production involves a greater animal welfare (Doughty et al., 2017; Mandolesi et al., 2020).

There is an increasing interest from meat industry to assess animal welfare at farm level as a previous step to the commercialization of animal welfare-friendly meat, as a response to consumers' demands. This pressure will lead to the implementation of labels that certify compliance with animal welfare standards in meat, which will help the consumer to identify those products that are more respectful of animal welfare and which will help to contribute to maintaining or recovering meat consumption (Faucitano et al., 2017; Mandolesi et al., 2020).

Animal welfare is a very complex concept that cannot be measured directly. In recent years, different systems for evaluating animal welfare on farm have been developed. (Caroprese et al., 2016; Richmond, 2016; Richmond et al., 2017). The most widespread use indicators based on animals, which can be observed and

objectified by trained personnel, and do not induce any stress to the animals. These evaluations can be carried out without animal handling. The selected indicators are considered valid, consistent over time (reliable), feasible (simple and practical to use on farms) and include at least 3 categories of indicators: animal-based, management-based and resource-based. (Hempstead et al., 2019). The Animal Welfare Indicators (AWIN) project followed Welfare Quality®, and developed similar welfare assessment protocols for sheep (AWIN, 2015; Richmond, 2016; Richmond et al., 2017) based on measurements that are reliable due to inter and intra observer agreement (Mattiello et al., 2019; Munoz et al., 2018).

This work is part of a broader project that claims that all necessary measures should be taken at the farm level to improve the welfare of the animals. These measures and the achievement of high standards of well-being must be communicated to consumers. This is the only way to improve the competitiveness of the lamb meat sector, making it sustainable and viable in the future.

To the best of our knowledge, few studies have been published where the welfare of fattening lambs reared from intensive to extensive conditions has been evaluated. Therefore, the objective of the present work is to study the welfare of lambs reared up to 4 months of age in different management systems in Europe and to detect the problems that may be affecting them.

## **Material and methods**

### ***Participating farms***

Nine farms were visited with the aim of assessing aspects of animal welfare linked to the production of lamb meat in different production systems throughout Europe (3 in Spain, 2 in Portugal, 1 in Germany, 1 in Slovenia and 2 in Italy).

#### *Spain*

In the Mediterranean regions of Salamanca (for INRA-401 breed) and Zamora (for Castellana breed), lambs were raised under an intensive system on commercial farms. Lambs were weaned when they were 4-6 weeks old and housed with straw bedding and free access to commercial concentrate, cereal straw and fresh water. In the Mediterranean region, located in Valladolid, Castellana breed lambs were raised under a semi-extensive system. Animals were weaned at 4-6 weeks old and housed together with straw bedding, allowed to graze outdoors (pastures were predominately oak and pine forests, cereal stubbles and vineyards) during the mornings; animals were kept indoors during the afternoon and night, with free access to commercial concentrate, cereal straw and fresh water. Three groups of INRA-401 and two groups of Castellana (Zamora) were assessed in 2018; three groups of Castellana (one from Zamora and two from Valladolid) were assessed in 2019.

#### *Portugal*

In the Mediterranean region, three groups of Churra Galega Bragançana lambs were raised, one group on the holding of the School of Agriculture of the Polytechnic Institute of Bragança and another two groups on a commercial farm. The production system used was semi-extensive system, whose feeding was based on grazing on natural pastures. The hours of grazing varied according to hours of light, heat and herd size. In winter, the flocks would be released in the morning to graze all day until dark. In the summer, the herds would leave at dawn and graze until midmorning, then they would be put in a stable under shade, and would come out when the heat had subsided. Once on the premises, all lambs had access to meadow hay and water ad libitum, and were supplemented with protein and mineral-rich concentrates. The lambs were not weaned, and were assessed in 2019.

#### *Italy*

In the Continental bioregion, located in Turin (North West of Italy), Biellese lambs were raised in CISRA, Teaching Animal Farm of the Veterinary Science Department, University of Turin. In the Alpine bioregion, located in Val Maira (CN), Western Alps, at an altitude of 1800-2000 m, Sambucana lambs were bred during the summer season. The production system used for Biellese breed is semi-intensive system (i.e., the lambs consumed about 500 gr of milk per day, after weaning (day 60), they were fed with around 150 g of concentrate per day and hay ad libitum until the slaughtering) while the production system for Sambucana lambs was based on grazing on natural pasture. In the semi-intensive system for Biellese lambs, the flocks would be released to

graze outside in autumn-winter season (period of investigation); whereas in the extensive system, Sambucana lambs would leave at dawn and graze until evening, then they would be recovered in a fence in summer season (period of investigation). The lambs were not weaned during the pasture in the Alpine bioregion. One group of lambs from each breed was assessed in 2018, and in in 2019 for a a total of 4 groups with total of 80 lambs.

#### *Slovenia*

In the Alpine region, located near Tolmin (Slovenia), autochthonous Jezersko-Solčava lambs were raised extensively on a farm with a flock of around 30 ewes. The lambs, born at the farm, were not weaned and reared with their dams until slaughtered. Until the end of November the flock was kept on a free Alpine lowland pasture utilizing a rotational grazing system without any feed supplementation. After that, they were kept free in a stable with an outdoor area available for grazing. While stabled, they were fed ad libitum with meadow hay. Additional rations of a feed mixture with vitamins and minerals for lambs were offered in an average daily amount of 100 g per animal. In the stable, the lambs had water ad libitum. Two groups of 15 lambs were assessed in 2017 and another two groups in 2018.

#### *Germany*

The lambs, all crossbred Texel-Merino-Blackhead-Charollais, were raised in a farm at an abandoned military training area on the Swabian Alb near Münsingen. The study area belongs to bio-region Kuppenalb, located in the eco-region called the “Western European Broadleaf Forests”. The study pasture of 170 ha is managed extensively, and grazed by a mid-sized flock of around 500 ewes. The insemination is carried out naturally in spring. During winter, traditional transhumance is practiced to the lower Swabian areas of Nördlingen. The animals graze all year long, and the only additionally provided fodder was mineral feed. One group of lambs was assessed in 2018 and another one in 2019.

#### ***Protocol used***

The lambs assessed on each farm participated in a larger project where carcass and meat quality, as well as environmental sustainability were evaluated. All the animals were managed according to the usual procedures in the farms of provenance. The animals were visited and assessed when they were 2-3 months old, around 1 month before slaughter.

The first level welfare assessment was applied according to the AWIN protocol for sheep (AWIN, 2015), the flow being: (1) qualitative behaviour assessment (QBA), social withdrawal, stereotypy, excessive itching, panting; (2) fleece cleanliness, fleece quality, tail length, faecal soiling, lameness; (3) familiar human approach; (4) stocking density, access to shade/shelter, water availability; (4) lamb mortality. Conditions given to fulfil the second level of welfare assessment were not satisfied, so only the first level was performed (AWIN, 2015). The criteria used to evaluate the indicators are shown in Table 1.

The visits were carried out in spring by different evaluators, all of them with experience in evaluating animal welfare. It must be highlighted that these indicators proved to be valid, reliable and feasible for sheep (Diaz-Lundahl et al., 2019; Munoz et al., 2018, 2019) and they address the main welfare concerns for sheep, covering freedom from pain, injury or disease.

During the visits, farmers were also interviewed to assess farm characteristics according to AWIN (2015) and a brief questionnaire on veterinary medicine use (Table 3) was also completed (10 farms).

*Table 1. AWIN recommendations for first level of welfare assessment*

<b>Parameter</b>	<b>Indicator criteria</b>
Lamb survival	Lamb mortality, %
Water availability	% (0/50/100)
Fleece cleanliness	% 0-100
Panting	% normal respiration
Access to shade and shelter	% (0/50/100)

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Stocking density	% (0/50/100)
Lameness	% ewes no lame
Faecal soiling	% 0-100
Fleece quality	% good coverage
Tail length	% full tails
Social withdrawal	% with no social withdrawal
Stereotypy	% with no stereotypy
Excessive itching	% no itching or scratching
Familiar human approach test	Closest distance of approach Voluntary contact (y/n)
Qualitative behaviour assessment (QBA)	PCA score plot

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### *Statistical analyses*

Data on farm characteristics, veterinary medicine use and welfare indicators were subjected to descriptive statistics: average, median, range and standard deviation were calculated. Data on QBA were subjected to principal component analysis (PCA), using the package “princomp” of the R software version 3.3.3 (R Core Team, 2019). The first and the second principal components (PC1 and PC2, respectively) were retained. Loadings (scores) for QBA indicators and assessments were plotted, the two axes being PC1 and PC2 (AWIN, 2015).

## **Results and discussion**

### *Farm characteristics*

The characteristics of the assessed farms are shown in Table 2. A great heterogeneity is observed because the breeds and the productive systems in which the animals have been raised are very different. This reflects how variable sheep production systems can be across Europe as well as the great ability of sheep to adapt to different systems (Font i Furnols et al., 2006; Morris, 2017).

It can be seen that there were no replacement ewes or rams in some farms; this is motivated by the fact that, in these cases, the farms were closed feedlots, where lambs arrived once they have been weaned at their origin farms (only lambs were present). On the other hand, the very high number of lambs on one of the farms corresponds to a bit intensively reared flock, where of mother ewes together with feedlot lambs are kept on the same farm. These are two common extreme systems for finishing lambs indoors (Navarro et al., 2020).

All the farms included in the project were dedicated to meat production, wool being a secondary product; environmental management was not contemplated in the declaration of most of the farms, even though some of them had an extensive management which could be linked to this characteristic (Bernués et al., 2011; Rodríguez-Ortega et al., 2017).

Regarding housing, only the purely extensive farms did not have sheds for the animals. In this case, the animals were exposed to the weather, while in the rest of the cases there was enough covered area to accommodate all the animals. In relation to castration, it is a practice that is not carried out on most farms and is in disuse (Needham et al., 2017). When it is carried out, it is usually done on lambs over 7 days old, in many cases without anesthesia (by means of rubber rings or burdizzo clamps), and farmers are aware that there are alternative methods that they plan to implement.

Most farms had a written health plan, although there are still examples of farms that still do not keep a written record of all plans, which is considered to need improvement. Likewise, although most of the farms carried out mortality counts (82%), some of the smaller ones did not. The range of lamb mortality is quite wide (6-23%), the average being around 11%. The destination of the lambs is mainly the slaughterhouse, followed by

replacement on the farm itself. A small percentage of the animals are sold for finishing in another feedlot or for life (breeders).

Table 2. Farm characteristics.

	<u>Average</u>	<u>Median</u>	<u>SD</u>	<u>range</u>
<b>Farm numbers</b>				
Ewes	376	200	469	0-1350
Rams	16	5	29	0-97
Replacement animals	138	35	184	0-420
Lambs	568	220	785	45-2190
Mortality recordings (0=no, 1=yes)	0,82	1,00	0,40	0-1
Lamb mortality (%)	11,6	11,4	5,2	6-23
<b>Lambs destination (%)</b>				
Sold for finishing	8,0	0,00	25,8	0-86
Sold for slaughter	70,7	75,2	28,1	0-100
Sold for breeding	7,1	0,0	14,6	0-37
Kept at farm	16,5	19,0	9,5	0-27
<b>Farm main purpose</b>				
Meat	1,00	1,00	0,00	1-1
Wool	0,10	0,00	0,30	0-1
Environmental management	0,18	0,00	0,40	0-1
<b>Housing</b>				
Shed housing area (m <sup>2</sup> )	1846	300	4217	0-13000
Animals with access to shade (%)	86	100	32	0-100
Housed animals (0=no, 1=yes)	0,64	1,00	0,50	0-1
<b>System type</b> (1=intensive; 2=semi-intensive; 3=semi-extensive; 4=extensive; 5=shepherded)				
	2,73	3,00	1,49	1-5
<b>Written health plant</b> (0=no; 1=yes)				
	0,64	1,00	0,50	0-1
<b>Castration</b>				
Are male lambs usually castrated? (0=no; 1=yes)	0,27	0,00	0,47	0-1
Castration method (1=rubber rings; 2=burdizzo clamps)	1,67	2,00	0,58	1-2
Castration age (0=at birth; 1=0-7 days; 3=7 days – 3 months)	3,00	3,00	0,00	3-3

Are lambs anaesthetized? (0=no; 1=yes)	0,00	0,00	0,00	0-0
Do the farmers know alternatives to castration? (0=no; 1=yes)	0,27	0,00	0,47	0-1

To deepen the health plans in the farms, a survey was carried out on the use of medicines in those farms that expressed their consent to do so (n = 10). The questionnaire was based in a low number of questions (as shown in Table 3), very far from the detailed questionnaire recently developed for dairy sheep and goats (Lianou et al., 2020). There was a written record of the treatments that the animals receive (especially antibiotic treatments, which must be declared), although there are some examples where the record can still be improved. On the other hand, the existence of a health plan does not necessarily imply that it is fully recorded in writing; in this sense, there was a written plan for the antibiotic treatment of animals in 70% of cases, which is indeed a step beyond the general health plan of a farm.

Written plans include: antiparasitic (internal / external) every 6-12 months, vaccination against Clostridia, Pasteurella, Chlamidia, Brucella, Corynebacterium (depending on each country legal basis and breeders' associations recommendations), and selenium supplementation for ewes before mating. This vaccination and treatment plans are directly related to the most frequent diseases; when farmers were asked about this issue, they reported diseases of respiratory (5 out of 10 reported some cases of pneumonia, possibly caused by Pasteurella), digestive (coccidia -one farm-, unspecified parasites -three farms- or diarrhea -one farm-), feet (five farms reported ulcerative dermatitis) and skin (lip scab and infectious labial dermatitis in one farm) origin. These findings are in agreement with previous studies where digestive and respiratory diseases were the most frequent health problems in lamb farms (González et al., 2016), whereas those related to feet are relatively common in either extensively (Munoz et al., 2019) or intensively (EFSA Panel on Animal Health and Welfare (AHAW), 2014) reared animals. It is worth to mention that two out of ten farms declared that all the animals reaching the new location were subjected to quarantine.

Regarding the search for veterinary advice for the treatment of sick animals, only half of the cases were always consulted. This is motivated by the farmer's experience. Once the symptoms and signs of a disease are identified by the farmer, the treatment is usually known, and the veterinarian is informed a posteriori rather than consulted. Albeit this is a relatively common practice, we would like to stress that the veterinary advice should always be sought, because this is a key factor in maintaining the farm biosecurity (Doidge et al., 2019). The administration of the treatments is normally carried out by the owner or manager of the farm, the shepherd or some employee. The course of treatment is usually completed. In any case, the treated animals are visibly marked and separated in those cases where it is considered strictly necessary. It should be noted that none of the farmers acknowledges having led to the detection of antibiotic residues in the animals from their farm in the months prior to the survey. Beyond antimicrobial residues, we consider that conveying information from slaughterhouses on the prevalence of diseases, as suggested by (Mazoudier et al., 2020), could contribute to a deeper concern of farmers about animals health and treatments and to look for veterinary advice more frequently. It must be taken into account that all these farms were assayed between 2017 and 2020, and that changes in legal requirements may have contributed to the improvement in the plans and use of drugs, particularly antibiotics.

*Table 3. Average and median answers to the questionnaire on veterinary medicine use in 10 selected farms.*

	<b>Average</b>	<b>Median</b>	<b>SD</b>	<b>range</b>
Does the farm have a health plan? (0=no, 1=yes)	0,75	1,00	0,46	0,00-1,00
Does the farm maintain written records for treatments including medicated feeds? (0=no, 1=yes)	0,75	1,00	0,46	0,00-1,00
Does the farm have written plans for treating sick animals? (0=no, 1=yes)	0,63	1,00	0,52	0,00-1,00

Is the veterinarian's advice sought before administering medicines?				
Always (0=no, 1=yes)	0,50	0,50	0,53	0,00-1,00
Most of the time (0=no, 1=yes)	0,38	0,00	0,52	0,00-1,00
Sometimes (0=no, 1=yes)	0,13	0,00	0,35	0,00-1,00
Other than veterinarian, who is allowed to administer medicines to animals?				
Owner (0=no, 1=yes)	0,75	1,00	0,46	0,00-1,00
Manager (0=no, 1=yes)	0,63	1,00	0,52	0,00-1,00
Herdsmen (0=no, 1=yes)	0,25	0,00	0,46	0,00-1,00
Family (0=no, 1=yes)	0,00	0,00	0,00	0,00-0,00
Farm worker (0=no, 1=yes)	0,13	0,00	0,35	0,00-1,00
Following administration of a medicine, is the course of treatment completed?				
Always (0=no, 1=yes)	0,86	1,00	0,38	0,00-1,00
Sometimes (0=no, 1=yes)	0,14	0,00	0,38	0,00-1,00
Never (0=no, 1=yes)	0,00	0,00	0,00	0,00-0,00
Is extra-label usage of medication done only based on the orders or written guidelines from a veterinarian? (0=no, 1=yes)				
	0,50	0,50	0,53	0,00-1,00
Are treated animals always visibly marked as "treated"? (0=no, 1=yes)				
	1,00	1,00	0,00	1,00-1,00
Were there any antibiotic residue violations in the past 6 months? (0=no, 1=yes)				
	0,00	0,00	0,00	0,00-0,00
Are treated animals physically separated from other animals? (0=no, 1=yes)				
	0,50	0,50	0,53	0,00-1,00

### ***Assessment of lambs' welfare***

The results of the first level welfare assessment on farms showed in general a high degree of compliance with the needs of the animals (Table 4), which also corresponds to good productive results. When it comes to autochthonous breeds, insufficient welfare scores have been reported in certain areas (Katarina et al., 2020), contrary to the findings of the current study. In terms of productivity, most of the farms showed average survival values of the offspring higher than 1 lamb per ewe. Neither stereotypy nor excessive itching were observed in any of the animals assessed in the farms, these indicators being characteristic in closely confined animals (EFSA Panel on Animal Health and Welfare (AHAW), 2014). Social withdrawal was also not observed in any of the farms.

Given that some of the farms did not have sheds for the animals, a certain degree of panting was observed in some animals, although the percentage was low and associated with those farms where the available shade (shade and shelter) was not appropriate. These cases occurred in summer, with high temperatures and with the animals unable to seek shade in shepherded farms, because lack of shelter is not common in intensive, semi-intensive or semi-intensive farms (Munoz et al., 2018).

Contrary to what was found by other authors (Katarina et al., 2020), but in agreement with welfare reports in extensively reared sheep (Munoz et al., 2018), very few cases of animals that had some dirt in the fleece (one intensive case) or that had very small losses of wool were reported (one semi-intensive and one intensive case).



In fact, following the AWIN protocol recommendations, the second level welfare analysis was not considered necessary in any of the animals or farms. In relation to tail docking all the animals had kept the full tail (Woodruff et al., 2020). Laminitis, which is an usual problem in dairy herds or adult animals (Mondragón-Ancelmo et al., 2020; Munoz et al., 2019), was only a marginal problem in the farms evaluated in this case.

In relation to animal housing, the stocking density in confined animals was appropriate. It was always observed that intensive animals had more than enough space in which to move and express their usual patterns of behaviour (Richmond et al., 2017). Likewise, water was always available in quantity and quality.

The familiar human approach test yielded a flight distance of approximately 2 m, the highest score corresponding to the shepherded farm. It must be noted that intensive, semi-intensive and semi-extensive reared lambs are more used to human closeness than extensively reared ones, which may partly help to explain this finding (Hempstead et al., 2019). It is worth to mention that most of the animals eventually approached the assessing person. It should also be noted that almost half of them were ruminating during the observation period, an activity that sheep do when they feel relaxed and are free of anxiety (De et al., 2018).

*Table 4. Results of the first level welfare assessment in all the visited farms.*

	<b>Average</b>	<b>Median</b>	<b>SD</b>	<b>Range</b>
Lamb survival per 100 ewes	125	113	35,5	83-186
Percentage of animals with				
Stereotypy (% with no stereotypy)	100,0	100,0	0,0	100-100
Social withdrawal (% with no social withdrawal)	100,0	100,0	0,0	100-100
Excessive itching (% no ichting or scratching)	100,0	100,0	0,0	100-100
Panting (% normal respiration)	99,7	100,0	1,0	95-100
Fleece cleanliness (% clean)	99,8	100,0	1,0	95-100
Fleece quality (% good coverage)	99,7	100,0	1,0	96-100
Tail length (% full tails)	100,0	100,0	0,0	100-100
Faecal soiling (% with no fecal soils)	99,5	100,0	1,4	94-100
Lameness (% no lame)	99,9	100,0	0,3	99-100
Stocking density (% appropriateness)	100,0	100,0	0,0	100-100
Access to shade and shelter (% appropriateness)	64,7	100,0	49,3	0-100
Penned area (m <sup>2</sup> )	511	90	1013	0-3600
Water availability (% appropriateness)	100,0	100,0	0,0	100-100
Percentage of animals ruminating	43,0	50,0	21,0	10-80
Familiar human approach test				
Flight distance (m)	2,0	2,0	1,5	0,0-5,0
Sheep approached (0=no; 1=yes)	0,6	1,0	0,5	0,0-1,0

QBA relies on the ability of humans to integrate perceived details of behaviour into descriptors with emotional connotation that can be scaled and added to other quantitative indicators (Mattiello et al., 2019). Following the AWIN protocol (AWIN, 2015), an attempt is made to assess the emotional state of animals by observing and scoring a series of 20 descriptors on a scale, which may have negative (aggressive, agitated, apathetic, defensive, fearful, frustrated, listless, physically uncomfortable, subdued, tense, wary) or positive (active, alert, assertive, bright, calm, content, inquisitive, relaxed, sociable, vigorous) connotations (Richmond, 2016; Richmond et al., 2017). The convergent validity between QBA, behaviour and physiology has been previously demonstrated

(Mialon et al., 2021; Richmond et al., 2017). It has also high intra- and inter-observer reliability, validity and on-farm feasibility (Mattiello et al., 2019).

QBA indicators considering data from all assessments were plotted in the two axes plot shown in Figure 1. The analysis revealed two dimensions of lamb behaviour explained by the first two principal components (PC1 and PC2) corresponding to 28 and 15 % of the variance, slightly lower than reported in lambs (Mialon et al., 2021) and goats (Battini et al., 2018) but similar to those observed in extensively reared sheep (Richmond, 2016).

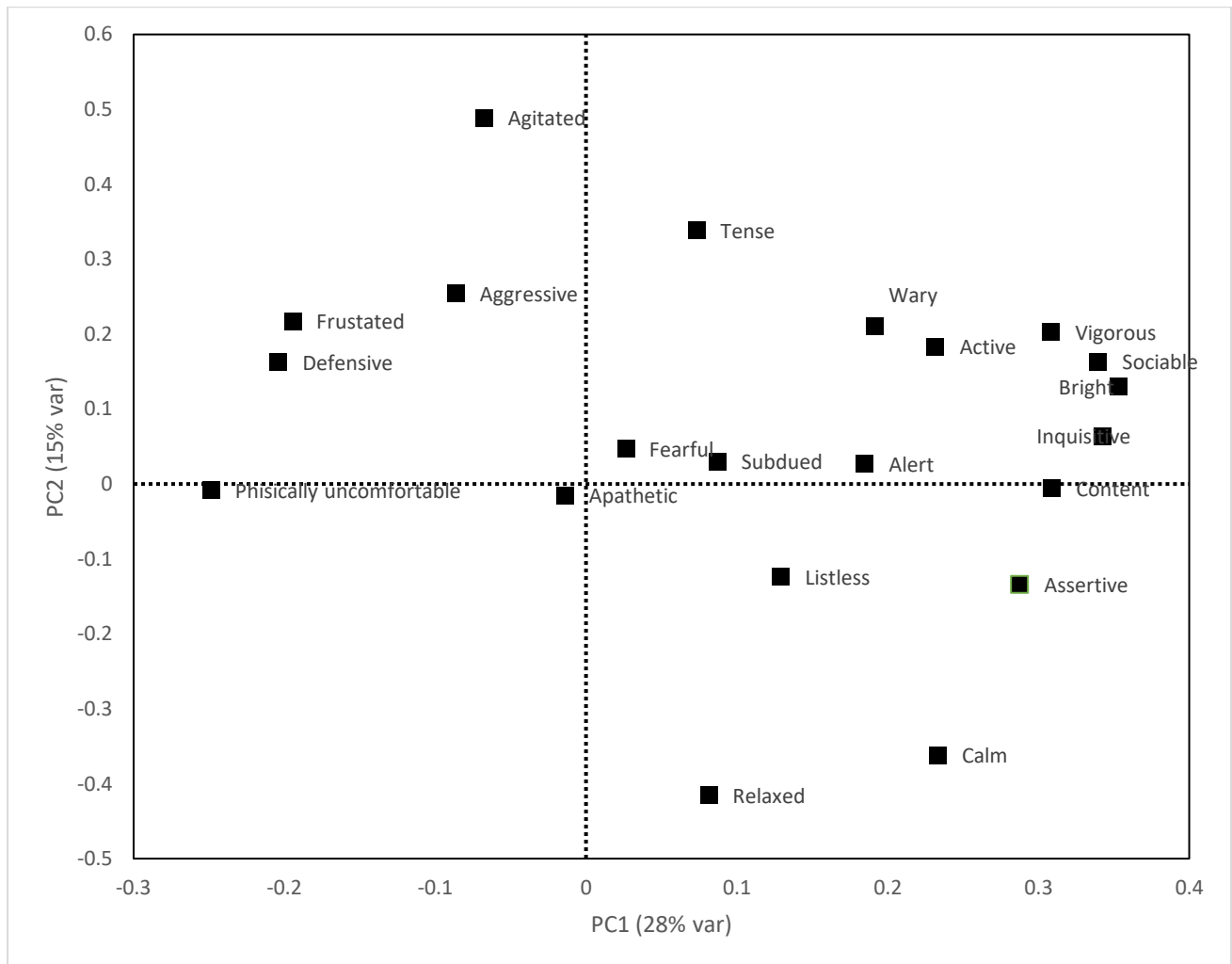


Figure 1. PCA plot of Qualitative Behaviour Assessment descriptors.

According to this plot, the most desirable QBA scores are for farms described on PC1 positive and PC2 negative values; the least desirable QBA scores are for farms described on PC1 negative and PC2 positive values (Table 5).

Table 5. Indicators classified by their location in the first two principal components.

	PC1	PC2
Positive	Bright, inquisitive, sociable, content, vigorous, assertive, calm, active, wary, alert, listless, subdued, relaxed, tense, fearful	Agitated, tense, aggressive, frustrated, wary, active, sociable, defensive, bright, inquisitive, fearful, subdued, alert
Negative	Physically uncomfortable, defensive, frustrated, aggressive, agitated, apathetic	Relaxed, calm, assertive, listless, physically uncomfortable, apathetic

Although all the farms seemed to meet the minimum requirements to ensure a high degree of welfare for the animals, the objectification of the emotional state through the QBA seems to yield highly variable results. Indeed, QBA offers a different point of view on animal welfare and does not need to be directly linked to the other mentioned indicators (Battini et al., 2018).

Thus, the representation of each assessment (Figure 2, each point representing an assessment) on the PC axes places them in very different positions. This diversity is mainly due to the heterogeneity of the farms, as has already been shown when detailing their characteristics. Likewise, the behaviour and mental state of lambs reared in intensive and extensive conditions might be not comparable, given their different habituation to different stimuli, such as positive or habitual handling (Mota-Rojas et al., 2020). In this sense, animals raised in intensive systems do not have to fear of predators (as it may happen in extensive systems), since they have closed contact to humans who handle them (Cramer et al., 2020).

Those assessments performed in the intensive and semi-intensive farms are grouped around positive PC1 values, while the most extensive ones are distributed less grouped and in negative PC1 values (Figure 2). In fact, extensively reared lambs scored higher in descriptors such as aggressive, defensive, physically uncomfortable or apathetic, whereas intensively reared lambs showed higher values in descriptors such as agitated and fearful but also in other as active, sociable, vigorous, subdued, calm, inquisitive and assertive.

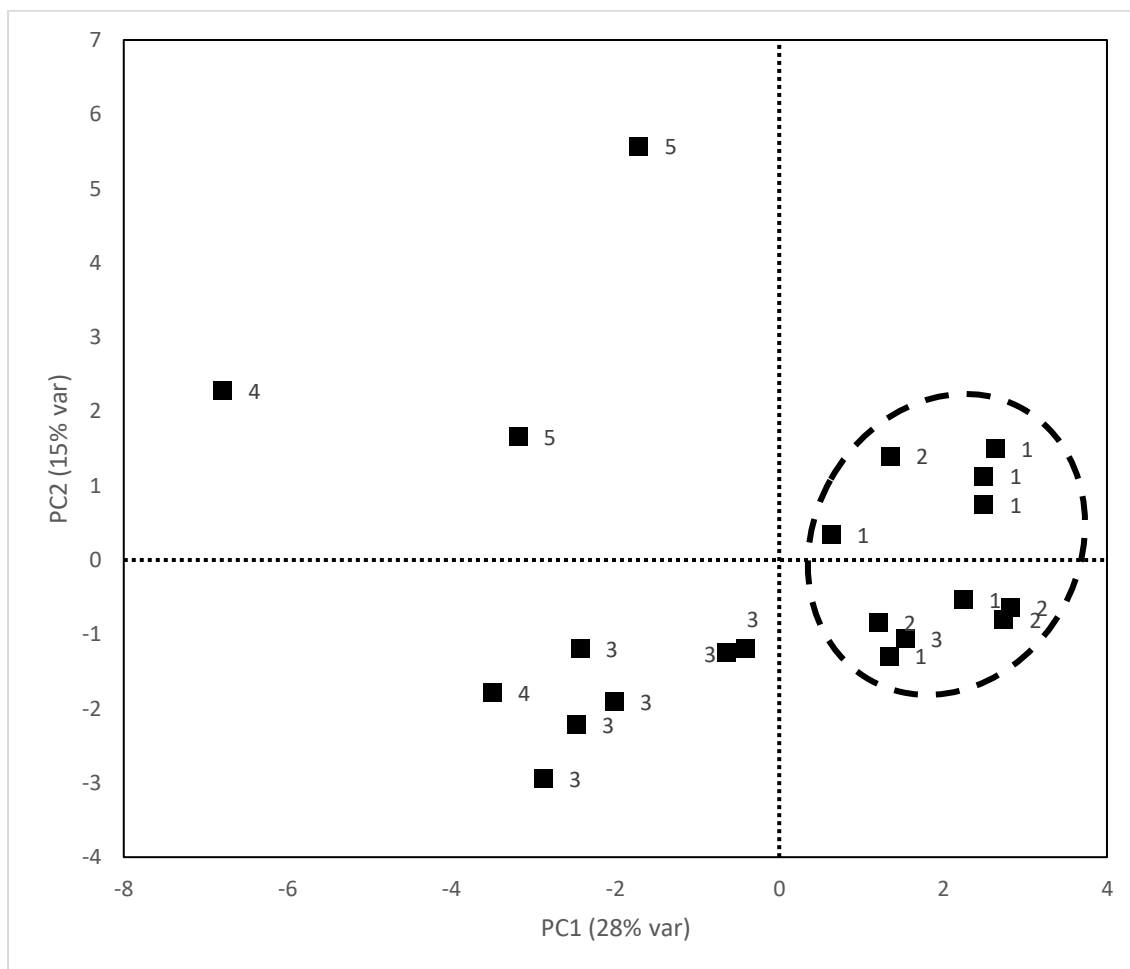


Figure 2. Graph representation of the farms (each dot is a surveyed farm) within the first two components of the principal component analysis performed on QBA indicators. The numbers correspond to the production system to which each farm was classified (1=intensive; 2=semi-intensive; 3=semi-extensive; 4= extensive; 5=shepherded).

Albeit it is not the objective of this work to give an idea of the emotional state of all the lambs reared in all the productive systems of Europe, this first approximation seems to indicate that lambs reared in intensive conditions show an apparently calmer mental state than those reared in very extensive conditions. In this sense, according to Battini et al. (2018), QBA can promote a discussion about the mood and level of activity of the animals.

## **Conclusion**

On average, these results showed that fattening lambs in different locations across Europe, apart of good feeding for commercial purposes, they were provided with:

- Good housing. Fleece was mainly clean and only in one case animals were subjected to mild heat stress with no access to shade. Ease of movement was ensured always (no need to assess in extensively reared animals), with stocking densities above 1,5 sqm per lamb and no hoof overgrowth.
- Good health. Despite some individuals having very small fleece loses, punctuation achieved by all the farms indicated a general absence of lesions in body, head and legs. Likewise, lameness, faecal soiling and ocular discharge were absent, mucosa colour was right (not anaemic), and respiratory and fleece quality presented no major issues. Moreover, despite some farms used to carry out castration, lambs for the current project were not castrated.
- Appropriate behaviour. Lambs were kept together (there was no social withdrawal), with no signs of generalized stereotypes or excessive itching. The familiar human approach test revealed an average (and median) flight distance of 2 m, with animals approaching humans after a short period of time (no fear).

Even if the rearing conditions fully complied with the minimum requirements to ensure animal welfare, animals from different rearing systems seemed to express different degree of positive emotional state.

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