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Ciclo XXX

Animal welfare in mountain dairy farms: an approach *from farm to fork*

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Leonardo Zanier in Libers…di scuignì lâ, Poesie 1960-62
Ed. Ediesse, Roma 1998

Abstract

Animal welfare is a key component of the ecosystem services framework in mountain areas and represents a topic of growing concern among public opinion. This study was conducted to test at first whether standard welfare assessment protocols for dairy cattle, such as the Welfare Quality®, are able to identify critical farm in terms of welfare outcomes (animal-based measures) when applied to small-scale, traditional mountain farms. Since the standard protocol was deemed unsuitable, the EFSA protocol for small-scale dairy farms was used in both housed and pasture-based conditions in traditional mountain farms practicing the vertical transhumance during summer-time. As a third step, consumers' attitudes and perspectives on animal welfare in mountain farms were also collected. Given the role of mountain farming in maintaining ecosystems and ensuring the delivery of public goods and services, the results of this study aim on the one hand to contribute towards the development of welfare assessment protocols fitted for the purpose and on the other hand to set the basis for an effective and transparent dialogue among stakeholders.

List of Publications

International journals

European Food Safety Authority, 2015. Scientific Opinion on the assessment of dairy cow welfare in small-scale farming systems. EFSA Journal, 13, 4137-4239.

Zuliani, A., Romanzin, A., & Bovolenta, S. (2016). Animal welfare and ecosystem services in mountain areas. Options Mediterraneennes, Series A, 116, 223-226.

Zuliani A., Romanzin A., Corazzin M., Salvador S., Abrahantes J.C., Bovolenta S., 2017. Welfare assessment in traditional mountain dairy farms: above and beyond resource-based measures. Animal Welfare, 26, 203-211.

Zuliani A., Mair M., Kraševec M., Lora I., Brscic M., Cozzi G., Leeb C., Zupan M., Winckler C., Bovolenta S., 2017. A survey of selected animal-based measures of dairy cattle welfare in the Eastern Alps: towards context-based thresholds. Journal of Dairy Science, 101, 1428 -1436.

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Table of contents

1. Introduction

1.1 The evolving paradigm of animal welfare

Animal welfare has become a major concern for public opinion and consumers mainly since the intensification of animal production (Fraser D. G., 2005) that took place after the second World War. In 1965 the UK government commissioned a study on the welfare status of animals intensively farmed, which resulted in the Brambell Report and the internationally known "Five Freedoms" (Brambell Committee, 1965). More specifically, they referred to the freedom from thirst, hunger, fear, distress, discomfort, pain, malnutrition, injury, disease and expression of natural behavioural. The Five Freedoms paradigm was better defined and further extended by John Webster (1994) adding a checklist useful to evaluate husbandry systems, referred as Five Provisions. The Five Provisions, even more than the Five Freedoms have certainly influenced animal welfare legislation (e. g. Council Directive 98/58/EC concerning the protection of animals kept for farming purposes) and are the basis of many private assurance schemes in the European Union (Mellor, 2016).

In contrast to the relevance of provisions (or resources) for the attainment of good animal welfare, Donald Broom (1996) stated that "a useful scientific definition of animal welfare is that it must refer to a characteristic of the individual animal rather than something given to the animal by man". This statement paved the way to the inclusion of animal-based measures into welfare assessment protocols (Whaytt et al., 2003). The Welfare Quality® (Welfare Quality®, 2009) was one of the largest research project aiming at developing a standardized methodology for the assessment of animal welfare in order to translate animal welfare assessments into easily understandable product information for consumers. Despite the Welfare Quality consortium made the attempt to develop standard protocols suitable for all

faming systems and combing animal-based, resource-based and management-based measures, the framework (see Chapter 3, Table 3.1) and the measures therein were tailored to indoor housing and intensive farming systems. In order to address the lack of information regarding welfare assessment in extensive and small-scale farming systems, the European Food Safety Authority (EFSA) was asked to provide a scientific opinion on the feasibility of current welfare assessment methods in so-called non-conventional small-scale dairy farming settings (characterized by e.g., maximum 75 lactating cows, dual purpose/local breeds, family-run farms). One of the outcomes was a protocol modified after the Welfare Quality® for small-scale dairy farming systems (EFSA, 2015). Despite a few indicators (e.g. lying time and social behavioural indicators) that were excluded due to the long time needed to collect them, all animal-based measures were considered suitable to assess independently the welfare status of the herd even in small-scale settings. In addition, while the variability of available resources (i.e. risk factors) and animal-based measures was great within the sample, no significant relationship was found between the presence of risk factors and negative welfare outcomes. These results were consistent with previous findings (Fraser D., 2014) on the importance of relying on animal-based measures, instead of available resources, to define the welfare status of the herd, as the range of welfare outcomes can vary greatly even if similar resources are provided. This assessment approach based on welfare outcomes was recently embraced also by the World Organization of Animal Health (OIE, 2015) and the International Standard Organization (ISO, 2016) in their effort to outline welfare management plans relevant at the global level and applicable at a local scale.

1.2 Mountain farming and ecosystem services

Mountain areas represent almost 30% of the European Union and have 18% of agricultural holdings which contribute to around 8% of the total EU agricultural output (European Environment Agency, 2010). The primary sector employs comparatively more people in mountain areas than in the lowlands and more than half of the revenues are linked to livestock farming. Mountain farms are in general smaller than those in lowlands since the topographic and climatic constraints have limited the opportunities for intensification. While these limitations have on the one hand often curbed the chances for increasing mountain farmers' incomes, on the other hand they have resulted in a higher delivery of ecosystem services (McMorran, et al., 2015). The ecosystems services framework was first developed for the United Nations Millennium Development Assessment and was used to estimate the contribution of ecosystems to human well-being (Millennium Ecosystem Assessment, 2005). Mountain ecosystems support about one quarter of terrestrial biodiversity and their conservation is considered pivotal for sustainable development (United Nations, 2015). For instance, the small-scale and diversified nature of mountain agriculture plays a key role in maintaining a range of highly valued species and habitats, such as grasslands (European Environment Agency, 2004). At present, however, with the exception of some provisioning services (e.g. food), most of the ecosystem services are either undervalued or have no market value at all. Being able to measure and quantify in economic terms the value of ecosystem services would help inform policymakers and consumers about the real costs and benefits of what is produced and eventually support those systems that contribute the most to their maintenance. In fact, farm and land abandonment, as it is currently experienced in the Alps, not only would have an impact on biodiversity, but could also affect socio-economic aspects determining the loss of traditional productions or cultural landscapes (Battaglini et al., 2014).

Given the abovementioned positive externalities linked to mountain production systems as well as their fragility, the EU has recently introduced the optional quality term "mountain product" in the Regulation No. 1151/2012 and in the Delegated Act No. 665/2014 in an attempt to support mountain agriculture and unlock the market advantage of mountain products.

1.3 Animal welfare and ecosystem services in mountain areas

In this thesis it is suggested that animal welfare should be considered as a key aspect of the ecosystem services framework in mountain areas (Zuliani et al., 2016). The relationships between ecosystem services and animal welfare as well as the role domesticated ruminants play in mountain ecosystems is displayed in Figure 1.1. Animals rely on provisioning (e.g. forage) and regulating services (e.g. clean water) to achieving good welfare levels. At the same time good animal welfare seems pivotal to ensuring human well-being. For instance, enhanced animal welfare is linked to provisioning services such as safer human food (Noordhuizen and Metz, 2005), to regulating services such as disease regulation (Keesing, et al., 2010) and to cultural services such as humane treatment of animals (McGlone, 2001).

This win-win relationship between human, animal and environment well-being has recently been framed within the "One Welfare" concept (Pinillos et al., 2016) and seems of special relevance where small-scale, semi-extensive livestock farming systems such as those located in mountain areas, represent the means of preserving ecosystems and ensuring the provision of its services to people well beyond mountain areas.

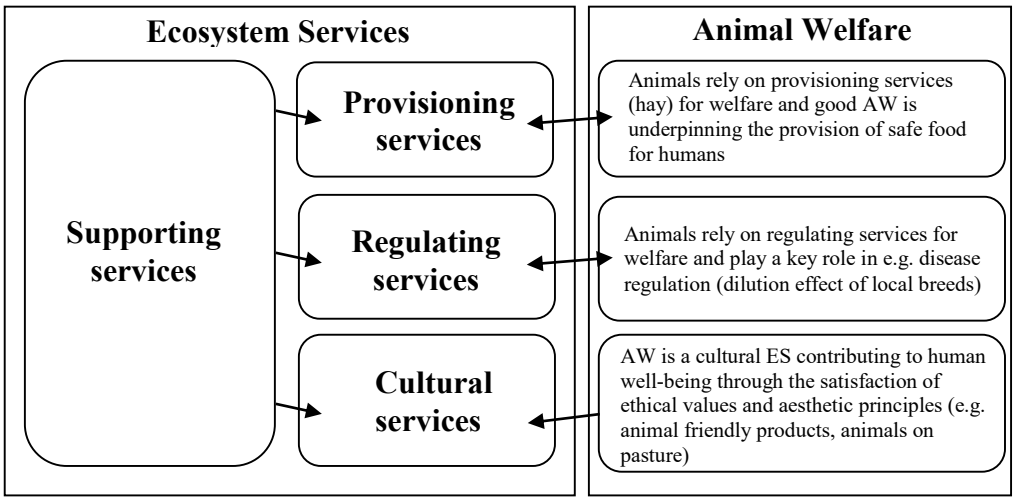

Figure 1.1 Relationship and interdependences between the ecosystem services framework and animal welfare.

For what concerns animal welfare in mountain farms, it is thus crucial not only to make sure that good welfare outcomes are obtained but also that the proper assessment methods are applied.

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2. Aims

Given the suggested key role of animal welfare in the ecosystem services framework and the importance of suitable welfare assessment tools for monitoring and thus ensuring good welfare outcomes in mountain farming systems, this research project aims at:

1. testing whether standard welfare assessment protocols for dairy cattle such as the Welfare Quality® are suitable for traditional mountain faming systems. More precisely, the first paper aims at exploring the appropriateness of using Ease of Movement, as an indicator of animal welfare, instead of animal-based measures, to identify critical farms in terms of welfare. We initially compared welfare scores obtained using the Welfare Quality protocol for dairy cows in alpine farms where cows are considered: i) tethered all year round (but some have access to pasture for less than 100 days); and ii) tethered but having access to pasture for more than 100 days or reared in loose-housing systems (with or without access to pasture) to seek differences between the two groups. Then, welfare was investigated on the basis of animal-based measures, neglecting information on management and resources.

2. applying the EFSA protocol for small-scale dairy farms on traditional mountain farms of the Eastern Alps still practicing the summer transhumance to highland pastures. More precisely, the aim of the second paper was to measure welfare outcomes before, during and after pasture turn out in a sample of small-scale dairy cattle farms in Italy, Austria and Slovenia. This study wanted to contribute to the identification of critical welfare conditions and achievable welfare outcomes for the different husbandry conditions characterizing a

transhumant system. Moreover, a comment on context-based benchmarking as a method for encouraging action-taking and ultimately drive welfare improvement on farm was given.

3. investigating consumers' attitudes and perspectives towards dairy cow welfare in mountain farms. In the third paper three research objectives were identified in order to highlight potential communication gaps and opportunities between mountain producers and consumers. The first objective was to understand the way consumers conceptualize mountain environment and mountain farming. The second objective looked into consumers' preferences and acceptance on husbandry systems and thirdly, on consumers' preferences and knowledge on animal welfare attributes currently employed in dairy cow welfare assessment.

3. Welfare assessment in traditional mountain dairy farms: above and beyond resource-based measures

Original paper: Zuliani A., Romanzin A., Corazzin M., Salvador S., Abrahantes J.C., Bovolenta S., 2017. Welfare assessment in traditional mountain dairy farms: above and beyond resource-based measures. Animal Welfare. 26, 203-211.

3.1 Introduction

Mountain farms are small-scale, family businesses that greatly contribute to high-value food chains in terms of quality and diversity of their products (Kohler and Romeo, 2013). In addition, because of their size and low/local inputs, mountain farms deliver ecosystem services such as maintenance of cultural heritage, preservation of agro-biodiversity, disaster risk reduction and space for recreation and tourism that are vital for sustainable development far beyond mountain areas (Battaglini et al., 2014).

In Italy, 78% of mountain dairy farms are micro-scale enterprises with less than 20 cows and most of farms can be considered small-scale as not exceeding 75 lactating animals (EFSA, 2015). Despite a sharp farm abandonment rate of 64% that characterized the Italian Alps between 1980 and 2010, mountain farms still account for 44% of national dairy farms (ISTAT, 2012). In the Italian Alps, dairy cattle are traditionally kept indoors and tethered during winter in low-land farms and moved to highland pastures during summer (so called transhumance). A study carried out by Sturaro et al (2013) in the autonomous province of Trento, a mountain area in the northeastern Italian Alps, estimated that more than 70% of the farms in the province were using tie-stall systems. At the same time, the majority of farms (55 %) was practicing the traditional summer transhumance of lactating cows to highland pastures.

Animal welfare assessment is an ongoing challenge and several methods have been identified to assess it at herd level. The largest research project on animal welfare funded by the European Commission was the Welfare Quality® project (Blokhuis et al., 2010) involving 44

research institutes and universities from all over the world. The Welfare Quality Assessment Protocol (WQ, Welfare Quality® 2009) combined animal-based, resource-based and management-based measures in order to determine an overall level of welfare. The measures that affect animal welfare through the physical environment or available resources (eg housing system) are referred to as resource-based measures while the management practices (eg disbudding/dehorning) that could affect animal welfare are called management-based measures (EFSA, 2012). The response of an animal to these resources and management is assessed through animal-based measures (ABMs) which are increasingly preferred over resource-based and management-based measures (non ABM) among animal welfare experts because they reflect the actual response of animals to the environment and the management practices to which they are exposed to (Whay et al., 2003; EFSA, 2012; OIE, 2015). Nevertheless, for most citizens and consumers, animal welfare is mainly linked to housing systems (Te Velde et al., 2002; Vanhonacker et al., 2008) and the WQ for dairy cattle, within the principle of good housing, has a non ABM, Ease of Movement, that considers cows tethered all year round if they do not have access to an outdoor or pasture area for at least 100 days. The length of summer transhumance to highland pastures in the Alps is defined by the length of the vegetative season, which may or may not exceed 100 days depending on pasture altitude, gradient and other climatic factors. Thus, according to the definition of Ease of Movement and to the scoring systems of the WQ most farms, even if practicing summer transhumance, are classified as having a year-round tie-stall system and scored poorly on such a criterion. Permanent tethering for lactating cows is considered critical or even unacceptable in terms of welfare according to several studies (e.g. Ostojić-Andrić et al., 2011; Popescu et al., 2013) and has already been banned in some Scandinavian countries (e.g. Norway). On the other hand, tie stall systems where cows have access to pasture or are allowed to exercise are

deemed to ensure better outcomes for several welfare measures, such as lameness, metabolic and reproductive disorders (Corazzin et al., 2010, Popescu et al., 2014).

In this study we compared at first welfare scores obtained with the WQ for dairy cows in alpine farms where cows are considered: i) tethered all year round (but some have access to pasture for less than 100 days) and ii) tethered but having access to pasture for more than 100 days or reared in loose housing systems (with or without access to pasture) to seek differences between the two groups. Then we investigated welfare on the basis of ABMs neglecting information on management and resources. The aim of this work was to discuss the appropriateness of using resource and management-based measures and related thresholds in welfare assessment instead of ABMs to identify critical farms in terms of welfare by presenting the case of small-scale mountain dairy farms in the eastern Italian Alps.

3.2 Material and methods

Farm selection and visits

The WQ was used to measure dairy cow welfare in 46 farms in the Eastern Italian Alps (834 dairy cows and heifers were assessed). The target population was selected according to the known ratios of tie-stalls/loose housing systems and spread of traditional transhumance practice in mountain areas (Veissier et al., 2008; Sturaro et al., 2013), resulting in 80% of tie-stalls and transhumant systems and 20% loose housing (ie freestalls) and permanently indoor systems in the sample. All farmers were recruited through breed associations and were rearing dual-purpose breeds (i.e. Italian Simmental and Rendena). Two groups (23 farms vs 23 farms) in which different breeds where evenly allocated, were identified according to the definition of Ease of Movement described in the WQ. The first group was considered tethered all year (TAY) because cows were tethered for more than 265 days. In the TAY group, six farms had permanent tethering systems whereas the other 17 tie-stall farms provided cows with access

to summer pasture for less than 100 days. In the second group cows were either tethered only during winter and had access to summer pasture for more than 100 days or were reared in a loose housing system (TWiL) with or without access to pasture. More precisely, nine farms had a loose-housing system whereas all the other 14 tie-stall farms provided cows with access to summer pasture for more than 100 days. Three out of nine farms with a loose-housing system did not provide cows with access to pasture. Three observers with previous experience in dairy production were trained to use the WQ for dairy cattle and tested for inter-observer reliability reaching at least substantial agreement (Landis and Koch, 1977) in all ABMs considered for the study (Cohen's kappa for categorical variables or Spearman's rho for continuous measures > 0.6). Each observer visited 15, 15 and 16 farms respectively and a balanced number of TAY and TWiL farms. All farm visits took place during late-winter/early-springtime before the traditional summer transhumance to alpine pastures.

Welfare measures

Fifty ABMs and non-ABMs (Table 3.1) collected in the two husbandry systems, TAY and TWiL were collected strictly following the WQ definitions and methodologies (Welfare Quality® 2009). With the exception of information on time of access to pasture /outdoor run, rates of dystocia, downer cows, mortality, disbudding/dehorning and tail docking practices that were retrieved using a questionnaire, all remaining measures were collected on animals or on farm facilities. Recorded measures were aggregated into 12 criteria, four principles and into an overall welfare score (Welfare Quality® 2009). Calculation of scores followed a bottom-up approach where all measures taken at herd level were weighted by experts and aggregated into criterion-scores, then into principle-scores using a Choquet integral and finally into a farm overall-welfare score (Welfare Quality® 2009). Possible values for criteria and principles ranged between 0 and 100. The WQ distinguished four classes for the overall

welfare score according to the results obtained in the welfare principles: excellent when welfare was at the highest level (ie the farm was scored more than 55 in all principles and at least 80 in two of them); enhanced when animal welfare was good (ie the farm reached more than 20 in all principles and at least 55 in two of them); acceptable when animal welfare met minimum standards (ie the farm was scored at least 10 in all principles and more than 20 in three of them) and not classified when welfare was unacceptable (ie the farm did not reach at least 10 in all principles). Animal-level measurements were collected according to the WQ guidelines for sample size calculation. All animals were assessed in herds with 30 or less cows.

Statistical analysis

Welfare principles, criteria and measures obtained from the computation were compared between the two groups using logistic regression (TAY vs TWiL). A False Discovery Rate strategy was followed in order to control for multiplicity, as multiple testing in a single study results in an increased probability of detecting significant findings just by chance (Benjamini and Hochberg, 1995). Differences in the overall welfare scores between TAY and TWIL were assessed for significance using Fisher's Exact Test. The second part of the study aimed at investigating welfare using ABMs only and no information on resources and management. ABMs that were not seen in more than 90% of the farms were excluded from data analysis in order to avoid the development of clusters on the basis of rare conditions (eg hampered respiration was an uncommon condition, recorded in 4 % of farms and thus excluded from data analysis). Cluster analysis was performed using the R package ClustOfVar (Chavent et al., 2012) in order to put together variables which were bringing the same information based on a measure of homogeneity. Boostrap samples (n = 100) of the observations and the corresponding 100 dendrograms were obtained to define a stable partition. The number of

stable clusters of AMBs was defined as the number of clusters that produced the larger mean of adjusted Rand index (Hubert and Arabie, 1985). A principal component analysis (PCA) was first performed on the ABMs previously selected to reduce dimensionality with the condition to lose as little information as possible by maximizing the variance between components.

Table 3.1 Principles, criteria, measures and type of the Welfare Quality® assessment protocol for dairy cows. Animal-based measures (ABMs) retained for cluster analysis are displayed in bold**.**

Welfare Principles	Welfare Criteria	Welfare Measures	Type of measure
Good Feeding	Absence of prolonged hunger	**Very lean cows**	ABM
	Absence of Prolonged thirst	Is the number of functioning drinkers sufficient and clean? Are there at least 2 drinkers/cow?	Non ABM
Good Housing	Comfort around resting	Time needed to lie down Frequency of animals lying partly or completely outside the supposed lying area Frequency of collision with housing equipment during lying down **Cleanliness: udder; legs; flank**	ABM
	Thermal comfort	No measure has been developed yet	-
	Ease of movement	Is the cow tethered all year round (>265days)? Does the cow have regular exercise (1h/day)?	Non ABM
Good Health	Absence of injuries	**Hairless patches** (carpus, **tarsus, hind leg, side/udder, neck/shoulder**); **lesions** (carpus, **tarsus**, hind leg, side/udder, neck/shoulder); **swellings** (carpus, **tarsus**, hind leg, side/udder, neck/shoulder); **lameness**	ABM
	Absence of disease	**Nasal discharge**, ocular discharge, hampered respiration, **coughing**, diarrhea, **mastitis (somatic cell count) , vulvar discharge, dystocia, downer cows, mortality**	ABM
	Absence of induced pain	Dehorning, disbudding; use of analgesics, anesthetics Tail docking with rubber ring or surgery; use of analgesics, anesthetics	Non ABM
Appropriate behaviour	Expression of social behaviour	Frequency of **head butts** and **displacements**	ABM
	Expression of other behaviours	Percentage of days/year with at least 6h on pasture	Non ABM
	Good human-animal relationship (GHAR)	Cows that can be touched (**GHAR1**), that can be approached closer than 50 cm (**GHAR2**), between 100 and 50 (**GAHR3**), and above 100 cm (**GAHR4**)	ABM
	Positive emotional state	**Qualitative behaviour assessment (QBA)**	ABM

Once the principal components explaining up to 80% of the total observed variability (Lê et al., 2008) within ABMs were obtained, a hierarchical clustering analysis of farms was performed using as input those principal components. The number of clusters was defined looking at the minimum growth of within-inertia, which is a measure of variance within clusters. A Kruskal–Wallis test was used to test clusters' farm descriptors for statistical differences. Provided significance, post hoc tests with Bonferroni-type adjustment were applied to seek which of the pairwise comparison were responsible for the overall difference. All statistical analysis were performed using R version 3.2.2 (R Foundation for Statistical Computing, 2015).

3.3 Results

Welfare Quality® approach

The first part of this study investigated potential differences in welfare in two husbandry systems, TAY and TWiL using ABMs and non ABMs identified by the WQ project. Within the TAY group the mean number of cows per farm was 17 (standard error of the mean, SEM 1.9), the average number of days on pasture for all farms in the group was 60 (SEM 8.3) and the average milk production was 5 726 kg/cow/year (SEM 303.4). Within the TWiL group the mean number of cows per farm was 31 (SEM 6.7), the average number of days on pasture for all farms in the group was 117 (SEM 9.7) and the average milk production was 4 661 kg/cow/year (SEM 274.4).

Table 3.2 displayed farm descriptors collected in TAY and TWiL farms and sorted according to the overall welfare score obtained by each farm. No difference in terms of frequency of overall welfare score classes was found between TAY and TWiL (Fisher Exact Test, P = 0.183).

Similarly, no significant differences were found between TAY and TWIL when comparing welfare principles, criteria (Table 3.3) and measures (not shown).

Table 3.2 Overall welfare score and farm descriptors of TAY (cows tethered all year) and TWiL (cows tethered and having regular exercise or in loose-housing systems) farms chosen according to the definition of Ease of Movement (Welfare Quality 2009).

Overall Welfare Score	Number of farms		Mean number of cows per farm (SEM)		Mean milk yield, kg/year/cow (SEM)		Mean number of days tethered (SEM)		Mean number of days on pasture (SEM)	
	TAY	TWiL	TAY	TWiL	TAY	TWiL	TAY	TWiL	TAY	TWiL
Not classified	0	3	-	100 (13.7)	-	5298 (451)	-	0 (0)	-	120 (11.5)
Acceptable	18	13	19 (2.3)	18 (4.8)	5711 (369)	4283 (409)	314 (9.8)	178 (29)	51 (9.8)	117 (16.5)
Enhanced	5	7	11 (2.3)	25 (5.8)	5777 (493)	5088 (391)	274 (4)	139 (49)	93 (4)	105 (19.6)
Excellent	0	0	-	-	-	-	-	-	-	-

Animal-based approach

As no differences were highlighted between TAY and TWiL, we decided to seek meaningful groups of farms on the basis of ABMs only. Twenty-five ABMs out of 41 were retained for cluster analysis. The number of clusters that maximized the mean adjusted Rand index was 24, implying no real need to exclude additional ABMs from PCA. Principal component analysis identified 11 components which were used as inputs to develop a hierarchical clustering of farms. Four clusters of farms were deemed appropriate to describe our sample of mountain farms on the basis of ABMs (Table 3.4). Cluster 1 and 2 represented the most traditional alpine farms in terms of herd size, milk yield and days on pasture. Cluster 2 and 3 had the smallest mean herd size, 14 cows/ herd and 16 cows/herd respectively. Cluster 3 encompassed cows with high milk yields (significantly different from cluster 1 and 2, $P = 0.006$ and $P = 0.018$ respectively) and mostly permanent tethering housing system (significantly different from cluster 1, $P = 0.039$). Cluster 4 was made of 3 farms with the greatest mean herd size and with the shortest mean time spent tethered.

Table 3.3 Principles, criteria, measures of TAY (cows tethered all year) and TWiL (cows tethered and having regular exercise or in loose-housing systems) farms chosen according to the definition of Ease of Movement (Welfare Quality 2009).

	TAY				TWiL			
Principles Criteria	Mean	SEM	Median	Range	Mean	SEM	Median	Range
Good feeding	46.5	2.5	45.6	40.8	38.7	3.8	40.8	59.4
Absence of hunger	46.9	5.2	40.0	88.4	44.4	6.0	19.0	91.8
Absence of thirst	58.8	1.2	60.0	28.0	52.2	5.2	60.0	97.0
Good housing	25.7	0.9	26.4	19.1	50.8	3.3	42.4	52.3
Comfort around resting	46.4	2.7	48.4	56.2	49.9	2.3	52.1	44.2
*Ease of movement	15.0	0.0	15.0	0.0	59.8	6.9	34.0	66.0
Good health	66.3	4.0	66.9	63.8	54.5	3.7	49.0	65.9
Absence of injuries	87.4	2.6	91.6	41.0	91.8	1.2	93.0	22.2
Absence of diseases	74.0	4.3	64.6	63.4	59.4	4.0	56.6	66.7
Absence of pain	73.2	7.4	100.0	80.0	60.3	8.1	28.0	80.0
Appropriate behaviour	43.2	2.1	41.7	38.5	51.9	2.6	53.0	54.5
Social behaviour	96.3	2.2	99.9	49.6	91.4	1.9	96.4	36.1
Other behaviours	27.7	3.9	41.6	43.7	52.6	4.4	53.6	99.9
Good human-animal relationship	78.9	2.7	80.4	64.5	76.1	3.3	77.0	68.3
Positive emotions	48.1	3.7	48.8	68.5	48.3	3.4	45.1	74.7

*Not included in the analysis

Results of cluster analysis are displayed in a heat map (Figure 3.1) which is a cross-tabulation of cluster of farms and ABMs. The main feature of cluster 1 in comparison to the others was a moderately high rate (10.8 %) of cows with somatic cell count (SCC) above 400 000 cell/ml. The main feature of cluster 2 is a moderately high rate (12.6 %) of cows displaying nasal discharge. Additionally, the frequency of headbutts expressing agonistic behaviors was the highest (0.4) among all clusters. Cluster 3 is characterized by moderately high mean prevalence of integument alterations on the tarsal region expressed as hairless patches (24 %), lesions (13.7 %) and swellings (26.2 %). Highly positive patterns were observed on measures related to health status as no signs of nasal discharge, vulvar discharge, dystocia and mortality on farm were reported. Positive emotional state and good human-animal relationship were also considered important features of cluster 3. Main features of the cluster 4 were integument

alterations related to hairless patches found on the side/udder and the hindquarter and poor behavioural and human-animal relationship.

Table 3.4 Farm descriptors and animal-based measures mean values in four cluster of alpine dairy farms

Farm descriptors	**Cluster** (mean)			
	1	**2**	**3**	**4**
Number of farms	28	11	4	3
Number of cows (mean)	26	14	16	54
Milk yield (mean Kg/cow/year)	4835[a]	4932[a]	8258[b]	5402[ab]
Days tethered (mean)	207[a]	252[ab]	342[b]	115[ab]
Days on pasture (mean)	92	93	22	100
Animal-based measures				
Nasal discharge (%)	3.0	12.6	0.0	1.2
Vulvar discharge (%)	1.7	0.8	0.0	0.0
Dystocia (% last 12 months)	2.9	3.8	0.0	6.2
Downer cows (% last 12 months)	0.8	1.3	4.2	2.5
Mortality (% last 12 months)	1.7	0.0	0.0	4.3
Coughing (coughs/cows/15min)	2.3	3.9	1.0	7.3
Somatic cell count (% > 400 000 last 3 months)	10.8	2.4	3.8	4.0
Very lean cows (%)	14.1	20.1	19.8	19.0
Hairless patches tarsus (%)	10.5	13.1	24.0	4.0
Hairless patches hindquarter (%)	5.2	2.1	0.0	25.6
Hairless patches neck/shoulder (%)	2.7	2.4	8.3	8.0
Hairless patches side/udder (%)	1.5	3.0	10.3	13.6
Lesions tarsus (%)	0.5	2.4	13.7	1.3
Swellings tarsus (%)	0.5	1.8	26.2	0.0
Severe lameness (%)	4.0	1.5	3.4	0.0
Dirty legs (%)	52.6	85.7	64.3	74.8
Dirty flanks (%)	29.0	57.3	60.1	44.6
Dirty udder (%)	7.1	32.1	20.9	17.3
Headbutts (frequency)	0.2	0.4	0.1	0.2
Displacements (frequency)	0.1	0.1	0.0	0.1
Positive emotions score	46.0	49.3	68.0	37.4
Cows touched, GHAR1 (%)	65.6	75.9	72.6	31.5
Cows approached closer than 50 cm, GHAR2 (%)	29.9	18.3	25.8	30.9
Cows approached between 50 and 100 cm, GHAR3 (%)	3.5	4.3	1.1	19.0
Cows approached over 100 cm, GHAR4 (%)	1.0	1.5	0.6	18.6

[a-b] Farm descriptors' differences in Kruskal-Wallis test followed by Bonferroni's post-hoc comparison ($P < 0.05$)

Positive emotions score (37.4) was reported to be the lowest among cluster. Almost 40 % of the cows could not be approached at all (over 100 cm, GHAR4) or approached between 50 cm and a meter (GHAR3) when tested for a good human-animal relationship. Additionally, high rates of dystocia (6.2%) and coughing episodes (7.3%) were observed on farms belonging to cluster 4.

All clusters showed poor conditions in terms of cleanliness. More than 50% of animals in all clusters had dirty lower legs, ranging from 52.6 % of cluster 1 to 85.7 % of cluster 2. Udder cleanliness conditions ranged from 7.1 % of dirty udders in cluster 1 to 32.1 % of dirty udders in cluster 2. High rates of very lean cows were also observed in all clusters (range: 14.1%-20.1%).

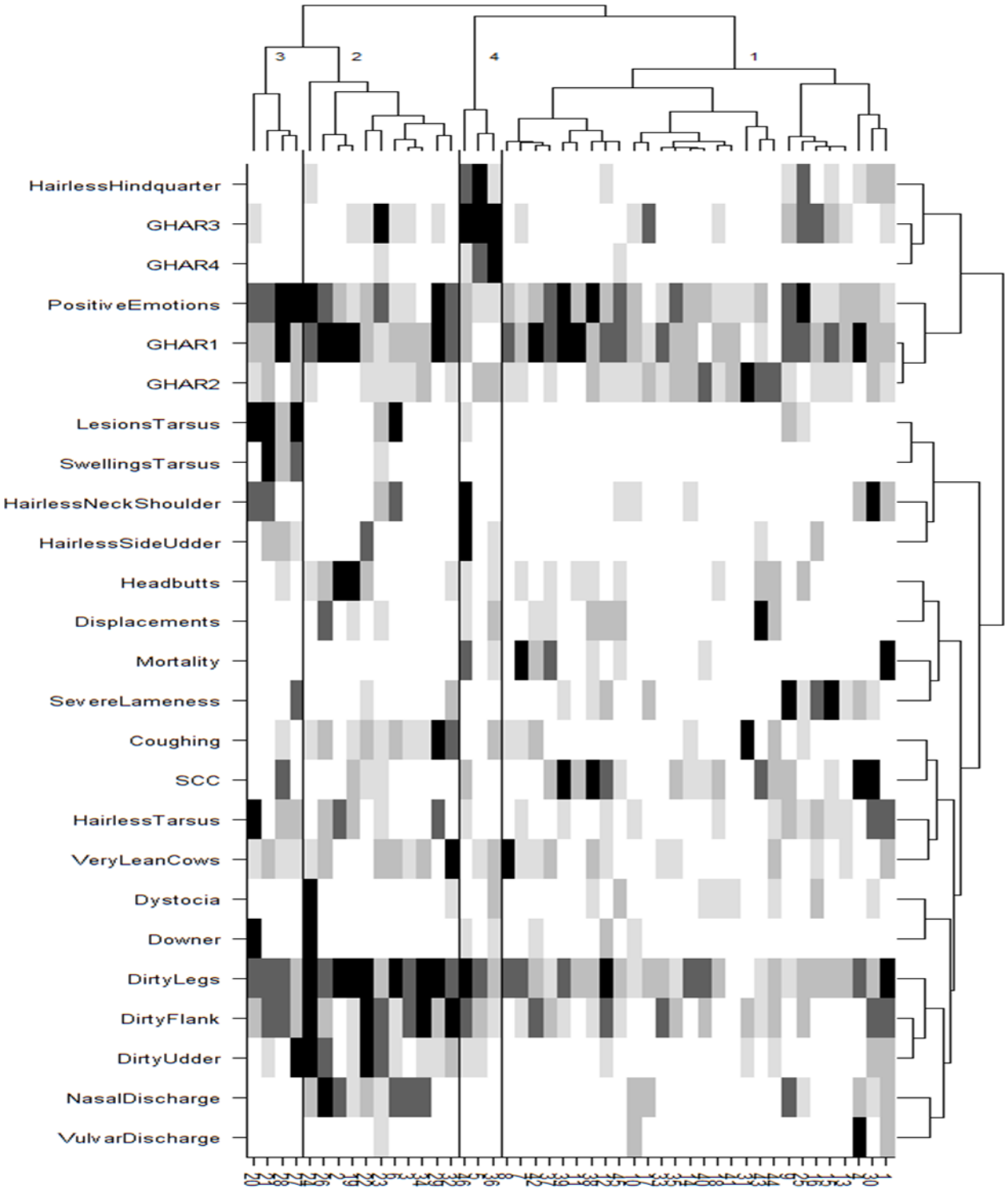

Figure 3.1 Heatmap displaying results of cluster analysis performed on ABMs (rows) and farms (columns). Five levels of shading (white to black) based on a 20% increment of occurrence were used for each welfare condition (positive or negative) in the corresponding farm. Dendrogram branches were named according to the farm cluster number.

3.4 Discussion

The Welfare Quality® protocol when applied to a sample of mountain dairy farms was unable to capture differences in terms of welfare between cows considered tethered all year round (TAY) and cows in a tie-stall system with regular exercise or in a loose housing system (TWiL). Despite the growing concerns towards permanent tethering, all farms in TAY group reached an "acceptable" level of welfare, whereas three farms with loose-housing system (TWiL group) resulted "not classified" because of their unacceptable levels of welfare. It is however worth considering that "enhanced" levels of welfare were achieved only in those farming systems practicing the summer transhumance to highland pastures and belonging to both TAY and TWIL groups. In this regard, the threshold of 100 days on pasture seems inappropriate for discriminating housing systems (TAY vs TWiL) and inform welfare scores given that the length of access to summer pasture is dependent on the length of the vegetative season (ie about 90 days in the Italian Alps). On the other hand, an ABMs approach as suggested in the second part of this study may help farmers and welfare specialists in identifying and addressing specific animal-welfare issues regardless of the housing system involved. As shown by clusters 1 and 2 (Figure 3.1 and Table 3.4), good level of welfare may be reached in most tie-stall farms which provide cows with an average of 90 days of access to high-land pastures when comparing animal-based measures collected in this study with those found in the literature. In fact, several studies investigated welfare of dairy cows both in loose-housing and tie-stall systems (Popescu et al., 2013; Burow et al., 2013; de Vries et al., 2015), some focused on mountain regions or low-input systems (Regula et al., 2004; Mattiello et al., 2005; Corazzin et al., 2010; Kirchner et al., 2014) and one targeted small-scale farming systems (EFSA, 2015). In our study the main signs of disease associated to dairy production (Oltenacu and Broom, 2010) displayed lower than usual mean prevalence. Severe lameness

ranged between 0 and 4.2 % while the mean prevalence of lameness is deemed to be around 20% (de Vries et al., 2013; Burow et al., 2013; Popescu et al., 2013). Severe lameness is generally less prevalent in tie-stall systems (Sogstad et al., 2005) and was also reported at lower rates (Corazzin et al., 2010; Mattiello et al., 2011) in other mountain farming systems rearing dual-purpose and low yielding breeds. Swellings and lesions were reported at rates that ranged between 11% (Popescu et al., 2013) and 43% (de Vries et al., 2013) whereas we observed prevalences that ranged between 0.5 and 26.2%. This finding might be related to different productivity levels associated to breed type and is supported by similar results presented by Mattiello et al. (2011). In fact, higher swelling and lesion rates (26.2% and 13.7% respectively) were observed in cluster 3 where the highest milk yields (significantly higher than milk yields in clusters 1 and 2) were also reported. In our study, high SCC were recorded in 2.4 and 10.8% of cows while being reported to be between 6 and 14% of cows by Popescu et al. (2013) and between 8-13% by de Vries et al. (2013). Moreover, SCC expressed as the mean bulk-milk value (198092 cells/ml) was also lower than that reported by Bovolenta et al. (2008; 2009) and Romanzin et al. (2013) in dairy cows reared in mountain area. Despite higher SCC being reported in farms with poor cleanliness conditions (Dufour et al., 2011) which were a concern in all clusters and in similar studies regardless of the housing system, cluster 1 had high SCC prevalence but good udder cleanliness levels (warning threshold for high SCC was set at 19 % of cows/herd by de Vries et al., 2014). Mean rates ranging between 14.1 and 20.1% of very lean cows were observed in our study. Our values were higher than those reported in other studies which were spanning between 3% (de Vries et al., 2013) and 17% (Burow et al., 2013). This finding might be due to the fact that in transhumant systems calving is usually planned to happen during winter resulting in more cows at peak lactation during late-winter/early-springtime, when our study was performed.

Cluster 3, with its small farms, with higher milk yields and little access to pasture showed the best outcomes in all behavioural measures. Upper-end values in good human-animal relationship (GHAR 1) and ranging from 65.6% and 75.9% of cows accepting contact with humans were reported for all smaller farms and mainly in tie-stall systems such as those represented by clusters 1, 2 and 3. This finding is consistent with the fact that better human-animal relationship is more common when frequent interactions between cows and stockmanship are maintained (Uetake et al., 2002). However, high values in both positive emotional state (QBA) and GHAR were also reported in organic and low-input Spanish farms (Kirchner et al., 2014) and in herds with prolonged (120-300 days) access to pasture (EFSA, 2015). Positive findings on behavioural measures in such a wide variety of husbandry systems could underline the role of management skills and knowledge more than farm's physical resources in determining good animal welfare outcomes (Fraser 2014). This could also explain why frequency of agonistic behaviours, which are inversely related to good social outcomes (i.e. the lower the frequency the better the score) was lower in cluster 3 than what reported by Popescu et al. (2013) in other tie-stall systems with and without regular exercise. Mean frequency of headbutts per cow per hour in all-year tie-stall systems in Romania was reported to be 0.52 whereas mean frequency in cluster 3 (where cows were tethered for longer time) was 0.1. Similarly, frequency of displacements was more than ten times lower in cluster 3 compared to what reported by Popescu et al. (2013). However, agonistic behaviours were recently removed from the protocol for small-scale farms for being too time-consuming in such a context (EFSA, 2015). In addition to a time issue, measures taken from small-scale farms might be misleading on the real occurrence and prevalence of targeted conditions in those herds, as they could represent the condition of a single animal more than the actual prevalence of the condition in the herd. To avoid the issue, several studies select herds with a

minimum size of 30 (Ostojić-Andrić et al., 2011; Popescu et al., 2013) which would however exclude most farms located in mountain areas from the analysis. Repeated assessments would therefore be beneficial in order to identify recurrent issues in small-scale farms. Moreover, as already suggested by Weary et al. (2016), a wider stakeholder involvement aiming at understanding and incorporating animal welfare concerns of the general public into the science-based assessment methodologies would contribute to create a more comprehensive and thus effective approach to improve dairy cow welfare.

3.5 Conclusion and animal welfare implications

Welfare data collected in this study suggested that tie-stall systems do not necessarily produce negative welfare outcomes. The pressure for welfare improvement in the dairy sector should not focus simply on banning tethered systems but on identifying specific welfare issues through the collection of relevant ABMs. In fact, the case of small-scale mountain farms, showed how resource-based measures such as Ease of Movement and related thresholds for acceptability (ie at least 100 days of access to pasture) were not useful in discriminating critical farms in terms of welfare. Conversely, a selection of ABMs was helpful for clustering farms according to their major welfare characteristics. In a second step of the on-farm welfare assessment process, non-ABMs could play a role as potential risk factors to be investigated in order to correct those management practices negatively affecting dairy cow welfare.

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4. A survey of selected animal-based measures of dairy cattle welfare in the Eastern Alps: towards context-based thresholds

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4.1 Introduction

Animal welfare has become a major public concern in the debate regarding sustainable livestock farming (Fraser, 2005) and societal expectations towards improved animal welfare have to be met by all farming systems. In order to ensure animal welfare, robust assessment methods are required. In Europe, the Welfare Quality® project (Blokhuis, 2008) was one of the most important efforts towards the development of on-farm welfare assessment systems aiming at transferring science-based measures into reliable and transparent information to consumers. The framework and the measures therein were tailored to indoor housing and intensive farming systems (Welfare Quality, 2009). Despite the ongoing global agricultural transition to intensive and large-scale farming systems, small-scale farms are still the majority in Europe. Mountain farms are one example of traditional small-scale operations (Wymann von Dach et al., 2013), mainly due to environmental and topographical conditions. In order to address the lack of information regarding welfare assessment in small-scale dairy farms, the European Food Safety Authority (EFSA) provided a scientific opinion on the feasibility of current welfare assessment methods in so-called non-conventional small-scale dairy farming settings (characterized by e.g., maximum 75 lactating cows, dual purpose/local breeds, family-run farms). One of the outcomes was a protocol modified after the Welfare Quality® protocol (WQ) for small-scale dairy farming systems (EFSA, 2015) applicable to farming systems in which cows have access to pasture all year round, seasonally (summer) and no

access to pasture at all. This protocol was tested on 124 farms in 4 European countries (Austria, France, Italy, and Spain). However, the assessments were performed for consistency reasons during winter and thus cows in mountain farms with summer grazing on highland pastures were only evaluated indoors.

Recently, the importance of performing dairy cattle welfare assessment using animal based-measures (ABMs) and acknowledging context-based variability in welfare outcomes was emphasized also by the World Animal Health Organization (OIE, 2015) and the International Standard Organization (ISO, 2016). ABMs are direct indicators of animal welfare and reflect - amongst others - the context characterizing each farming system (i.e. environment, resources and management practices). For example, dairy cattle farming in the Alps is often characterized by indoor housing during cold months and a pasture-based system during summer time. Moreover, in some regions summer grazing takes place at a higher elevation compared to the areas where winter farming takes place (Battaglini et al., 2014). This management practice aims at exploiting pastures located at higher altitudes during the warmest months of the year (i.e., from June to September). Most farmers let cows graze also on valley pastures before and after the transhumance to facilitate the transition from the indoor management and feeding system to the highland pasture-based system. This vertical transhumance, i.e. the shift from the valley to the highland areas and vice versa, implies a substantial change of environment, available resources and management practices. Thus, in transhumant systems combining indoor winter housing and pasture-based husbandry during summer, ABMs would need to be monitored throughout the year to capture the variation of welfare outcomes resulting from the change in context and to address the main issues characterizing each context.

The aim of this study was to assess ABMs, focusing on non-behavioural clinical outcomes, at different time points in a sample of small-scale dairy cattle farms practicing vertical transhumance in the Eastern Alps (Italy, Austria and Slovenia). The results can contribute to the identification of critical welfare conditions, to the discussion around achievable welfare outcomes for the different husbandry conditions characterizing a transhumant system as well as to inform targeted welfare management strategies.

4.2 Material and methods

Study area and farms

The survey was carried out in 67 small-scale dairy farms located in the Eastern Alps (Table 4.1). The study area is characterized by mountains and encompassed neighboring provinces of three European countries: Austria (Innsbruck, Tiroler Oberland, Tiroler Unterland; n = 25), Slovenia (Osrednjeslovenska, Gorenjska, Goriška; n = 21) and Italy (Trento, Bolzano, Vicenza, Udine; n = 21). The farms involved were selected through breeders' associations, dairy farmers' organizations and organic farming associations as well as using personal contacts. All farms met the criteria to be considered small-scale according to the definition of EFSA as described above (2015). The majority of farmers sold their products through cooperatives (73%) which produced mainly according to either the European 'Geographical Indication' or 'organic' certification schemes (54%). Moreover, only farmers practicing the traditional seasonal movement of the entire herd from valley farms to highland pastures during summer were included. With almost 70%, tie-stall systems were predominant in the sample as expected for small-scale systems in general and mountain farming systems during wintertime specifically (Nash et al., 2016; Sturaro et al., 2013).

Table 4.1 Farm descriptors of 67 alpine dairy farms practicing vertical transhumance.

Farm descriptors	Mean	Standard error	Min	Max
Dairy cows (n)	22	1.7	6	63
Milk Yield (Kg/cow/year)	5,928	183	3,330	10,200
Pasture (h)	3,080	167	1,200	11,568
Concentrate at peak lactation (Kg/cow/day)	5	0.3	0	10
Family members working in the farm (n)	3	0.1	1	6
Income from dairy production (%)	67	3.4	10	100
Farm surface (ha)	18	1.6	0	80
Altitude winter farm (m asl)	622	43.9	6	1,500
Altitude summer farm (m asl)	1,392	37.5	710	2,096

Data collection

The assessment protocol for non-behavioural animal-based measures (ABM) of welfare followed the methodology proposed by EFSA for small-scale dairy farms (EFSA, 2015). Although based on the WQ framework (Welfare Quality, 2009), the EFSA protocol differs from the latter as regards some measures. Records of coughing episodes were removed from the protocol as the EFSA working group considered this measure too time consuming. Instead, two additional measures were added as they were considered to be relevant for small scale systems: longevity (expressed as the percentage of cows in the fourth lactation or higher) and claw condition (classified as good condition or overgrown). The measure addressing ocular discharge was redefined by adding a new category (i.e. distinguishing between serous and purulent ocular discharge). Similarly, teats were considered separately from the rest of the udder when scoring for soiling.

All ABMs were collected complying with the EFSA adapted protocols. They were divided into ABMs observed (ABMo) and ABMs recorded (ABMr) from farm records. The former included body condition score (BCS), soiling, integument alterations (hairless patches, lesions, swellings and claw overgrowth) and clinical conditions (lameness/severe lameness, ocular discharge, nasal discharge, vulvar discharge, hampered respiration and diarrhea). The

ABMr aimed at retrieving information on longevity, incidence of downer cows, dystocia, sudden deaths or emergency slaughter/euthanasia (i.e. 'mortality') and milk somatic cell count (SCC) from farm records during "12-month-period". In addition, detailed information on farm characteristics, management and resources were collected in order to shed light on the Eastern alpine farming system and its practices (Figure 4.1). Assessments were carried out three times in each farm to capture the variation of non-behavioural ABMs along the seasonal changes in management and husbandry practices characterizing traditional transhumant systems of the Eastern Alps. Farm visits were divided in two parts: first, animals and resources were assessed in the barn or on pasture, and in a second step the farmer was interviewed to retrieve data on management practices and farm records. Sample size was determined according to WQ guidelines, which requires to assess all animals in herds of 30 or less and up to 50 animals in larger farms (maximum herd size 63 animals).

The first assessment was performed in the home farm at least two weeks before cows were moved to highland pasture; the second assessment was performed on pasture (5-7 weeks after cows had been moved to highland pasture); and the third assessment was performed in the home farm again (2-4 weeks after the cows had left the mountain pasture).

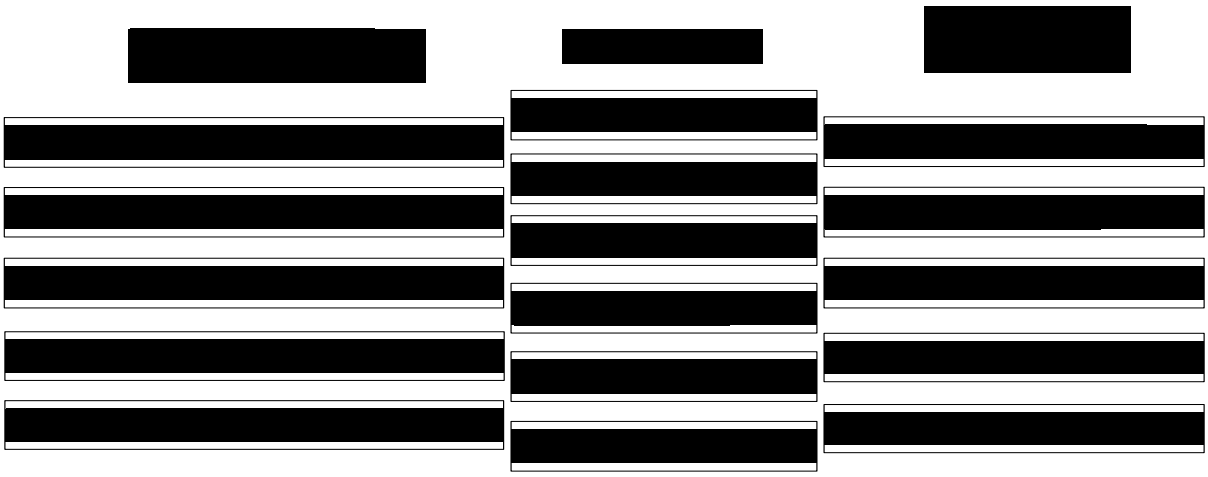

Figure 4.1 Framework used for data collection in small-scale dairy farms of the Eastern Alps. From left to right, the graph displays distal and proximal factors, environment and resources respectively, affecting cows' welfare outcomes.

Assessors with a veterinarian/animal science background attended an ad-hoc training on the EFSA protocol using video-clips, photographs and direct examination of 20 cows. Agreement between observers and the trainer was tested using kappa statistic. Observers not meeting the criterion of sufficient agreement ($k > 0.6$) were retrained through the provision of additional video-clips and photographs.

Statistical analysis

Summary statistics were performed for each set of animal-based measures obtained from observations (ABMo) and from farm records (ABMr). The effect of the assessment (before pasture BP, during pasture DP and post-pasture PP) on the prevalence of the different ABMo was tested using Friedman's test as no measure displayed a normal distribution. When an overall significant effect of the assessment was detected, post-hoc pairwise comparisons were performed with Wilcoxon test and using Bonferroni correction. Moreover, from all herd-level measures, quartiles were identified for ABMo and ABMr in order to suggest critical/achievable levels applicable to small-scale mountain dairy farms for the two conditions (de Vries et al., 2013). Measures with zero prevalence were excluded from the benchmarking exercise.

4.3 Results and discussion

Farm and management descriptors

The 67 farms involved in the study (Table 4.1) were located on average at 622 m asl during winter time and at an average of 1392 m asl during summer time. The mean herd size was 22 lactating cows and Simmental was the most prevalent breed. The average milk yield was estimated to be just below 6000 kg/cow/year. In addition to highland pasture areas, each farm had on average 18 ha of land for forage production and partly for valley grazing during mid-

seasons. Three family members were usually employed in dairy farming, which contributed to 70% of the family's income. Cows were allowed to graze and exercise on both valley and highland pasture for an overall mean amount of about 3000 h/year. The average amount of concentrate given to cows at peak lactation was estimated to be around 5 kg/cow/day.

The majority of farmers (64%) practiced seasonal calving (i.e. winter calving) to match lower production and thus lower energy requirements to the alpine pasture-based feeding system (Piccand, et al., 2013; Horn, et al., 2013). Functional foot trimming was practiced once a year in almost all farms mostly before pasture turnout. A slight majority of farms (54%) did not practice routine disbudding of calves and when practiced, no analgesics/anesthetics were used. Natural mating was also not commonly practiced in the sample. In terms of treatments, around 40% of farmers declared to have treated at least one cow for mastitis during the last year while about only 18% of farmers declared to have used antiparasitics before or during pasture turnout.

Animal-based measures

A total of 3,702 cows were assessed in the course of the study. Summary statistics for ABMo and ABMr are displayed in Table 4.2 and Table 4.3, respectively.

In terms of body condition, no significant differences in the prevalence of lean cows were observed between assessments (BP, DP and PP), similarly to findings of Corazzin et al. (2010) and Peric et al. (2017) in transhumant systems in the Eastern Alps. In contrast, Burow et al. (2013) reported an increased prevalence of very lean cows when animals were moved from winter indoor housing to summer pasture in Denmark.

Table 4.2 Prevalence of animal-based measures observed (ABMo) in 67 alpine dairy farms before (BP, n = 1206), during (DP, n = 1197) and post pasture season (PP, n = 1299).

ABMo %	BP median, min-max (n)	DP median, min-max (n)	PP median, min-max (n)	BP vs DP	BP vs PP	DP vs PP
Lean cows	7.2, 0-60 (149)	3.7, 0-50 (112)	0.0, 0-57 (101)	ns	ns	ns
Dirty legs	43.3, 0-100 (570)	6.3, 0-100 (184)	56.7, 0-100 (685)	< 0.001	ns	< 0.001
Dirty teats	13.4, 5-100 (304)	6.7, 15-100 (159)	10.0, 0-100 (279)	< 0.001	ns	0.011
Hairless legs	33.0, 0-100 (490)	20.0, 0-73 (309)	5.0, 0-84 (175)	< 0.001	< 0.001	< 0.001
Hairless body	7.7, 0-70 (174)	10.0, 0-50 (152)	0.0, 0-57 (99)	ns	< 0.001	< 0.001
Lesions and swellings	8.0, 0-100 (136)	0.0, 0-40 (62)	0.0, 0-14 (35)	< 0.001	< 0.001	0.004
Lameness/severe lameness*	0.0, 0-23 (57)	0.0, 0-17 (56)	0.0, 0-17 (37)	ns	ns	ns
Claw overgrowth	0.0, 0-100 (118)	0.0, 0-47 (28)	0.0, 0-36 (19)	< 0.001	< 0.001	ns
Ocular discharge	0.0, 0-17 (19)	0.0, 0-60 (76)	0.0, 0-3 (1)	0.012	0.028	< 0.001
Vulvar discharge	0.0, 0-5 (1)	0.0, 0-0 (0)	0.0, 0-20 (4)	ns	ns	ns
Hampered respiration	0.0, 0-3 (1)	0.0, 0-5 (2)	0.0, 0-3 (2)	ns	ns	ns
Diarrhea	0.0, 0-7 (2)	0.0, 0-75 (26)	0.0, 0-13 (7)	0.006	ns	0.010

*Cows classified as lame in tie-stall systems/severely lame in loose-housing systems

This difference might be linked to the high yielding breeds (i.e. Holstein) and to the lack of seasonal-calving practices employed in Danish dairy systems, resulting in a decrease in BCS when cows are moved on pasture during early lactation stages (Roche et al., 2007; Piccand, et al., 2013) in addition to the natural variability of forage quality due to seasonal and altitudinal differences.

The percentage of animals with clean legs and teats was significantly higher during pasture than before, but cleanliness deteriorated again after the pasture period. The positive - but short - effect of pasture on cleanliness observed here might be driven by the difference in housing systems and thus availability of clean lying areas between assessments (i.e. winter tie-stall system and summer free-range pasture-based system). However, while the median percentage

of cows with dirty legs when indoors was higher than reported by Whay et al. (2003) for loose-housing systems and Popescu et al. (2013) for tie-stall systems, the median rates of dirty teats (minor splashings included) observed throughout the study were lower (below 14 %). This might be due to a higher attention paid to teat cleanliness in small herds compared to larger herds (i.e., where less time is available for cleaning routine) as well as to the time at which farms were visited (i.e., soon after milking).

The prevalence of integument alterations (i.e. lesions, swellings, and hairless patches) on both legs and body was significantly lower after the pasture period compared to both other time points. Additionally, in indoor systems (BP and PP), the median percentage of cows per farm with integument alterations was always lower than what has been reported in several studies throughout Europe (e.g. Whay et al., 2003; Mattiello et al, 2011; Popescu et al., 2013). A beneficial effect of pasture on integument alterations, due to low friction and the absence of constraining environments where collisions are more likely, was observed in many other studies carried out in both mountain and lowland areas (Keil et al., 2006; Corazzin et al., 2010; Burow et al., 2013).

The median prevalence of lameness/severe lameness (tie-stalls-loose-housing) was 0% for all assessments and no effect of the change in husbandry system was found. However, the prevalences have to be interpreted cautiously. The lameness scoring system used for tie-stall systems distinguishes between non-lame and lame animals only and is less sensitive in detecting mild lameness compared to the 3-step locomotion scoring method used in loose-housing systems, which differentates between mildly and severely lame animals (Leach, et al., 2009). Therefore, overall lameness prevalence is presented for tie-stall systems (thus including also a part of the mild lameness cases), while for loose-housing systems only severe lameness prevalence is reported. The unexpected lack of an effect of the assessment may on

the one hand be due to the focus on the usually less prevalent severe lameness but it may also be explained by the higher attention paid by farmers to claw health in transhumant systems (Regula et al., 2004), to the less demanding yields characterizing small-scale systems resulting in fewer productivity-related clinical conditions (Oltenacu & Broom, 2010), as well as to the beneficial effect of farming systems with seasonal pasture access (Rutherford et al., 2009).

No cases of nasal discharge were observed and in accordance with several studies carried out in indoor systems throughout Europe (e.g. Popescu et al., 2013; de Vries et al., 2013; Coignard et al., 2013; Zuliani et al., 2017), low prevalences for the other clinical measures (i.e. ocular discharge, vulvar discharge, hampered respiration and diarrhea) were found throughout the assessments. Nevertheless, both ocular discharge and diarrhea were significantly more prevalent during pasture than before and subsequently decreased again. For ocular discharge, prevalence after the pasture period was also lower than before pasture. The increased prevalence of liquid feces in cows on pasture may reflect the diet change from dry to mainly fresh forage (Corazzin et al., 2010; Burow et al., 2013). The findings for ocular discharge might be related to the presence of flies and their feeding behaviour on cattle eye secretions, especially when on pasture (Palacio et al., 2015).

Table 4.3 Summary statistics for animal-based measures retrieved from farm records (ABMr) in 67 alpine dairy farms and related expert-based critical welfare thresholds defined by Welfare Quality®, 2009.

ABMr (% of cows during last 12 months)	Min	25th	Median	75th	Max	Alarm Thresholds*
Fourth lactation or higher	0.0	26.3	35.3	50.0	69.2	na
Dystocia	0.0	0.0	0.0	2.5	14.3	5.5
Downer cows	0.0	0.0	0.0	2.3	10.0	5.5
SCC >400.000 ml	0.0	0.0	5.7	15.0	78.8	17.5
Mortality	0.0	0.0	0.0	2.1	23.1	4.5

* WQ, Welfare Quality®, 2009; na = no reference available

Concurrent with low prevalences of clinical findings throughout this study, also the AMBr (Table 4.3) showed a low prevalence. For example, the low median rates of dirty teats might have had a positive effect on SCC prevalence (median of 5.7% of cows/farm/year had SCC higher than 400.000 cell/ml), similarly to what previously described by Zuliani and colleagues (2017) in traditional mountain farms. In addition, low prevalence of clinical finding, such as lameness/severe lameness, might have also contributed to longevity and productive lifetime (i.e., median of 35% of cows per farm were at their fourth lactation or higher).

Context-based thresholds

Assessment protocols adopting ABMs have the potential to provide a common currency for the animal welfare status across a diversity of husbandry systems. However, two main approaches have been followed to identify critical thresholds for ABMs depending on the purpose of the assessment. One option to gain those values is to ask experts for their opinion regarding unacceptable/acceptable thresholds above/below which welfare would be compromised. Experts have also been asked to rank ABMs according to their relative importance (de Graaf et al., 2017). This approach aims at identifying acceptable welfare conditions in terms of impact on the animal and it was applied among others, by the WQ consortium (WQ, 2009) to assessment protocols for indoor systems as well as, later on, for pasture-based systems by Burow et al. (2013).

In recent years, another approach has come forward, using benchmarking of on-farm data as a way inducing change through the identification of critical thresholds at which action is needed on the basis of the ABMs collected in a sample of farms. The best and worst-performing groups are defined by data distribution (e.g. quartiles) and welfare improvement is pursued by targeting achievable welfare outcomes as obtained by peers. Despite having different aims, a benchmarking approach was applied by von Keyserlingk et al. (2012) in

North America and by de Vries et al. (2013) in Europe as well as within private initiatives (e.g. Business Benchmark on Farm Animal Welfare and Freedom Food).

Since the establishment of thresholds for ABMs in welfare management plans is also embedded in the recent ISO technical specification on animal welfare (ISO, 2016), it seems more and more important to understand how thresholds would work in different husbandry systems, such as those characterizing the transhumant system of the Eastern Alps. Figure 4.2 displays thresholds for ABMs for the assessments BP, DP and PP as derived from a benchmarking approach (i.e. best and worst quartile) in our sample of small-scale mountain farms. It is interesting to notice that thresholds for some ABMs differ according to the time of assessment and are often quite different from both expert-opinion thresholds and worst quartile thresholds proposed in other studies. For example, the worst quartile threshold in this study for very lean cows is a prevalence of 26 %, 20% and 14 % for BP, DP and PP, respectively. These prevalences would translate in 'Absence of prolonged hunger' scores of approximately 20, 30 and 50, respectively according to the expert-opinions gathered in the course of the Welfare Quality project (Welfare Quality, 2009). The WQ scores range from 0 to 100 (with 100 indicating the best condition) and thus both BP and DP thresholds would be considered by the WQ experts not acceptable by far. On the other hand, the PP threshold corresponds to a "neutral" situation beyond which action would be recommended. However, benchmarking based on a sample of Dutch farms (de Vries et al., 2013) revealed a threshold for identifying poor welfare farms (worst quartile) of 6.7 % of very lean cows per farm, a prevalence apparently hardly achievable in mountain farms at least before the pasture period in the present study. The potential thresholds defined for lameness/severe lameness are in contrast to the example of BCS. In fact, lame/severely lame cows were comparatively rare in the present study and the worst quartile limits ranged between 8 % (BP) and 5 % (PP). These

prevalences would translate in WQ lameness scores between 60 and 80; however, these scores might be overestimated due to the difficulty in detecting mild lameness in tie-stall systems. De Vries and colleagues (2013) set the critical threshold for severely lame cows in the Netherlands at just below 12 %, as a result of the higher prevalence of lameness in intensive dairy farming systems compared to small-scale mountain farming systems. A different pattern is displayed for soiling of legs, for which a upper (worst) quartile level of 80 % was defined when the animals were housed (BP and PP), dropping at 17 % during pasture. The WQ critical threshold has been set at 50 %, resulting in a challenging target for most farmers in mountain areas during winter time. However, while the prevalence of some welfare outcomes (soiling, hairless patches and very lean cows) in the worst quartile is unacceptable according to the expert-opinion approach taken by the WQ, most prevalences in the best quartile reached 0%. These results suggest that high welfare standards are widely achievable in mountain farms of the Eastern Alps. As shown above, the definition of acceptable (expert-based) or achievable (industry-based) welfare thresholds changes according to the source consulted and the context investigated. From a pure animal welfare perspective, an expert based approach is to be preferred as it provides an objective and universal judgment on acceptable (and unacceptable) farming practices. However, given the challenges and costs associated with inducing changes for welfare improvement as well as the time needed to achieve significant results (Tremetsberger and Winckler, 2015), a more engaging approach should be embraced. Benchmarking, by showing welfare outcomes that can be achieved in similar farming conditions, seems more suitable than normative goals for encouraging action-taking and ultimately drive welfare improvement on farm (Main et al., 2014). The thresholds identified through benchmarking should only be used in the farming systems and contexts in which they have been identified, and they should not serve as the basis setting static minimum welfare

standards. Benchmarking should instead be considered as an effective on-farm welfare management strategy and a stepping stone towards continuous welfare improvement .

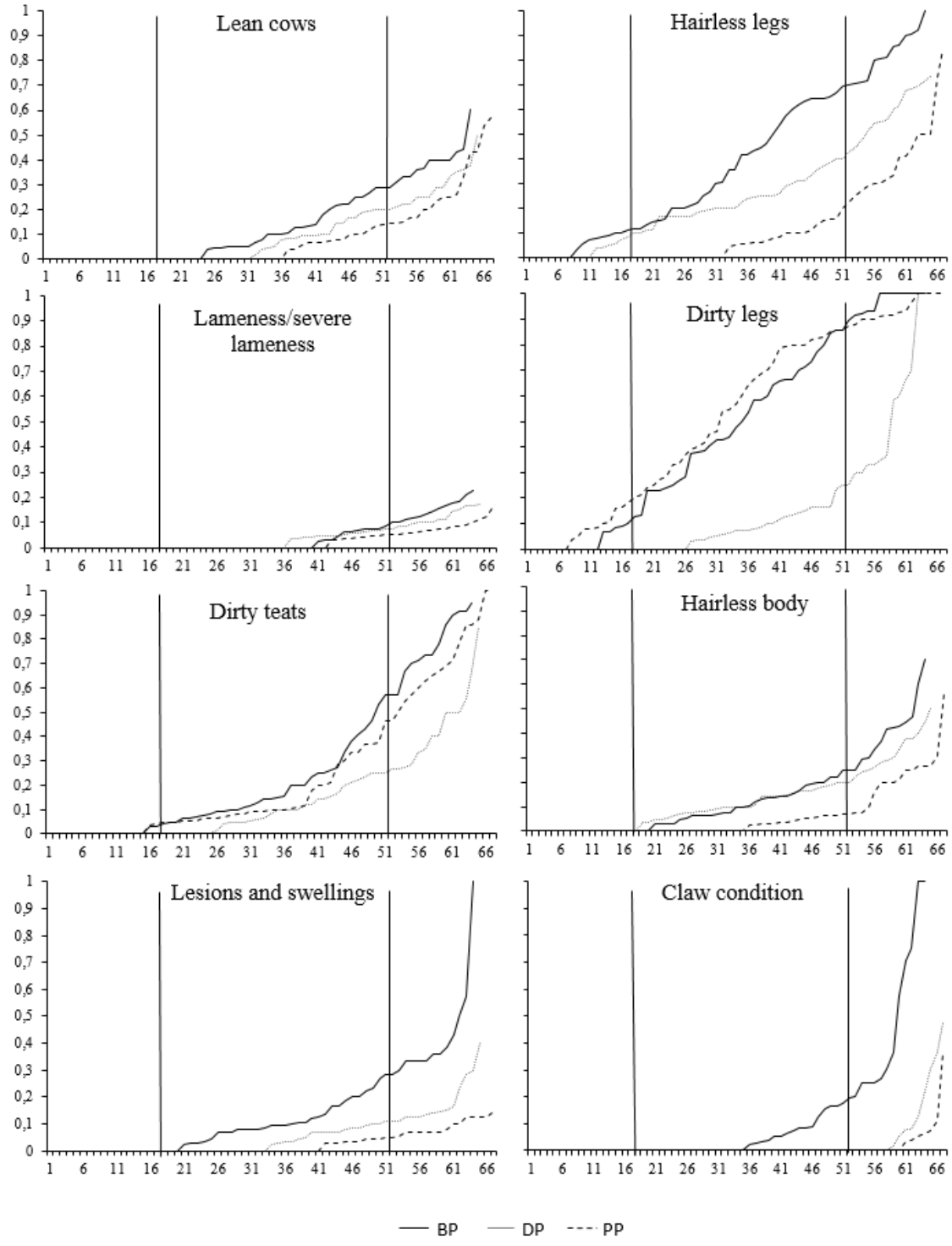

Figure 4.2. Overview of prevalence (%) of each welfare condition (y axis) in a sample of 67 small-scale dairy cattle farms assessed (x axis) before pasture (BP), during pasture (DP) and post-pasture (PP). Solid vertical lines represent thresholds at first and third quartile.

4.4 Conclusion

Dairy farming systems and practices vary not only worldwide but also within the same country according to the available resources and traditions. If the ultimate aim of welfare assessment protocols is to monitor and promote welfare improvement, this might be achieved by defining unacceptable welfare conditions as well as achievable targets from on-farm data. While the first aspect is applicable to all farming systems, the latter should be informed by a deep understanding of the different farming systems, its practices and its challenges and can be developed over time. The present study aimed to contribute to this broader scope by providing field data from the dairy cattle transhumant system and respective animal welfare outcomes in the eastern Alps.

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5. Animal welfare in traditional mountain dairy farms: consumers' perceptions and attitudes

Original paper: Zuliani A., Esbjerg L., Grunert K. G., Bovolenta S., 2018. Animal welfare in traditional mountain dairy farms: consumers' perceptions and attitudes? Submitted to Livestock Science

5.1 Introduction

Mountain areas represent almost 30% of the European landmass. Agriculture is part of the cultural and economic landscape and highly contributes to the provision of ecosystem services and related public goods (Battaglini et al., 2014). Mountain farms are generally small-scale, because of the environmental and climate constrains that limit housing options and forage production. The resulting lower outputs, the higher productivity costs and the remoteness compared to lowland farms hinder the economic competitiveness of this farming system and eventually hamper its existence. In spite of the crisis hitting small-scale and mountain producers, the majority of European consumers living in Alpine countries (Eurobarometer, 2011) recognizes the added value of mountain production and particularly cheese as the most important mountain product and relates it to a composite of positive attributes such as purity, authenticity and simplicity. Given the multiple positive externalities linked to mountain production systems as well as their fragility, the EU has recently introduced the optional quality term "mountain product" in the Regulation No. 1151/2012 and in the Delegated Act (EU) No. 665/2014 in an attempt to unlock the market advantage of mountain products.

Animal welfare is, together with origin, another quality attribute that is of great interest to consumers and could represent a further way to differentiate and support sustainable farming systems. Small-scale and extensive systems are perceived as inherently welfare-friendly (Turner and Dwyer, 2007). Mountain dairy farms are generally small-scale (in Italy, 78% of mountain dairy farms are micro-scale enterprises with less than 20 cows) and provide pasture

access during summer. However, during winter time, animals are kept indoors, usually tethered. Despite several studies showing that good welfare outcomes are neither linked to farm-size (Robbins et al., 2016) nor provision of resources (Zuliani, et al., 2017), most citizens and consumers simply relate animal welfare to a single resource-based indicator, i. e. housing system (Te Velde et al., 2002; Ellis et al., 2009; Weinrich et al., 2014). Tethering is thus considered by most consumers as an unacceptable husbandry practice.

As part of a larger project on mountain products and ecosystem services, this qualitative study aims at investigating consumers' attitudes and perspectives towards dairy cow welfare in mountain farms. Three research objectives were identified in order to highlight potential communication gaps and opportunities between mountain producers and consumers. The first objective was to understand the way consumers' conceptualize mountain environment and mountain farming. The second objective looked into consumers' preferences and acceptance on husbandry systems and thirdly, on consumers' preferences and knowledge on animal welfare attributes currently employed in dairy cow welfare assessment.

5.2 Material and methods

In this study, focus group discussions were chosen as a method to collect consumers' attitudes and perspectives on animal welfare in mountain farms.

Participant information

Three focus groups were conducted and involved 22 people in total (Table 5.1). Each focus group consisted of 6 - 9 people recruited on a voluntary basis with the criteria being that they were cheese purchasers/eaters and belonging to a defined community. Focus group discussions were carried out with the three main consumer groups that purchase mountain cheese in the eastern Italian Alps, namely consumers living in mountain communities or in Italian and Austrian urban communities. The identification of these target groups also aimed

at capturing the highest variability of structural determinants known to affect attitudes towards animal welfare (Kendall et al., 2006), that is to say the urban-rural factor, socio-economic indicators as well as previous animal-related experiences. Consumption and location profiles were deemed more important in explaining attitudes than age and sex and thus were the only inclusion/exclusion criteria used. Participants from the mountain community (n=7) were recruited through project advertisement at the local cheese shop. Italian (n=6) and Austrian (n=9) urban dwellers were recruited through organizations with an explicit interest in local food and environmental issues (e.g. Slow Food).

Table 5.1 Participants' socio-economic characteristics and cheese consumption habits

Variables	Classes	Urban community Italy, n=6	Urban community Austria, n=9	Mountain community Italy, n=7
Age (years)	18-30	0	2	3
	31-45	3	3	2
	46-60	2	4	0
	> 60	1	0	2
Gender	Female	3	5	3
	Male	3	4	4
Education	Secondary	4	3	5
	Graduate	2	6	2
Income (€)	< 30.000	0	1	5
	31.000-45.000	1	5	2
	46.000- 60.000	3	2	0
	> 61.000	2	1	0
Dairy farm visits	Never	1	0	2
	Once	2	1	3
	More than 5 times	3	8	2
Cheese consumption	Daily	1	3	2
	2-4 times/week	3	5	4
	Once a week	2	1	1

Focus group discussions

A moderator guided the discussions, following a semi-structured interviewing method. The discussion followed a funnel approach, where general questions were asked first and more specific points on animal husbandry and welfare were addressed later in the discussion. At first, socio-demographic data were collected using a written questionnaire. Before starting the discussion, a broad introduction on the EU Regulation concerning "mountain product" was provided to the groups. Then participants introduced themselves to each other in terms of their job, hobbies, outdoor activities and special dietary requirements.

The conceptualization of mountain farming was initially investigated by asking participants to make a collective drawing on what the idea of mountain/mountain environment was evoking from them and by sharing it with the others. Afterwards, participants were invited to write down and explain three words that were best describing mountain farming compared to lowland farming. Pictures on 6 types of housing systems for dairy cattle during summertime and wintertime were displayed and participants were asked to comment on them and later to rank them according to their preference. While the main focus was put on housing system, horned and dehorned cows as well as different breeds and farm sizes were also represented in the pictures. Subsequently, the indicators currently used to assess dairy cow welfare and based on the EFSA protocol for small scale farms (EFSA, 2015), adapted after the Welfare Quality framework (Welfare Quality, WQ, 2009), was provided to participants. They were invited to discuss about the framework and eventually to rank the indicators according to their priority in terms of farm animal welfare. As a final step, consumers were asked to provide their opinion on the concept of quality when related to a cheese produced in mountain farms.

The group discussions were video-recorded, transcribed verbatim and translated to English. All conversations that related to a defined topic or theme were classified and given a code

name. Analysis was assisted by the use of Nvivo software (QSR International Pty Ltd. Version 11, 2015).

5.3 Results

Conceptualization of mountain environment and mountain farming

The ideas and words that came to mind more often during the first part of the focus group discussions are displayed through word clouds in Figure 5.1.

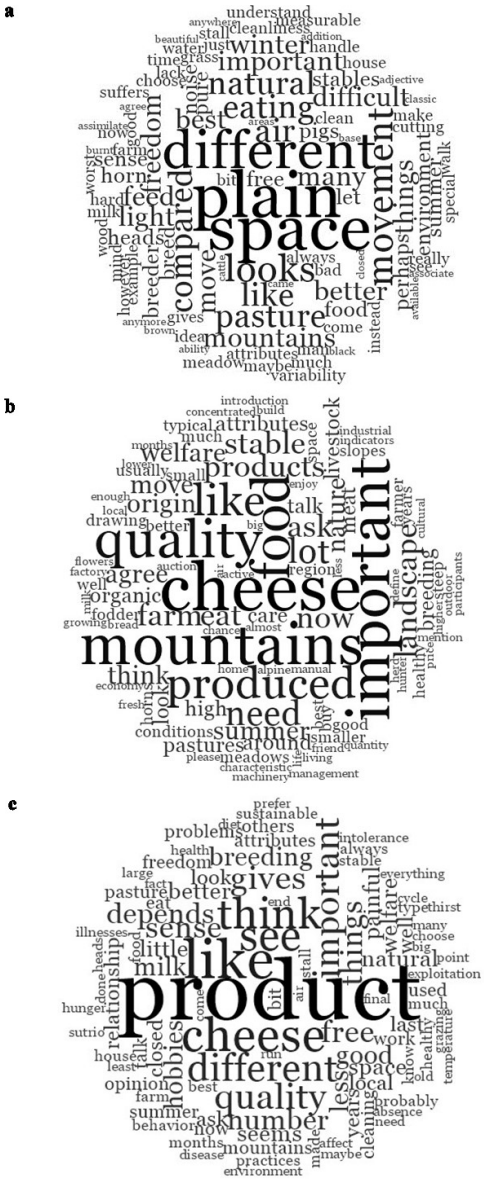


Figure 5.1 Conceptualization of mountain environment and mountain farming by: a) Italian urban consumers; b) Austrian urban consumers; and c) Italian mountain consumers.

Participants from the Italian urban group depicted the mountain environment mainly with stereotypical features such as mountain peaks with snow and summit crosses, a shepherd attending cows which wear bells, ski lifts and paths for bikes and people, a river and meadows with flowers.

When asked what the concept of mountain was evoking from them, participants from the mountain community drew objects related to their daily life such as houses, wild plants and mushrooms, wood fire, water streams, wildlife and domesticated ruminants. While also Austrian urban consumers drew similar features, they also mentioned downsides of the mountain environment such as steep slopes, forest encroachment and weather variability. The hardship of mountain farming as a job was highlighted by Italian urban consumers only when asked to write down 3 words on mountain farming and was not pointed out at all by participants from the mountain community. The concept of "healthy environment" and consequently healthier fodder, healthier animals and healthier products were the most mentioned characteristics of mountain livestock farming in all groups. Participants from the local community put lots of emphasis on the fact that mountain farming by being small-scale is more sustainable and uses "a resource and not exploits it until it is depleted". Moreover, they perceived, by being closer to the production site, that they could "see" and thus trust the entire supply chain. For both participants from Austria and the Italian mountain community, mountain farming ensures the maintenance of traditional productions as well as a traditional landscape "that is very similar to that of my grandfather". For Austrian participants, mountain farms have also a role to play in biodiversity conservation, meaning not only plant species but also rare cattle breeds. The concept of biodiversity was postulated also by Italian urban consumers, which mentioned also that cows in mountain farms have more freedom to move and are surrounded by a noiseless environment.

Husbandry systems' preferences and acceptance

When looking at the pictures (Annex 5.1), participants from the mountain community were struck by the different farm sizes and expressed their preference for small scale farms because "the cow is seen as an animal, not as a milk dispenser" and "maybe they are brushed every day. I expect this last farm (Annex 5.1, case 6) not to be focused on profit, it is probably more a hobby than anything else". One participant expressed strong concern "about the fact that having so many animals, the risk of epidemics and illness leads to the use of drugs and antibiotics, so the magnitude of product usage will be greater in case 4 and 5". These concerns probably affected mountain consumers' choice when asked to rank favourite (i.e. Annex 5.1, case 2) and least favourite (i.e. Annex 5.1, case 5) husbandry systems.

Stronger emphasis was put by urban consumers on pasture access and freedom of movement. They also referred to the importance of "light and fresh air". Italian urban consumers were also concerned about cleanliness of the cows and manure management system. Austrian urban consumers pointed out the presence of horned cows and mentioned that "it is important that cows have horns because they need them for displaying their behaviour in the herd". Both urban groups agreed on the most favoured (i.e. Annex 5.1, case 1) and least favourite (i.e. Annex 5.1, case 6) husbandry system.

Welfare indicators' preferences and knowledge

When participants were asked to discuss about the criteria they used to choose the best and the worst farming systems and what welfare indicator they consider the most important, all agreed on the need for adequate space being the cows either in tie-stalls or loose housing systems. Participants from the mountain community brought up again the idea that "everything depends on the number of animals, fewer animals receive better treatment". In addition, they mentioned that cows looked happier and less lean in the farming systems they

preferred. For Austrian and Italian urban consumers, the quality of feed as well as the relationship the farmer has with the cows contribute to animals' well-being.

Despite the participants raised similar themes, the ranking exercise (Table 5.2) on the indicators currently used to assess welfare on small-scale farms reveled some differences on the priorities the different groups hold. When consumers were asked to rank welfare attributes currently used to carry out assess cows' welfare in mountain farms, urban consumers attributed great importance to good feeding principles. Austrian urban consumers expressed strong concern on painful practices such as dehorning and disbudding, in contrast to the Italian urban consumers who considered the practice of little concern, an actually they were not fully aware of it ("is it a common practice?" and "do the animals suffer?"). For participants living in the mountain community, absence of disease was the most important indicator of well-being. In terms of least important indicators, all groups mentioned that they ranked natural behaviour as the least important indicator not because they considered it not important but because they felt it was going to be achieved if all others criteria were met.

Table 5.2 Consumers preferences (1 = most important; 5 =least important) on dairy cattle welfare attributes

Principles	Criteria	Urban community Italy, n=6	Urban community Austria, n=9	Mountain community Italy, n=7
Good feeding	Absence of hunger	1	1	2
	Absence of thirst	1	1	2
Good housing	Animal cleanliness	4	4	3
	Loose housing system	2	2	3
Good health	Absence of injuries	3	4	3
	Absence of diseases	2	3	1
	Absence of pain (disbudding/dehorning)	5	1	3
Natural behaviour	Good human-animal relationship	3	3	4
	Appropriate behaviour	5	5	5

Cheese quality attributes

When participants were asked to discuss about the concept of quality when referred to cheese, all agreed that origin, local production and longer ripening time were important characteristics. Austrian urban consumers emphasized their interest for cheese produced with "high quality hay milk" and coming from organic, extensive and small scale production systems. This latter aspect was seen as a synonym of quality also by Italian urban consumers. Additionally, they were extremely interested in the sensory attributes of cheese, such as smell, color and flavor.

5.4 Discussion

While the level of public understanding of dairy production and animal welfare has already been investigated (Miele et al., 2007; Vanhonacker et al., 2012; Spooner et al., 2014), the attitudes of consumers toward animal welfare in mountain farming systems is still unexplored. Given the optional quality term "mountain product" recently introduced in the EU and progressively transposed by member countries into the national legislation as well as the growing consumers' concern toward animal welfare, we undertook this study intended to elicit consumers' views and to shed light on the abovementioned topics. Focus groups are qualitative research techniques deem suitable to gather everyday knowledge on unexplored topics (Calder, 1977). They can highlight underlying motivations and values, which are not generally revealed through closed interview questions. This approach has been used in marketing research since the 1950' in order to facilitate and bring forth a wide variety of viewpoints by the means of an active group interaction.

Participants were recruited using a purposive sampling method to select consumers belonging to a defined geographical identity (mountain community vs urban community) and with an explicit interest in local food. This choice was driven by the assumption that this group of

people might be the most motivated in purchasing "mountain products" and at the same time, the most interested in additional food-related ethical issues such as animal welfare and sustainability.

In agreement with previous findings (McMorran et al., 2015) and despite background differences among participants, all groups conceptualize mountain areas as a healthy environment where healthy fodder and healthy animals produce healthy food. Mountain farming was also expected to be small-scale and was acknowledged to use sustainably local resources and preserve biodiversity.

In terms of husbandry systems' preference, all groups believed that access to mountain pasture during summer time was an essential aspect for ensuring animal well-being. However, there were different views over the winter husbandry system. Urban consumers preferred loose housing systems and free-range systems over tie-stall systems, and no acceptance was shown for permanent tethering. In contrast, mountain consumers expressed no concern for tie-stall systems because of the tight relationship they perceive between small-scale and low burden of disease as well as between low burden of disease and animal well-being.

When looking at the ranking exercise on welfare indicators currently used to assess animal welfare in small-scale farms, it appears that mainly urban consumers hold contrasting views simultaneously. For example, Austrian urban consumers showed to be aware about the potential issues related to the practice of disbudding/dehorning and coherently set the absence of painful practices as a priority in ensuring animal well-being. While the topic has been studied among farmers (Kling-Eveillard et al., 2015) no information is available on how this practice is perceived by consumers. However, despite their claims, when asked to choose a favorite farming system, Austrian urban consumers picked a farm where cows were all dehorned. Additionally, while small scale was considered a distinctive feature of mountain

farms and a key attribute of quality, this value was not supported by the choice of a small scale farm in the husbandry systems exercise.

The results of this qualitative study show that consumers expect mountain farming to be healthier and small scale. However, while participants from the mountain community link these features to farming systems highly representative of the mountain areas in terms both of breeds, farm scale and husbandry system, urban consumers displayed a "realistically informed idealism" (Spooner et al., 2014). In such attitude, consumer theoretically recognise limits and added values of mountain farming but in practice they struggle in acknowledging its real features.

Insights into consumers' perceptions and attitudes are necessary to involve all stakeholders into the ongoing debate on animal welfare, especially in fragile systems such as those located in mountain areas. The results of this study may contribute to reveal the gap between urban consumers conception of mountain farm animal welfare and science-based welfare assessment criteria, and to urgently spur an effective and transparent dialogue between consumers and producers.

Annex 5.1
Case 1

Winter

Summer

Case 2

Winter

Summer

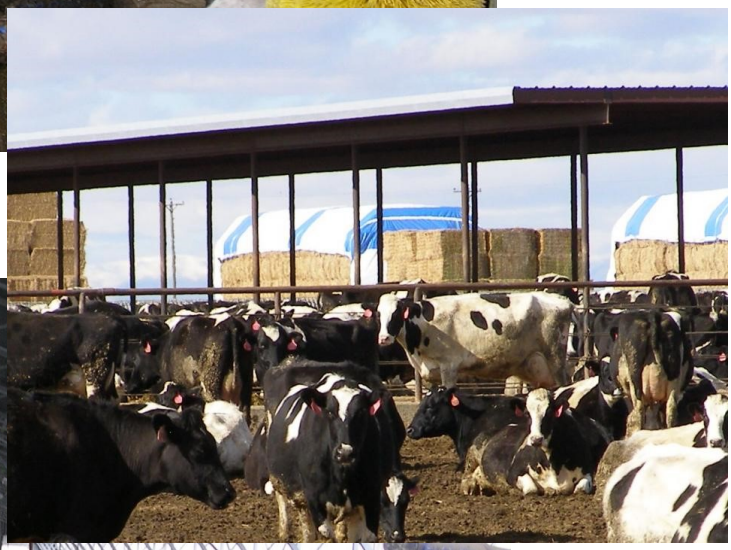
Case 3

Winter

Summer

Case 4

Winter

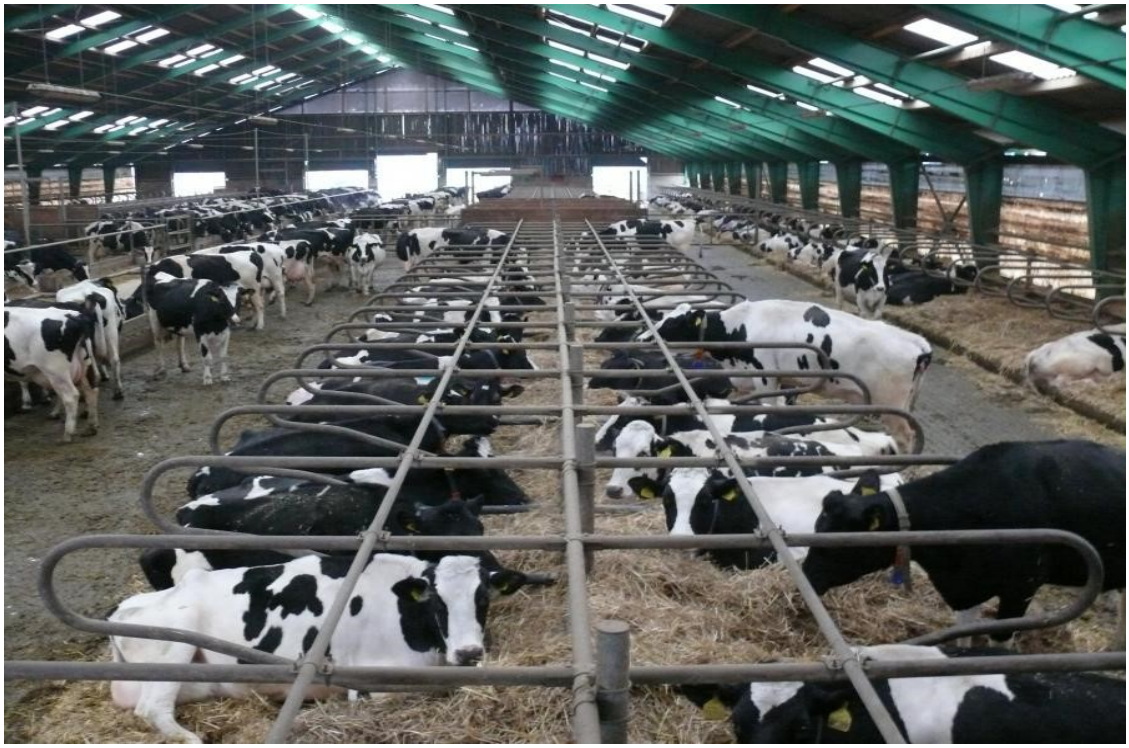


Summer

Case 5

Winter

Summer



Case 6

Winter

Summer

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6. Conclusions

Animal welfare plays a key role in the ecosystem services framework. Monitoring and enhancing welfare outcomes seems of special relevance in small-scale, semi-extensive livestock farming systems such as those located in mountain areas. However, in order to obtain reliable results and provide meaningful recommendations, it is necessary to use proper welfare assessment tool that are fit for purpose.

The results obtained in the first paper suggested that tie-stall systems do not necessarily produce negative welfare outcomes. Thus, the pressure for welfare improvement in the dairy sector should not focus simply on banning tethered systems but on identifying specific welfare issues through the collection of relevant animal-based measures. In fact, the case-study presented herein showed how resource-based measures, such as Ease of Movement were not useful in discriminating critical farms in terms of welfare.

The second study indicated on the one hand that small scale alpine farming system are very diverse in both farming practices and prevalence of outcome-based indicators and on the other hand that high levels of animal welfare can be achieve when small-scale alpine farms are properly managed resulting in 0% prevalence for most outcome-based indicators. If the ultimate aim of welfare assessment protocols is to monitor and promote welfare improvement, this might be achieved by defining unacceptable welfare conditions as well as achievable targets based on a deep understanding of the different farming systems, their practices and husbandry conditions.

If farmers are key stakeholders to be involved in the discussion around animal welfare, certainly also consumers have an important role to play for the power their beliefs and their spending habits exert on the market. For this reason, as well as for the recent introduction of

the optional quality term “mountain product” we undertook the third study, intended to elicit consumers’ views on animal welfare in mountain farms. The results showed that consumers expect mountain farming to be healthier and small scale. However, while participants from the mountain community link these features to farming systems highly representative of the mountain areas in terms both of breeds, farm scale and husbandry system, urban consumers mainly hold a stereotypical imagery of mountain farms.

In conclusion, the results of this thesis emphasize the importance of using welfare assessment protocols based on outcomes rather than resource-based measures as a better tool to monitor and enhance welfare levels in traditional mountain farms. Moreover, this research has shed some light into the gap between urban consumers’ conception of mountain farm animal welfare and science-based welfare assessment criteria.

The relevance of this project may be seen only if framed into bigger perspectives such as those provided by the “ecosystem services” framework or the “One Welfare” approach. Proper welfare assessment and monitoring tools suitable for mountain farms as well as an effective and transparent dialogue among stakeholders, would help enhancing animal welfare and ultimately the provision of ecosystem services well beyond mountain areas.

7. Future directions

The approaches and methodologies presented in this thesis have been used to inform the development of a research project proposal (i.e. H2020-SFS-2017-stage 2, proposal number 773791-2 – PERGRASS, Positioning Ecosystem seRvices into policy and decision-making for sustainable GRASSland farming systems) and a grant proposal successfully funded (i.e. Interreg V-A Italia – Austria 2014 2020, project code ITAT 2009 – TopValue, il valore aggiunto del prodotto di montagna/Mehrwert von Bergerzeugnissen).