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Behavioral assessment of sheep in different housing conditions in Austrian farms

Az állatjóllét értékelése juh telepeken különböző tartási körülmények között Ausztriában

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1.ABSTRACT

In managing sheep, it is essential to assess their welfare continuously and address any welfare concerns that arise effectively. To achieve this, a thorough protocol built on valid, practical indicators is necessary. This thesis aimed to review existing scientific literature to identify and evaluate protocols and specific welfare indicators for sheep. During the review, well-established indicators, like lameness detection and body condition scoring, were highlighted for their reliability and relevance.

Additionally, this work delves into the housing systems used on Austrian sheep farms, focusing on the unique welfare considerations in extensive versus intensive setups. This section explores behavioral assessment tools and strategies, considering how varying environments affect sheep behavior and welfare. Through this comparative analysis, insights into the impact of management practices on sheep welfare are developed, offering a foundation for informed welfare assessments across different farm settings.

This Thesis gives a good overview and summary of different possibilities to assess animal welfare in sheep. Welfare assessment protocols will be discussed as well as behavior assessment observations, their differences and suitability for different housing systems.

1. ÖSSZEFOGLALÁS

A juhok tartása során elengedhetetlen jóllétük folyamatos értékelése és a felmerülő jólléti aggályok hatékony kezelése. Ennek eléréséhez valid indikátorokra épülő, gyakorlatias protokollokra van szükség. Ez a dolgozat a meglévő tudományos irodalom áttekintését tűzte ki célul, hogy bemutassa és értékelje a juhokra vonatkozó állatjólléti protokollokat és egyes specifikus jólléti mutatókat. Az összefoglaló bemutatja a már jól bevált mutatókat, mint a sántaság észlelése és a testállapot-pontozás, amelyek megbízhatóak és relevánsak.

Ezen túlmenően ez a munka az osztrák juhfarmokon alkalmazott tartási rendszerekkel foglalkozik, az extenzív és az intenzív telepek egyedi jólléti szempontjaira összpontosítva. Ez a rész a viselkedésértékelési eszközöket és stratégiákat tárja fel, figyelembe véve, hogy a változó környezet hogyan befolyásolja a juhok viselkedését és jóllétét. Az összehasonlító elemzésen keresztül betekintést nyerhetünk a gazdálkodási gyakorlatok juhok jóllétére gyakorolt hatásába.

Ez a dolgozat jó áttekintést és összefoglalást ad az állatjóllét felmérésének különböző lehetőségeiről juhok esetében. Szó esik a jólléti értékelési protokollokról, valamint a viselkedésértékelési megfigyelésekről, azok különböző tartási rendszerekhez való alkalmasságáról.

CONTENT

2.INTRODUCTION

Animal welfare has consistently been a matter of concern to varying extents within society and has undergone significant development over the years. Since animals cannot directly communicate their needs, their well-being relies on our ability to interpret and understand their requirements, along with our commitment to assessing, maintaining, and enhancing the conditions in which they are kept [1].

Sheep are kept in a wide range of environments (e.g., extensive, partially indoor with seasonal or diurnal changes, or indoors) and for various reasons, which complicates the assessment of their welfare. To gain an accurate understanding of the quality of life of livestock, it is essential to evaluate their welfare using practical and reliable protocols. Additionally, it is crucial to effectively address any welfare issues as they arise [2].

The implementation of on-farm protocols to assess the welfare of farmed animal species, including sheep, has become increasingly vital [3].

These welfare assessment protocols play a significant role in enhancing the quality standards of production processes. They enable farmers and veterinarians to identify not only areas of poor welfare but also examples of exemplary farming practices. Consequently, the use of these protocols supports continuous welfare improvement by facilitating comparisons among farms and promoting benchmarking [4].

In the European Union, several sheep-derived products are officially recognized with a protected designation, reflecting their unique quality and origin [5].

Integrating welfare monitoring systems into the standards for such animal-friendly products could further enhance their market value. This approach would contribute to quality assurance for consumers, emphasizing the welfare of the animals as an essential component [6].

The main purpose of this thesis was to get a literature review on behavioral assessment methods and protocols which are used for sheep. Not only protocols are listed, but also animal-based methods are described and reviewed. The focus is on the different husbandry systems which are mainly used in Austria.

3. MATERIALS/METHODS

To explore the variations in the general well-being assessments of sheep under different housing systems in Austria, this thesis undertakes a structured and in-depth literature review. The primary objective was to identify and compare behavioral assessment methods specific to Austrian sheep farming conditions, as well as to understand the applicability and relevance of these indicators within the country's extensive and intensive sheep housing systems.

The research process involved targeted searches through academic databases such as PubMed, ScienceDirect, and Google Scholar. The search was meticulously refined by focusing on English and German keywords to capture relevant studies. Using these databases allowed for a rigorous collection of studies, filtering those that specifically discussed welfare indicators such as body condition scores, lameness assessments, and other keywords like “behavioral assessment”, “sheep” and “animal welfare”.

To enhance the understanding of sheep welfare in Austria, the research also incorporated data from national sources. Relevant statistical data were gathered from Statistik Austria as well as various Austrian sheep breeding organizations. These resources provided valuable insights into the local context of sheep welfare, enabling a nuanced understanding of welfare challenges and protocols unique to Austrian sheep farming. This dual approach, combining international scientific literature with local data, allows for a more detailed evaluation of welfare standards and practices within Austria's extensive and intensive sheep farming systems.

4. SHEEP FARMING IN AUSTRIA

In Austria, there are approximately 401,000 sheep distributed across about 26,000 farms. The average farm size is around 15 sheep per farm, though there are significant variations between smaller and larger operations [7].

Most of the sheep are concentrated in regions like Tyrol, Lower Austria, and Styria, which have a strong tradition in sheep farming. Around 85% of the sheep are raised for meat production, with lamb meat being the most important economic sector. Only about 6% of the sheep are used for milk production, while the wool industry has limited economic significance. The self-sufficiency rate for lamb meat stands at around 80%, indicating that a portion of demand is still met through imports, providing opportunities for domestic producers [8].

Additionally, sheep farming is closely linked to landscape management, especially in alpine and mountainous areas where sheep play a key role in maintaining cultural landscapes. Most farms are small-scale, contributing to ecological practices and diversification. Overall, sheep farming contributes to rural development and the preservation of biodiversity in Austria [7].

In Austria, various sheep husbandry systems exist that are tailored to the regional conditions and economic objectives of the farms. Among the most commonly practiced forms are extensive grazing and stall husbandry or a combination of both [9].

5. EXTENSIVELY MANAGED SHEEP

Extensive grazing is particularly prevalent in alpine regions, where sheep are raised on large, natural pastures. This husbandry method allows sheep to exhibit natural behaviors and plays a crucial role in landscape preservation and biodiversity promotion. Sheep in extensive grazing systems help manage the growth of undesirable plant species and improve soil structure. Furthermore, this system enhances animal welfare by providing access to fresh grass and a natural environment, positively affecting their health [10].

Extensive sheep systems enable sheep to experience a more "natural lifing." This approach allows sheep significant autonomy and control over various aspects of their daily activities, such as grazing, exploring, socializing, ruminating, and expressing maternal instincts [11].

These features of extensive systems align with the "natural living" framework—one of the three main conceptual models for assessing animal welfare. This approach emphasizes giving animals the opportunity to express behaviors inherent to their species, which connects directly to the "Five Freedoms" concept, specifically the freedom to perform natural behaviors, as well as the "Five Domains" model, addressing the absence of behavioral or social restrictions [12].

To ensure the welfare of animals in low-contact systems, it is essential that the sheep genotypes involved display behavioral and physiological traits that support a self-sufficient lifestyle. While this approach might seem minimal in human intervention, those managing sheep in easy-care systems must still have advanced knowledge and skills. This expertise is necessary to anticipate potential issues within the system, effectively plan interventions that protect sheep welfare, and develop a long-term breeding strategy that preserves these self-sufficiency traits [13].

Through grazing in the form of transhumance, sheep can contribute to the connectivity of ecosystems, as seeds and small animals become entangled in their wool and are then dispersed across different areas. Additionally, the use of adapted traditional breeds helps preserve these valuable genetic resources and allows farmers to produce a unique niche product.

The European Food Safety Authority (EFSA) [14] classifies farms under extensive conditions into three categories: Semi-Extensive, Extensive, and Very Extensive. In Semi-Extensive systems, sheep are guided to improved yards where they may stay for extended periods without housing, with supplementation provided if the pasture is insufficient. Stockpersons check on the animals daily, though physical contact is not a routine for the animals. In Extensive systems, sheep are kept outdoors year-round, often on unimproved pasture, and receive supplementation as needed. The stockperson's involvement is limited to moving the flock and performing essential tasks. Very Extensive systems are characterized by unfenced, non-improved grazing areas, with rare visits from the stockperson and no supplementary feed. Regardless of the specific classification, sheep in these systems share similar basic needs and may experience similar welfare issues.

For this thesis, the term "extensive" refers to all these systems, where sheep are typically housed outdoors and have limited human interaction, mainly for essential management tasks.

5.1. Potential welfare issues

While the welfare of sheep is largely positive when assessed according to natural living, extensive systems create a different set of welfare issues to those that are seen in intensive (or behaviorally restrictive) production settings [12].

In extensive sheep farming systems, close inspections of animals are often limited and may occur as infrequently, especially in hill farming settings. This approach to farming leaves sheep's access to resources like food, water, thermal, and physical comfort subject to natural weather changes, which can lead to intermittent or temporary shortages—such as following a snowstorm. Moreover, the low frequency of close inspection raises the risk that disease or injury may go unnoticed or untreated over longer periods [11].

Imbalances in nutrition are a common issue in extensively managed livestock systems [15], with poor nutrition and related metabolic diseases being significant welfare concerns for adult sheep [16].

In extensive systems, where animals graze outdoors, their nutritional intake depends on the natural availability and quality of forage, which is highly susceptible to seasonal and climatic fluctuations [17].

If the plants fail to thrive or adverse weather conditions such as heavy rainfall or snow inhibit grazing, the dietary needs of the animals may not be met, leading to potential welfare risks [18].

Sheep living outdoors in extensive systems are vulnerable to various environmental hazards. These risks can be natural, such as uneven topography like cliffs or rivers, or the presence of poisonous plants that may harm the animals. Additionally, man-made hazards can pose significant welfare concerns, such as sharp barbed wire or broken fencing, which, if left carelessly in their environment, can lead to injury. These potential threats underscore the importance of proper management and monitoring in extensive farming systems to ensure the welfare of the sheep [18].

Disease and pain resulting from husbandry procedures are considered the primary welfare challenges faced by sheep [19]. Health issues such as lameness are a major concern for sheep farmers, particularly in Great Britain, where it has been identified as the leading cause of poor health in flocks [20, 21]. The prevalence and severity of health problems in sheep can also vary according to the age and sex of the animals, with different issues arising at different stages of life [22].

Ecto-parasites pose significant welfare risks to sheep in extensive systems, potentially leading to chronic stress, pain, and even death [13, 23, 24]. Parasitic diseases are a major concern, with estimates suggesting that nearly 30% of global spending on animal health is dedicated to the prevention and management of such diseases [25]. These parasites can have a substantial impact on sheep health and productivity, emphasizing the need for effective management strategies in extensive farming systems.

Gastro-intestinal parasites, particularly Coccidia, represent a significant health, productivity, and welfare challenge for sheep [26]. Coccidiosis, a disease caused by Coccidia that affects the intestines, is widespread across sheep-rearing regions globally, with nearly all domestic ruminants likely to experience infection at least once during their lifetime [27]. While housed animals are typically at higher risk [27], grazing sheep are also susceptible, as the longevity of the parasites on pasture remains uncertain [28].

The relationship between sheep and their owners is multifaceted. In extensive farming systems, the human-animal interaction is typically less direct than in intensive systems; however, the bond between the shepherd and the flock still significantly affects the animals' welfare. Despite thousands of years of domestication, sheep continue to find humans a source of fear, one of the most startling stimuli they encounter, as highlighted by various studies [29–31]. This suggests that the nature of human interaction with sheep, even in less intensive systems, can influence their well-being.

A strong human-animal relationship requires consistent, repeated interactions over an extended period, often weeks or even months [32, 31]. However, in extensive farming, sheep frequently experience either neutral or negative forms of contact with humans, such as during restraint, shearing, or medical treatments. Furthermore, even before direct handling occurs, activities like working the flock with dogs can already serve as significant stressors for sheep [11]. These stressors hinder the development of positive human-animal relationships, which can ultimately affect the welfare of the animals.

Another upcoming risk for extensive sheep in Austria is the wolf. The number of wolves spending at least some time in Austria increased once again in 2023 as you can see in Figure 1. Based on recent data from Austrian provinces, analysed in collaboration with the Research Institute for Wildlife Science and Ecology, 104 individual wolves were identified in Austria over the past year. Approximately 18 of these were pups, distributed across six packs within the country. Two of these packs had territories extending partially into Czech territory. Most of the adult wolves are likely transient individuals passing through the region [33].

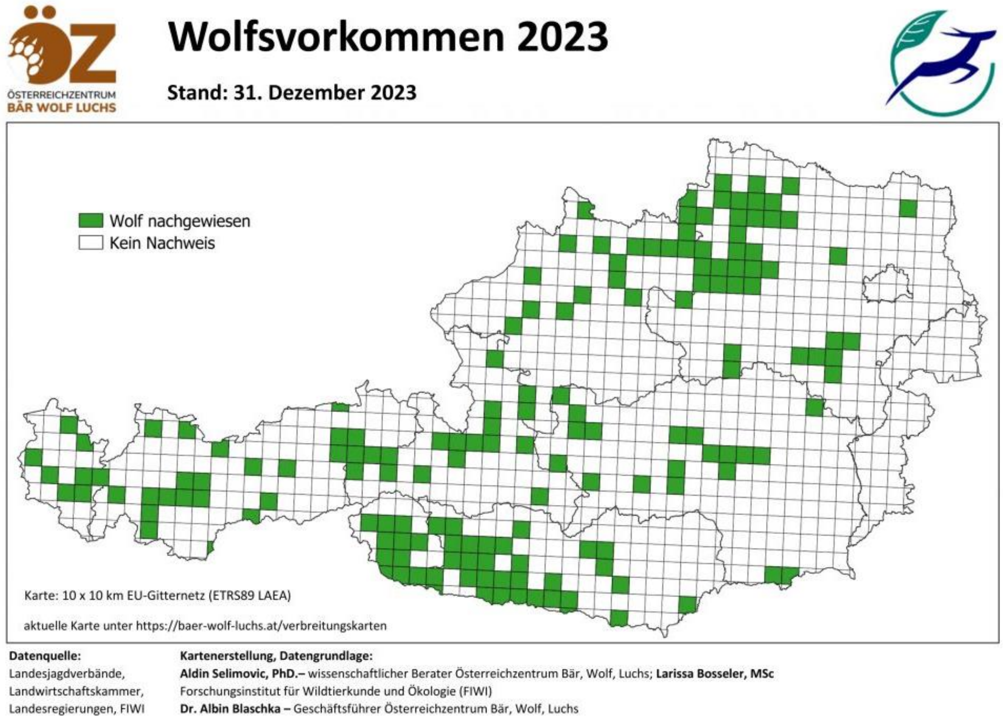

Figure 1: The green areas indicate the wolf presence in Austria in 2023 [33]

5.2. Behavioral Assessment

In assessing sheep welfare, identifying both the risks of compromised welfare due to infrequent monitoring and indicators of actual welfare deficiencies is essential. Such assessments help to detect conditions that might lead to poor welfare, such as low fleece coverage, which can increase the risk of thermal discomfort during adverse weather. Therefore, welfare assessments should aim not only to observe current welfare conditions but also to proactively identify and address risk factors that may predispose sheep to welfare issues [34].

During my research I found some studies which specify in behavioral assessment in extensive housing systems.

As highlighted in the article by the Animal and Veterinary Science Group [34], extensive research has already identified key welfare challenges in sheep, along with several welfare assessment schemes [35–37] . Some welfare indicators [22, 38, 39] are used frequently, yet most focus on housed sheep and rely heavily on resource-based indicators or primarily on animal health indicators [38]. For this reason, the article emphasizes animal-based indicators, which are often seen as more reflective of an animal's experience compared to resource-based indicators. This preference for animal-based, or outcome-focused, measures has made them the favoured approach in welfare assessment. The framework for developing sheep welfare indicators in this project relied on the Welfare Quality [40] project, which outlines four main principles and twelve criteria for assessing animal welfare. These principles and criteria were used to select relevant indicators that would comprehensively cover sheep welfare needs, ensuring that the assessment includes both the physical and behavioral aspects of welfare. This approach provides a structured and balanced basis for evaluating sheep welfare across different settings, aligning with established standards in animal welfare science.

In the research article from Carolina A. Mundoz [41], six animal- based indicators were used: body condition score (BCS), fleece condition, skin lesions, tail length, dag score and lameness as seen in Table 1.

Animal Welfare Indicators	Pregnancy				Weaning				Total
	Percentage	SD	MIN	MAX	Percentage	SD	MIN	MAX	Percentage
	(n = 3,000)				(n = 3,200)				(n = 6,200)
BCS									
Thin ≤ 2.25	8.4 (253)	±9.8	0	45	12.7 (407)	±11.3	0	43	10.6 (660)
Adequate 2.5–3.5	90 (2701)	±9.6	55	100	84 (2688)	±10.1	56	100	86.9 (5389)
Fat ≥ 3.75	1.5 (46)[a]	±2.8	0	12	3.3 (105)[b]	±3.7	0	13	2.4 (151)
Fleece condition									
Score 0	91.6 (2748)	±11.6	54	100	90.3 (2891)	±16.4	23	100	91 (5639)
Score 1–2	8.4 (252)[a]	±11.6	0	46	9.7 (309)[b]	±16.4	0	77	9.0 (561)
Ewes with skin lesions	30.1 (904)	±23.5	0	94	31.5 (1011)	±28.6	1	100	30.8 (1915)
Total skin lesions	1637[a]				2624[b]				4261
Head/neck	10.8 (177)	±16.9	0	91	19.4 (508)	±50.2	0	283	16.1 (685)
Ear	35.9 (588)	±18.5	0	54	24.4 (639)	±19.2	0	64	28.8 (1227)
Eye	1.2 (19)	±1.1	0	3	0.3 (8)	±0.5	0	2	0.4 (27)
Body	17.9 (293)	±38.1	0	206	29.5 (773)	±100.1	0	560	25.0 (1066)
Rear	29.8 (488)	±45.3	0	219	19.4 (508)	±43.6	0	228	23.4 (996)
Legs	4.4 (72)	±9.7	0	53	7.0 (188)	±17.2	0	85	6.1 (260)
Dag score									
Score 0–3	98.9 (2967)	±2.2	91	100	95.4 (3054)	±12.7	31	100	97.1 (6021)
Score 4–5	1.1 (33)[a]	±2.2	0	9	4.6 (146)[b]	±12.7	0	69	2.9 (179)
Tail length									
Score 0	11.9 (356)	±16.2	0	67	16.4 (526)	±21.7	0	78	14.2 (882)
Score 1	88.1 (2645)	±16.2	15	100	83.6 (2674)	±21.7	22	100	85.8 (5318)
Lameness									
Score 0	95.7 (2872)	±3.2	85	99	94.8 (3034)	±2.6	90	99	95.3 (5909)
Score 1	2.9 (86)	±2.8	0	11	3.5 (112)	±1.8	0	7	3.2 (198)
Score 2–3	1.3 (40)	±1.0	0	4	1.7 (53)	±1.3	0	4	1.5 (93)
Further Care	2.6 (77)	±1.4	0	5	3.3 (108)	±2.3	0	11	3.0 (185)

[a,b] Values within a row with different superscripts differ significantly at $P<0.05$. The BCS classification was based on recommendations from [21].

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Table 1: The percentage, standard deviation (SD), as well as the minimum and maximum values recorded in each category based on the time of assessment, with raw numbers provided in parentheses. [41]

In this study, conducted across 32 farms within the high-rainfall and wheat-sheep zones of Victoria, a total of 6,200 ewes were examined. The welfare assessment of ewe flocks, based on six primary indicators, was generally favourable. Specifically, 86.9% of the ewes maintained an adequate body condition score (BCS), 91% exhibited healthy fleece, and 69.2% had no skin lesions. Additionally, 97.1% showed low dag scores, and 95.3% were free from lameness. However, a small subset (3%) of ewes required additional care due to significant welfare issues, often involving multiple health concerns. Severe lameness or foot-related problems, poor body condition, and conditions like active dermatophilosis or wool breakage were the most common causes for the need for further care in this group [41].

6. INTENISVE SHEEP FARMING

While intensive production is often linked with livestock like pigs and poultry, sheep can also be managed in intensive systems. In such systems, sheep are usually housed continuously with limited or no pasture access, relying on feed supplementation rather than grazing. This setup leads to frequent interactions between the animals and stock workers, as well as a structured environment that contrasts with the traditional grazing-based approach commonly associated with sheep farming [18].

The shift towards greater intensification in sheep farming has contributed to the establishment of permanent husbandry setups for dairy ewes and lambs raised for fattening. This development reflects a growing trend to meet production demands by confining sheep within controlled environments, which contrasts traditional extensive grazing systems and has implications for animal welfare and management practices [42].

In intensive meat production systems, ewes are typically bred at approximately one year of age. These animals are kept in mixed management groups, often comprising apromimatly a hundred individuals of different ages. Advanced reproductive technologies, such as artificial insemination or embryo transfer, are frequently utilized to enhance production efficiency. Lambs are raised by their mothers until weaning, which occurs between 8 and 12 weeks of age. After weaning, lambs are either slaughtered or transitioned to fattening processes. The fattening phase can take place in confined housing systems or specialized feedlots, depending on the production setup. While lambs are commonly managed intensively during this period, breeding ewes and rams may be maintained under varying systems, which could differ in terms of housing and feeding strategies. Daily supervision in these systems is conducted primarily at the group level. Animals are easily accessible for observation, but direct physical handling or the involvement of herding dogs is generally unnecessary. This approach streamlines management while maintaining adequate oversight of the flock [43].

6.1. Potential welfare issues

While sheep in intensive systems typically retain more freedom of movement compared to more confined animals such as pigs in stalls or veal calves in crates, unique welfare concerns persist in intensive sheep farming. Key issues include the reduction or elimination of natural grazing opportunities and limited space allowance, both of which impede sheep from displaying their natural behaviors essential for well-being [44].

Close confinement among sheep can exacerbate the spread of diseases, including respiratory issues, lameness, and mastitis, particularly in dairy sheep. This increased proximity promotes transmission of pathogens, impacting sheep health and necessitating additional management practices to control disease within intensive production systems [45, 46].

In intensive dairy systems, reproductive behavior in sheep is often altered to increase milk production. Ewes are typically bred at a younger age compared to those in more traditional or extensive systems. This practice aims to maximize productivity, although it can impact the overall health and welfare of the animals. Early breeding can lead to challenges in terms of physical development, which may affect their long-term health and efficiency in milk production. Consequently, the welfare of these sheep is often compromised by these intensified management practices [46].

7. BEHAVIORAL ASSESSMENT

Behavior is arguably one of the most critical indicators of animal welfare, as it reflects an animal's physiological and emotional state. Broadening the scope of behavioral assessments can further provide insights into the animal's motivation and mental state [47].

Additionally, behavior is relatively visible and straightforward to document or quantify in a non-invasive manner. However, interpreting the implications of specific behavior for an animal's welfare is often challenging. For instance, the significance of certain actions—such as tail flicking, ear positioning, walking, or lying down—can be difficult to evaluate in terms of the animal's overall experience. In this context, qualitative behavioral data can offer valuable insights, as they focus on the expressive quality with which the animal performs each behavior. For example, a tail flick might occur in a relaxed context, such as fly dislodging, or in an aggressive context. Recognizing these distinctions enhances the understanding of how an animal interacts with its environment and is an integral aspect of effective animal husbandry practices [44, 48].

7.1. Animal Welfare

Animal welfare refers to the overall well-being of non-human animals. The formal criteria for assessing animal welfare differ depending on the context and are predominantly discussed among animal welfare organizations, policymakers, and researchers [1].

The idea of animal welfare is multiple and encompasses a variety of definitions that address different aspects of an animal's well-being. According to the Brambell Committee (1969), welfare refers to both the physical and mental well-being of an animal. This perspective was expanded by the Farm Animal Welfare Council (FAWC) in 1992 with the introduction of the Five Freedoms, which focus on the absence of suffering and the ability of animals to engage in natural behaviors. Over time, it has been recognized that merely avoiding negative experiences is not sufficient. True animal welfare should also allow animals to reach high levels of biological function and experience positive states of well-being [44].

Animal welfare, whether on the farm, during transportation, at markets, or at slaughter facilities, should be assessed using the concept of the "Five Freedoms". These freedoms represent ideal conditions rather than minimum standards, providing a comprehensive framework for evaluating welfare across various systems. They also guide the measures and compromises required to safeguard and enhance welfare within the practical boundaries of a functioning livestock industry.

1. Freedom from Hunger and Thirst – Ensured through access to clean water and a diet that supports full health and vitality.
2. Freedom from Discomfort – Achieved by providing an appropriate environment, including adequate shelter and a comfortable resting area.
3. Freedom from Pain, Injury, or Disease – Secured through prevention strategies or prompt diagnosis and effective treatment.
4. Freedom to Express Normal Behavior – Facilitated by ensuring sufficient space, suitable facilities, and social interaction with conspecifics.
5. Freedom from Fear and Distress – Maintained by creating conditions and treatments that prevent mental suffering.

These principles form the foundation for promoting and maintaining animal welfare across all stages of livestock management [49].

Animal welfare indicators can be categorized into three primary groups:

1. Animal-based indicators, which are determined through direct observation or physical examination of the animals.
2. Resource-based indicators, which evaluate factors related to the animals' environment, such as housing conditions, availability of grazing areas, and access to water.
3. Management-based indicators, which focus on the policies and management practices adopted by farmers [3].

For assessing sheep welfare, animal-based indicators must meet specific requirements. They must be valid, ensuring they are directly relevant to the welfare of sheep; reliable, guaranteeing consistent results across different assessors or time points; and feasible, meaning their application is efficient in terms of time, labor, and resources [4].

7.2. Welfare Quality® project

The Welfare Quality® (WQ®) project adopts a comprehensive framework for evaluating animal welfare by categorizing it into four overarching principles based on the animals' experiences: adequate feeding, appropriate housing, good health, and natural behavior [50].

These principles are further refined into 12 distinct yet interrelated welfare criteria, designed to provide a thorough and nuanced understanding of animal well-being, which you can see in Table 2. This approach underscores the complexity of welfare assessments and the importance of addressing multiple dimensions to ensure the holistic welfare of animals [51].

The Welfare Quality Project was mainly developed for other species such as cattle, swine and poultry. The AWIN Protocol for example adapted the Welfare Quality Project to sheep.

Principles	Criteria
Good feeding	1. Absence of prolonged hunger (animals should not suffer from prolonged hunger, i.e. they should have a suitable and appropriate diet)
	2. Absence of prolonged thirst (animals should not suffer from prolonged thirst, i.e. they should have a sufficient and accessible water supply)
Good housing	3. Comfort around resting (animals should have comfort when they are resting)
	4. Thermal comfort (animals should have thermal comfort, i.e. they should be neither too hot nor too cold)
	5. Ease of movement (animals should have enough space to be able to move around freely)
Good health	6. Absence of injuries (animals should be free of injuries, e.g. skin damage and locomotory disorders)
	7. Absence of disease (animals should be free from disease, i.e. animal unit managers should maintain high standards of hygiene and care)
	8. Absence of pain induced by management procedures (animals should not suffer pain induced by inappropriate management, handling, slaughter, or surgical procedures, e.g. castration, dehorning)
Appropriate behaviour	9. Expression of social behaviours (animals should be able to express normal, non-harmful, social behaviours, e.g. grooming)
	10. Expression of other behaviours (animals should be able to express other normal behaviours, i.e. it should be possible to express species-specific natural behaviours such as foraging)
	11. Good human-animal relationship (animals should be handled well in all situations, i.e. handlers should promote good human-animal relationships)
	12. Positive emotional state (negative emotions such as fear, distress, frustration or apathy should be avoided whereas positive emotions such as security or contentment should be promoted)

Table2: The Welfare Quality® Project defines animal welfare through four core principles and twelve associated criteria, providing a comprehensive framework for assessing and improving the conditions in which animals live. [50]

7.2.1. Good Feeding

Prolonged thirst and hunger can significantly compromise animal welfare. Hunger will arise from malnutrition, undernutrition, or a combination of both. Malnutrition happens when the nutrient intake is imbalanced, whereas undernutrition refers to an insufficient overall supply of nutrients. There are various reasons why prolonged hunger leads to poor welfare outcomes. Firstly, either malnutrition as well as undernutrition induce stress, which, if severe or persistent, can result in debilitation, loss of body condition, immunosuppression, and increased susceptibility to disease. Therefore, extended hunger impairs biological functioning and is likely associated with an aversive emotional state, further exacerbating welfare concerns [2].

Three potential indicators have been proposed for this criterion:

1. Body Condition Score (BCS): Evaluated through manual palpation of the lumbar spine to determine the animal's nutritional status.
2. Tooth Loss: Assessed to identify issues related to aging, diet, or overall health that could impact feeding efficiency and welfare.
3. Lamb Mortality Rates: Derived from farm records, providing insight into health and management practices affecting the survival and welfare of lambs.

These indicators collectively address both direct and indirect aspects of animal well-being [52].

7.2.2. Good Housing

Housing and environmental conditions play a critical role in determining the welfare of sheep, encompassing three key aspects:

1. Comfort Around Resting: Ensuring that sheep have access to clean, dry, and adequately sized resting areas to promote physical health and prevent stress or injury.
2. Thermal Comfort: Maintaining environmental conditions within an appropriate temperature range to prevent heat stress or hypothermia, considering the sheep's breed, age, and wool coverage.
3. Ease of Movement: Providing sufficient space and appropriate flooring to allow sheep to move freely without restrictions, reducing the risk of injuries and supporting natural behaviors.

These elements are essential for promoting overall well-being and minimizing stress in managed sheep populations [53].

Some Indicators, if comfort around resting is given would be the lying time of the sheep, lying synchrony or coat cleanliness. The lying time is less if there is not enough space given to the sheep. Also, if not all sheep can rest at the same time is an indicator if there is enough space for comfort. The coat cleanliness gives us conclusion if the sheep must lie in dirty or wet ground [34].

7.2.3. Good Health

Good health is a fundamental aspect of animal welfare, defined as the absence of injuries, diseases, and pain [54]. These adverse states can arise from a variety of causes, including specific management practices. Either injuries as well as diseases can lead to acute and/or chronic pain, which significantly impacts welfare. Pain, being an aversive emotional experience, not only compromises the animal's physical condition but also represents a critical welfare concern due to its negative effect on emotional well-being.

Lameness is the most common sign of limb injury, which compromises the animals' welfare by causing long-term pain and impairing normal sheep behavior [53].

Lameness is commonly evaluated using gait scoring, with several scoring systems proposed for this purpose. These systems typically involve observing the animal's movement and posture to identify abnormalities or deviations from normal gait. The scoring frameworks vary in complexity, ranging from simple dichotomous scales (e.g., "lame" or "not lame") to more detailed multi-point scales that assess specific aspects of locomotion, such as stride length, weight-bearing, and limb movement. The choice of scoring system depends on the context, the level of precision required, and the feasibility of implementation in field conditions [34].

Sheep are susceptible to various ectoparasites, including mites, lice, and fly larvae, which can cause significant welfare issues such as itching, rubbing, biting, and reduced wool growth (68). These infestations are often identifiable through inspection of the wool and skin. In severe cases, infestations may result in breaks in wool fibers, which can be noticeable from a distance when ewes partially shed their fleeces

Assessment of fleece and skin condition is a key component of on-farm welfare evaluations [55, 37, 38]. While wool loss is able to be assessed in unhandled animals, a efficient examination of skin irritation requires direct observation of the sheep. Studies have demonstrated good inter- and intra-observer reliability for this indicator. Specifically, the judgement of wool loss has shown high intra-observer reliability, though further research is needed to establish inter-observer reliability, particularly when assessments are conducted at the group level [38].

7.2.4. Appropriate Behavior

The principle of appropriate behavior encompasses four key criteria as outlined by the Welfare Quality® (WQ®) framework:

1. Expression of Social Behaviors: Ensuring animals have the opportunity to engage in natural social interactions with conspecifics, which is critical for their well-being.
2. Expression of Other Behaviors: This often includes the observation and mitigation of stereotypic behavior, which may indicate poor welfare or unmet needs.
3. Quality of the Human-Animal Relationship: Evaluating the interactions between animals and their handlers to ensure they are positive and free from unnecessary stress.
4. Absence of General Fear: Sometimes referred to as promoting a "positive emotional state," this criterion focuses on minimizing fear and stress to support emotional well-being.

These criteria aim to assess and promote the behavioral and emotional aspects of animal welfare [50].

8. WELFARE ASSESSMENT PROTOCOLS

Standardized protocols are considered one of the most effective tools for assessing sheep welfare, as they encompass multiple dimensions of well-being and incorporate a diverse range of indicators[56].

Sheep farming across Europe occurs under a wide range of environmental conditions, from the cool and wet climates of northern Europe [57] and the Atlantic regions [58] to the arid, warm Mediterranean zones of southern Europe [59].

These diverse conditions have driven the evolution of numerous sheep breeds, each uniquely adapted to specific purposes and environmental challenges. This variety necessitates careful consideration in the creation of welfare protocols, posing the question of whether standardized approaches are feasible or if flexibility to accommodate local variables is essential [60]

Historically, the welfare assessment of sheep in European countries was relatively underexplored until Napolitano et al. [35] applied the Animal Needs Index 35 L, a methodology initially designed for cattle [61], to monitor the welfare of sheep on organic and conventional farms. Similarly, Stubsjøen et al. [37] developed a sheep welfare assessment framework in Norway, incorporating both animal- and resource-based metrics.

In 2014, the European Food Safety Authority (EFSA) issued a comprehensive scientific opinion detailing key risk factors, welfare outcomes, and suitable animal-based indicators tailored for various farming systems, from shepherding to very extensive practices, as well as different sheep categories like ewes and lambs [18].

This was followed by the European Commission's endorsement of the Animal Welfare Indicators Network (AWIN) protocol, which emphasized animal-based metrics within the four principles and 12 criteria outlined by the Welfare Quality® framework [50, 62].

The AWIN protocol has gained traction beyond Europe, being utilized in countries like Australia [12] and Mexico [63]. However, limitations persist, as AWIN does not support comprehensive farm-level assessments and can be resource-intensive, particularly in diverse production systems and large-scale farming operations [3].

Moreover, discrepancies among stakeholders regarding the importance of specific indicators, such as cleanliness or fleece quality, further complicate standardization efforts [64].

Consensus is growing around prioritizing animal-based measures for welfare assessment, as these metrics provide more direct insights into the animals' experiences than resource-based measures [18].

Recent studies continue to support this approach, emphasizing the value of animal-based parameters in designing effective and reliable protocols [34, 65].

All protocols comprise animal-based indicators and have been deemed feasible for on-farm application by their respective authors. In the Table 3 you can see all the animal- based indicators used in the different welfare assessment protocols, marked with an X. The AWIN Protocol Is also splitted in both Levels.

Indicator	Munoz [5,10]		Napolitano [7]	Stubsjøen [8]	AWIN [9]	
	2018	2019			First Level	Second Level
Lameness/Gait score	X	X	X	X	X	X
Body condition score	X	X	X	X		X
Fleece cleanliness	X		X	X	X	X
Faecal soiling/Diarrhoea	X	X		X	X	X
Tail length/Mutiliations	X	X	X		X	X
Skin lesions/Integument condition/Skin irritation	X	X	X	X		X
Fleece quality/Fleece condition	X	X			X	X
Familiar human approach/Fear/Flight distance	X	X		X	X	
Mastitis or other udder problems	X	X		X		X
Hoof overgrowth/Hoof condition	X		X			X
Panting	X				X	
Social withdrawal	X				X	
Stereotypy, excessive itching	X				X	
Occular discharge/Eye abnormalities				X		X
Respiratory quality/Coughing				X		X
Lamb mortality					X	
Water availability					X	
Access to shelter					X	
Stocking density					X	
Mucosa color						X
Animal appears sick				X		
Swollen joints				X		
Callus on carpus				X		
Nasal discharge				X		
Ear tag torn out				X		
Rumen fill	X					
Aggression	X					
Qualitative behaviour assessment	X					

Table 3: Here is an example of how to organize the list of animal-based sheep welfare indicators, including the protocols in which each indicator is included. The indicators are sorted based on the number of protocols that include them, and distinction [56].

8.1. Protocol of Napolitano (=Animal Needs Index 35 L)

Napolitano et al. developed a welfare assessment protocol in Italy [35], structured around four categories derived from the Animal Needs Index. That categories primarily prioritize on resource-based parameters, with a fifth category incorporating animal-based indicators. Within this category, seven animal-based indicators are evaluated: body condition, integument alterations, animal cleanliness, hoof overgrowth, lameness, lesions, and mutilations, to which dehorning and tail docking belong. Body condition was additionally highlighted as evidence of malnutrition and disease. However, the originator noted that body condition scoring was impractical during winter farm visits, as the sheep had not been shorn, making it difficult to identify thin or emaciated animals. Consequently, body condition was deemed ineffective for comprehensive welfare assessments under these conditions, despite its importance in welfare protocols.

Each indicator is scored based on its prevalence within the herd, where a higher frequency of noncompliance results in a lower score. The protocol's practicality and inter-observer reliability were tested by two trained observers on ten organic and ten conventional sheep farms in Southern Italy. These farms housed an average of 350 animals, with at least 20% of lactating ewes evaluated per farm. The assessments required no specialized equipment, and the average duration of the evaluation was approximately 85 minutes per farm.

The authors acknowledged a significant limitation in the protocol: the absence of direct measures for internal parasitism. To address this, they suggested incorporating parasite egg counts, which could improve the protocol's validity but would increase assessment time. Additionally, they recommended conducting farm visits shortly after shearing to facilitate the evaluation of body condition and lesions, as well as ensuring thorough training in lesion assessment to improve reliability.

Despite these limitations, the protocol was recognized as a useful tool for on-farm sheep welfare assessment, offering actionable management recommendations to farmers. However, the authors emphasized the need for further studies to validate the protocol across larger sample sizes and to assess its reliability under diverse conditions [35].

8.2. Protocol of Stubsjøen

Stubsjøen et al. [37] proposed a sheep welfare assessment protocol that integrates both animal-based and resource-based indicators, adapting elements of an established dairy cattle welfare protocol rooted in the Five Freedoms framework. The protocol is divided into two main components: on-farm measurements and the analysis of production data. It includes 16 animal-based indicators, 15 resource-based indicators, and three production-related metrics (slaughter weight, carcass classification, and fat class). The chosen animal-based parameters are detailed in Figure 4.

The assessment begins with flock-level observations to identify signs of clinical disease, lameness, and coughing. This is followed by clinical examinations of ten randomly selected animals. Behavioral assessments are conducted to evaluate anxiety levels and the human-animal relationship. Fear responses are measured using an adapted approach from Reference [66], which involves counting how often a person can approach and touch elected animals. To assess the care keeper-animal relationship, the human most familiar with the sheep enters pens and tags randomly selected ewes. Responses are categorized into four levels, ranging from 3 ("calm when approached") to 0 ("attempts to escape by jumping out of the pen"), with average scores calculated for each farm.

Resource-based indicators, like temperature and relative humidity, are calculated between three and 27 times depending on the farm size, and average values are computed. The entire on-farm assessment typically requires 3 to 5 hours and is conducted indoors. The second part of the protocol involves the analysis of production data, including individual carcass weight, fat class, and carcass classification. However, the authors highlighted insufficient evidence supporting the reliability of these three indicators as measures of welfare.

Inter-observer reliability was evaluated by two veterinary clinicians and one ethologist across 36 farms in Norway during the lambing season. Ten randomly selected sheep were assessed on each farm. While agreement among observers was generally high, challenges were noted with the scoring systems for body condition, carpal calluses, and claw conditions. The authors recommended refining these definitions and providing additional observer training. Moreover, further research is necessary to confirm the reliability and feasibility of the selected parameters [37].

8.3. AWIN

Between 2011 and 2015, the EU-funded Animal Welfare Indicators (AWIN) project was implemented to develop welfare assessment protocols for several species, including sheep, goats, horses, donkeys, and turkeys [40].

This project aims to develop a comprehensive protocol for on-farm welfare assessments tailored to specific species, utilizing primarily animal-based measures. This methodology aligns with the approaches established in the Welfare Quality® (WQ®) project, previously applied to pigs, poultry, and cattle. In the Animal Welfare Indicators (AWIN) project, similar principles and criteria from WQ® are adapted, emphasizing extensively managed adult ewes. Recognizing the unique living conditions of sheep, the principle of "Good housing" was added to encompass "Environment," acknowledging that sheep often spend significant periods of their productive lives outdoors. Following an extensive literature review and consultation with expert panels, a set of measures was identified to represent each of the four principles and 12 criteria outlined by WQ®. These measures are undergoing further investigation to ensure they are valid, reliable, and feasible. Although the focus remains on animal-based measures, some criteria required resource-based alternatives. For instance, the lack of prolonged thirst is estimated through the availability and cleanliness of water sources, in cases where no suitable animal-based measure was available. This dual approach ensures a holistic assessment of welfare in sheep under extensive management systems [11, 34].

The AWIN protocol employs a two-tiered strategy, comprising an initial herd-level screening followed by a comprehensive individual-level assessment [40].

The assessment framework operates on two distinct levels to ensure both efficiency and accuracy while minimizing animal stress. The initial evaluation focuses on the flock as a whole, employing reliable, animal-based indicators that are non-invasive and require little to no direct handling of the animals. These indicators, summarized in Table 1, provide a quick overview of welfare conditions. If this primary assessment identifies issues, such as non-compliance with animal welfare laws or the farm ranking in the lowest 5% compared to reference populations based on specific welfare criteria, a more detailed secondary evaluation is triggered.

This second phase involves comprehensive data collection at the individual animal level, requiring physical restraint for more precise measurements. The dual-tier system is designed to optimize efficiency by limiting unnecessary interventions while still addressing potential welfare concerns in a systematic and rigorous manner [67].

8.4. First and Second Protocol of Munoz

Munoz et al. developed two protocols, published in 2018 [68] and 2019 [12], aimed at assessing the welfare of extensively managed sheep using animal-based indicators. The authors conducted a thorough review of scientific literature and identified 17 potential welfare indicators, which were categorized according to the five domains of welfare. Of these, eight indicators were selected based on their validity, reliability, and feasibility for evaluating extensively managed ewes[68].

The first protocol was tested on 100 randomly selected ewes from a flock of 3,000 breeding ewes in Victoria, Australia. Assessments were conducted at three critical stages: pregnancy, lactation, and weaning. Four groups of 25 ewes each were evaluated. The protocol included a group flight distance test to measure the ewes' response to an unfamiliar human, followed by individual clinical examinations. This protocol demonstrated its effectiveness in identifying welfare risks, but the authors noted the need for further research to validate its reliability and feasibility [68].

The second protocol introduced in 2019 incorporated additional management- and resource-based indicators, such as nutrition management and shelter provision. The authors suggested that integrating these indicators with animal-based assessments could provide a more comprehensive understanding of welfare issues and inform strategies to mitigate them. Similar to the first protocol, this version effectively identified key welfare concerns while relying on fewer indicators [12].

9. QUESTIONS

How can we evaluate behavioral assessment in different housing systems in Austria?

To solve this question, we first started to evaluate different methods for assessing behavior of sheep. There are already many different methods for this. We can either use already finished protocols, such as Munoz, Napolitano or AWIN. Or we concentrate on good and bad indicators for a positive or negative condition during behavioral observation. Therefore, the qualitative behavioral assessment (QBA) gives us some good indicators to watch out for.

To focus on the Austrian housing systems, we evaluated the most used ones. There we dived deeper, looked at contra indications like potential welfare issues, but also on the positive aspects. Then we concentrate on the extensive sheep, because a lot of the protocols mentioned above were made with or used on housing sheep. Extensive sheep housing is very common in Austrian farms, therefore it is important to find a good evaluating system for these conditions. Two studies are mentioned to evaluate behavior in reference to extensive sheep housing.

When we start comparing the different protocols we can see, as shown in Table 3, that they all rely on different indicators. Some rely more only on animal-based indicators, like the AWIN Protocol [62] and some use a variety of different indicators like Stubsjøen, [37] incorporating both animal- and resource-based metrics. The Protocol of Napolitano [35] for example used mostly resource- based indicators.

They all have different origins, like Napolitano [35]used the Animal Need Index 35L, which was is originally used for cattle. The AWIN [62]protocol adapted the Welfare Quality® work, which was originally used for pig, poultry and cattle, to sheep.

When we compare the different protocols in concentrating on the different housing conditions, we can evaluate on which flocks they started. The First Protocol of Munoz [68] for example, focused on extensively managed sheep. It also only takes eight animal- based indicators into consideration, which makes the protocol easy to use and very variable. It needs more study to find out, if the protocol is also suitable for indoor sheep.

The AWIN [62] protocol uses the two phases, which makes it suitable for both, extensive and intensive housing conditions. Stubsjøen [37] is very similar to the AWIN Project, it first starts with the herd evaluation and then takes some individuals out of the flock. A study done by Napolitano [35] in 2009 compared the animal welfare in organic and conventional sheep farms using the ANI 35L method. In this study no big differences in animal welfare could be determined. Both systems provide adequate welfare [3]. Which makes the Napolitano Protocol also suitable for both husbandry systems.

The big difference between the husbandry systems makes it difficult to make one unit protocol for assessing sheep welfare. In Austria it is also difficult to find enough farms with the exact same husbandry system to compare the results when trying behavior assessment protocols. Therefore, it is easier to use some special chosen behavior indicators, which might fit best the selected husbandry systems to compare. Some of the protocols are also only tested on a small group of sheep and therefore more studies need to be done to on larger groups. Protocols which focus more on the animal- based indicators, like the AWIN protocol, make the protocol more variable and therefore better for the use on different housing systems. Another factor influencing the assessment of sheep behavior is the person doing it. Some measurements are relaying on the individual assessment and are therefore hard to compare with. To be able to evaluate the results, the professionals must undergo the same training and use the same standards, despite their individual opinion.

10. CONCLUSION

The aim of this study was to conduct a comprehensive analysis of scientific literature to summarize the available research on sheep welfare and identify animal-based welfare indicators as well as accepted welfare protocols which can be used to assess sheep behavior in different housing conditions used in Austria.

All protocols included animal-based indicators proved in the literature and appeared appropriate for on farm application, requiring minimal resources and causing little annoyance to the animals. Neverthless, none of the protocols have yet been extensively proved on larger scales or with larger sample sizes, making it difficult to confirm their reliability for consistently and accurately representing sheep welfare. Furthermore, not all protocols are useable for both intensive and extensive housing of sheep. More protocols were tested on housed sheep than on the extensive ones, but some new studies mentioned in this thesis concentrate on evaluating sheep welfare of extensive sheep.

In contrast to complete protocols, the amount of data available for individual indicators is more extensive. This discrepancy arises because most of the written protocols rely on professional opinions to select indicators. Commonly studied indicators, such as behavioral assessments, lameness, body condition score (BCS), fleece condition, and skin lesions, are widely recognized as reliable measures of sheep welfare. Conversely, other indicators like various pain assessment methods, are frequently referred to in the literature but are a topic to debate regarding their validity and feasibility. In extensively managed sheep different individual animal-based indicators can be used, more than the finished protocols.

11. SUMMARY

The thesis examines the assessment of sheep welfare, with a particular focus on behavioral evaluations in diverse housing conditions prevalent in Austria. Animal welfare, as a critical component of livestock management, requires consistent monitoring and reliable assessment methods to enhance ethical farming practices. This study reviews existing protocols and welfare indicators to determine their suitability for Austrian sheep farming systems, particularly those involving extensive and intensive management.

In Austria, sheep farming predominantly focuses on meat production, with approximately 85% of sheep raised for lamb meat. Extensive grazing systems are widely employed due to their ecological benefits, such as promoting biodiversity and preserving landscapes. These systems allow sheep to express natural behaviors but also expose them to risks, including nutritional imbalances, parasite infections, and predator attacks. Conversely, intensive systems, while offering closer oversight of sheep health and welfare, limit natural behaviors and may increase stress levels due to confinement and overcrowding.

Behavior is a fundamental indicator of animal welfare, offering insights into both the physical and emotional state of animals. Qualitative Behavioral Assessment (QBA) and standardized protocols, such as the AWIN framework, are highlighted in the thesis for their practical application in evaluating sheep welfare. These methods emphasize observing and interpreting sheep behaviors to infer their well-being.

The thesis compares welfare conditions in extensive and intensive systems. In extensive systems, sheep benefit from natural grazing opportunities and species-specific behaviors, aligning with the "natural living" concept of welfare. However, these systems are also associated with challenges such as inconsistent food availability, exposure to harsh weather, and limited human interaction, which may delay the detection and treatment of health issues. Animal-based indicators, including body condition scoring, fleece quality, and behavioral responses during handling, are critical for welfare assessments in these settings.

In intensive systems, sheep are housed with limited access to pasture and rely on supplementary feeding. This setup facilitates regular monitoring and close management but restricts freedom of movement and natural behaviors. Common welfare concerns in intensive systems include increased susceptibility to diseases, stress from confinement, and the impact of breeding practices aimed at maximizing productivity. Indicators such as lameness assessment, reproductive health, and overall health metrics are widely used in these contexts.

Various welfare protocols, including the AWIN protocol, the Napolitano method, and Munoz's framework, are reviewed for their relevance and effectiveness. While these protocols incorporate animal-based indicators and provide practical tools for on-farm application, many are more applicable to housed sheep, leaving a gap in comprehensive assessment methods for extensively managed flocks.

The study highlights the challenges in developing welfare assessment tools that cater to the unique needs of extensive systems, which dominate Austrian sheep farming. It emphasizes the need for further research and refinement of existing protocols to address these gaps. By integrating individual welfare indicators with broader frameworks, it is possible to create more effective tools for assessing and improving sheep welfare in diverse farming environments.

In conclusion, the thesis contributes to advancing the understanding of sheep welfare assessment by identifying the strengths and limitations of existing protocols. It underscores the necessity of tailored approaches that consider the specific challenges of extensive systems while maintaining the feasibility and reliability of welfare assessment methods. This research provides a foundation for enhancing sheep welfare in Austria and beyond, particularly in systems that prioritize ecological and ethical farming practices.

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Centre for Animal Welfare

Thesis progress report for veterinary students

Name of student: Gloria Schlögl

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Name and title of internal supervisor: Dr. Jurkovich Viktor

Department: Centre for Animal Welfare

Thesis title: Behavioural assessment of sheep in different housing conditions in Austrian farms

Consultation – 1st semester

Timing				Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2022	3	3	Thesis topic suggestions	
2.	2022	8	25	Thesis topic final	
3.	2023	2	21	Thesis form, topic outline	
4.	2023	10	23	Thesis progression check	
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Consultation – 2nd semester

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3.	2024	11	24	Thesis final version	
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5.					

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The thesis meets the requirements of the Study and Examination Rules of the University and the Guide to Thesis Writing.

I accept the thesis and found suitable to defence,

....

signature of the supervisor

Signature of the student: Gloria Schlögl

Signature of the secretary of the department: Valló Petra

Date of handing the thesis in: 2024.11.27

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