Chapter 10

Live Weight and Animal Welfare in Small Ruminants

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Abstract

Animal welfare is becoming an increasingly important component of global animal husbandry. Animal welfare is an important dimension that shows whether animal-based systems are sustainable. A husbandry system that results in low animal welfare is not sustainable and is considered unacceptable by many consumers. Animal welfare is assessed from the point of view that the animals' biological functions function optimally under the husbandry conditions and that they can maintain positive emotional states that correspond to their natural living conditions. The quality of food is determined by the welfare status of the animals from which the food originates and the quality and safety of the final product. Therefore, there is a need for strategies to improve animal welfare and for reliable monitoring systems on farms to assess animal welfare, manage potential risks and meet societal concerns and market demands. There is also a need for practical and standardised methods to assess animal welfare.

Live weight is used as an important selection criterion for improving the productivity of livestock. Changes in live weight in small ruminants are used to monitor animal health. It is also known that body condition scores based on live weight are more readily accepted by breeders when monitoring animal performance, health and welfare. By regularly monitoring body weight, body reserves can be identified and growth, reproductive performance, meat and milk production can be brought to the desired level. This study aims to emphasise the importance of live weight and welfare practises in small ruminants.

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1. Introduction

The rising global demand for animal-based foods poses significant challenges to sustainability and animal welfare, especially in intensive production systems (Odeon et al., 2025). Animal welfare is a crucial aspect of the food chain, as factors such as an animal's well-being, health, and stress levels prior to slaughter directly impact the quality of products derived from it (Blokhuis et al., 2008). Intensive farming techniques that prioritize high yields and production often subject animals to stress (Broom, 1986). While intensifying livestock farming is one way to meet the growing global demand for animal products, it raises concerns about animal welfare and the sustainable use of feed resources (Herrero et al., 2021; Resare Sahlin et al., 2024). Specifically, intensification in ruminant meat production focuses on increasing liveweight gain and improving resource efficiency through enhanced feed management (Wezel et al., 2015). Animal welfare remains a vital component of sustainability, as it both influences and is influenced by natural resource conservation, public health, and the economic sustainability of production systems (Paranhos da Costa, 2010). Given the ongoing global climate challenges, farm and land management decisions must balance climate concerns, economic profitability, animal welfare, and ecosystem health (Lanzoni et al., 2025).

Many sheep and goat breeds worldwide are intensively selected to improve meat, milk, and fiber production (Visser, 2025). Goats are present on five continents, with a global population exceeding one billion. Of these, 55.4% are located in Asia and 38.7% in Africa (Mazinani and Rude, 2020). This distribution corresponds with the expected pattern for animals well adapted to harsh environments and typically raised in extensive production systems (Amills et al., 2017). Similarly, the global sheep population, estimated at 1.1 billion, is distributed with 43.6% in Asia and 30% in Africa (Mazinani and Rude, 2020).

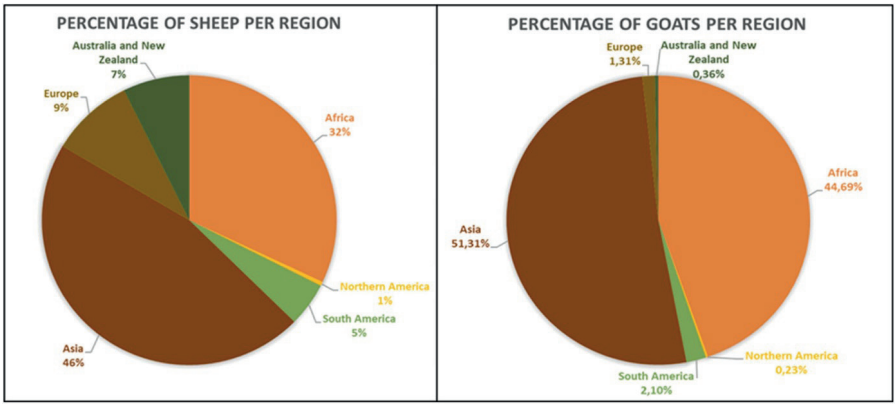

Figure 1. Worldwide distribution of small ruminants (Visser, 2025; FAOSTAT, 2024).

Sheep and goats are among the most versatile livestock species globally, thanks to their strong adaptability and ability to thrive in a wide range of ecological zones, including deserts, mountainous areas, and tropical climates (Amills et al., 2017). Although small ruminants are raised in diverse agricultural and geographical contexts, their populations are concentrated primarily in tropical and subtropical regions. In Africa and Asia, locally adapted breeds of sheep and goats are commonly raised due to their superior resilience to challenging environmental conditions. These animals are often kept in low-resource settings and marginal production areas. In contrast, in developed countries such as France and Italy in Europe, and Canada and the United States in North America, small ruminants are typically managed under intensive dairy production systems (Visser, 2025).

The welfare of animals is assessed from the point of view that the biological functions of the animals function optimally under the husbandry conditions and that they can maintain positive emotional states that correspond to the natural living conditions. The quality of food is determined by the welfare status of the animals from which the food is obtained and the quality and safety of the final product (Broom, 2010). Therefore, strategies to improve animal welfare and reliable on-farm monitoring systems are needed to assess animal welfare, manage potential risks and address societal concerns and market demands (Blokhuis et al., 2003; Caroprese et al., 2016). Animal welfare should be monitored in a way that is appropriate to farm conditions and does not impose significant additional burdens (Bozkurt et al., 2019). Animal welfare is a multidimensional concept based on the subjective experiences of animals (Broom, 2001). Therefore, animal welfare cannot be assessed directly; instead, measurements and assessments of

parameters that strongly reflect animal welfare can be used (Broom, 2010; Richmond et al., 2017). Although a more comprehensive assessment that includes physiological, behavioural and emotional states is necessary for the assessment of animal welfare, low body weight or body condition score values are highly correlated with low animal welfare.

Changes in live weight in small ruminants are used to monitor animal health (Broom, 2001; Richmond et al., 2017). In livestock farming, live weight and body condition are important factors influencing the productive period of animals (Robinson, 1990). The most practical indicator of the feeding level of sheep and goats is expressed by live weight and body condition score (Kenyon et al., 2014). Animals respond to unfavourable environmental conditions during their production period and even throughout their lives by using the fat and protein reserves in their bodies (Butler-Hogg, 1984; Fattet et al., 1984). Animals must have sufficient live weight and body condition before they reach physiological stages such as breeding, gestation and parturition (Özder et al., 1997). Live weight plays an important role in determining various traits, especially economic traits, of livestock. Parameters such as birth weight, early development, feed utilisation and growth rate can only be determined by knowing the live weight at different stages (Riva et al., 2001). By regularly monitoring body weight, body reserves can be determined and growth, reproductive performance, meat and milk production can be brought to the desired level. This study aims to emphasise the importance of live weight and welfare practises in small ruminants.

2. Live Weight And Animal Welfare in Small Ruminants

The welfare of farm animals is becoming an increasingly important part of global animal husbandry. Animal welfare is an important dimension that shows whether animal-based systems are sustainable. A husbandry system that results in low welfare is not sustainable and is considered unacceptable by many consumers (Broom, 2010; Miranda de Lama et al., 2019). There is also a need for practical and standardised methods to assess animal welfare (Blokhuis et al., 2003; Fraser, 2008; Grafton et al., 2015). However, the methodology for the scientific assessment of animal welfare has developed rapidly in recent years and animal welfare has become an important scientific discipline (Broom, 2010). An important question is how animal welfare can be measured. Live weight is used as an important selection criterion when selecting to improve the productivity of farm animals. Changes in live weight in small ruminants are used to monitor animal health. In addition, body condition score has been reported to be more readily adopted by

farmers than live weight to monitor animal performance, health and welfare (Brown et al., 2015; Richmond et al., 2017).

Brown et al (2015) reported in their study that the effect of sheep live weight on sheep performance and more recently on lamb performance has been the focus of numerous studies. The most recent of these studies were conducted by Behrendt et al. (2011); Ferguson et al. (2011); Oldham et al. (2011); Thompson et al. (2011); Hickson et al. (2012); Kenyon et al. (2012) and Schreurs et al. (2012). It has been shown that ewe live weight in relation to potential mature live weight and changes in live weight before and during pregnancy are reliable indicators of ewe and lamb production outcomes (Behrendt et al. 2011).

Live weight is a very important parameter for determining the market price of small ruminants and evaluating the economic efficiency of the farm. In fact, economic modelling shows that farm profitability can be increased if live weight of sheep and goats is maintained at an optimal level (Young et al., 2011). By regularly determining and monitoring live weight in sheep and goats, feed, labour, health and other costs can be kept at the lowest possible level (optimal), thereby increasing farm profitability (Brown et al., 2015). In addition, this approach, which ensures good monitoring of animal welfare, can prevent economic losses associated with poor animal welfare and enable the production of high quality and safe sheep and goat meat, resulting in higher priced product sales (Brown et al., 2015; Young et al., 2011).

Live weight is a widely accepted indicator of the energy status of sheep and goats at a given time. In small ruminants, live weight and live weight change influence animal productivity and optimisation can increase the profitability of the whole farm. This is due to the direct relationship between live weight and energy balance, so that an increase in live weight means an increase in fat and protein content. The live weight of sheep and goats is an important physiological parameter that needs to be monitored as it is directly related to the internal energy balance of the animals. In adult animals, the increase in live weight is accompanied by an increase in fat and protein tissue, while weight loss is inversely related. The lack of acceptance of live weight data collection among small ruminant producers can be attributed to the labour, time and associated costs required to regularly weigh a herd (Van Burgel et al., 2011).

A practical and effective way to help farmers identify sheep at risk or with compromised welfare is to closely examine a representative sample of the flock while the animals are on pasture during routine management tasks

such as vaccination, parasite control, or weaning. Since seasonal variations impact welfare, these thorough examinations should be conducted multiple times per year to ensure accurate assessments. Targeting critical periods, such as mid-pregnancy and weaning, focuses attention on times when welfare issues are most prevalent (Stubsjøen et al., 2011; Phythian et al., 2011). Providing farmers with simple and accessible tools to address common welfare problems may also increase the frequency of care given to sheep needing extra attention. These methods should be practical to perform while sheep remain on pasture or easy to implement in paddocks. For example, decision trees and checklists, which are user-friendly and readily available, can assist farmers in managing animals requiring additional care. Furthermore, sensor technologies offer promising alternatives. GPS tracking devices have been developed to support farmers in monitoring flocks and detecting sick animals (Fogarty et al., 2018; Umstätter et al., 2018). However, more research is necessary to improve the usability and wider application of these technologies (Munoz et al., 2019).

Animal welfare organizations are increasingly demanding more time and workforce to be allocated for monitoring sheep to ensure adequate welfare standards (Cronin et al., 2002). However, Petherick and Edge (2010) argue that fulfilling these requirements is becoming more difficult for the industry due to limited labor availability and economic constraints. Consequently, most sectors within the livestock industry have adopted automated technologies that allow producers to remotely measure and monitor animal production (Morris et al., 2012).

Liveweight is an important measure of an animal's current physical condition and its changes over time, providing valuable insight into how the animal responds to its environment (Baker et al., 1947). Factors such as growth, nutrition, health, stress, pregnancy, and genetics all influence liveweight (Brown et al., 2015; Coates and Penning, 2000), making it widely used in studies of these aspects in small ruminants. Globally, liveweight is one of the most commonly used measurements in livestock research because it is easy to collect and interpret, comparable across and within animals, sensitive to various influences, and provides quantitative data that can be flexibly used in statistical analyses. Additionally, methods for monitoring liveweight can be effectively applied in commercial farm management (Brown et al., 2015; Coates and Penning, 2000). Recording liveweight and making management decisions based on it are recognized as key factors in improving productivity and efficiency on commercial sheep farms (Brown et al., 2015; Wishart et al., 2015; Young et al., 2011). Advances in weighing technology have recently enabled new practical applications. The use of radio-frequency

identification (RFID) chips embedded in ear tags, combined with automated readers at weighing stations, allows for the easy collection and utilization of individual liveweight data (Morgan-Davies et al., 2006). Research and implementation in the field of Precision Livestock Farming (PLF), which employs technology for precise individual animal management, is on the rise (Banhazi et al., 2012). These weighing technologies offer promising opportunities to develop management systems that leverage liveweight data as a critical decision-making tool in sheep production (Brown et al., 2014).

The majority of research and commercial applications involving liveweight data rely on comparing measurements taken at different time points, either within individual animals or across groups. To obtain accurate and comparable liveweight values, it is crucial to recognize and control for the inherent variability and potential sources of error in such measurements (Wishart et al., 2017). Short-term liveweight variations in ruminants are influenced by several factors, including feed and water consumption (Whiteman et al., 1954), the duration since the last meal (Hughes, 1976), the quality and quantity of available forage (Hughes and Harker, 1950), the age of the animal and surrounding temperature (Lush et al., 1928), as well as individual differences in grazing behavior (Hughes and Harker, 1950).

Advancements in technology and the declining cost of electronic devices have enabled the creation of various sensor-based tools in livestock farming (Caja et al., 2016; Halachmi et al., 2019). These sensors can automatically collect real-time data, allowing for early identification of important issues such as production losses, decreases in liveweight, health problems, and risks to animal welfare at both the group and individual levels (Caja et al., 2016; Krueger et al., 2020; Maltz, 2020). This approach, commonly known as Precision Livestock Farming (PLF), is defined by Berckmans (2008) as "measuring variables, modeling data to extract useful information, and using these models to monitor and control animals in real time." A core aspect of PLF is its emphasis on the "sensor-equipped individual animal," which represents the smallest management unit in these systems (Halachmi et al., 2019). With increasing concern for animal welfare among consumers and producers (Alonso et al., 2020), sensor technology is expected to play an important role in improving welfare monitoring and management. These technologies support a move away from traditional manual assessments at the farm level (Krueger et al., 2020) toward automated or semi-automated continuous monitoring of individual animals (Maroto-Molina et al., 2020). There is strong agreement that PLF systems can substantially improve the profitability and sustainability of livestock production, including small

ruminant farming, under a variety of production settings (Bocquier et al., 2014; Rutter, 2017).

3. Conclusions and Recommendations

Live weight is a very important parameter for determining the market price of small ruminants and evaluating the economic efficiency of the farm. In fact, economic modelling shows that farm profitability can be increased if live weight of sheep and goats is kept at an optimal level. By regularly determining and monitoring the live weight of sheep and goats, the costs of feed, labour, health and other costs can be kept at the lowest possible (optimal) level, thereby increasing the profitability of the farm. In addition, this approach, which ensures good monitoring of animal welfare, can prevent economic losses associated with poor animal welfare and enable the production of high quality and safe sheep and goat meat, leading to the sale of products at higher prices.

Changing global consumption trends require innovations and changes in production strategies. Small ruminants are the easiest to adapt to strategies to produce high quality, safe food with a low carbon footprint to meet this demand. To be in line with global food production strategies, small ruminants must be reared in healthy and species-appropriate conditions. Overcoming the challenges associated with monitoring animal welfare in extensive sheep and goat farming which should be continued as a benefit is essential. Advances in technology and the decreasing cost of new electronic technologies have enabled the development of numerous sensor-based solutions for livestock farming. In this context, there is a need for new and practical solutions to better utilise live weight, which is highly linked to animal health and welfare.

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