REVIEW SCIENTIFIC PAPER
DOI: 10.63395/STEDConf14022025899M21
Submitted: 14.08.2025.
Accepted: 12.09.2025.

# THE ROLE OF ECOLOGICAL FACTORS IN FREE-RANGE ANIMAL FARMING: IMPLICATIONS FOR FEASIBILITY AND ANIMAL WELFARE

Milena Milojević, Suzana Knežević, Maja Došenović Marinković, Goran Stanišić

Academy of Applied Studies Šabac, Unit for Agricultural and Business Studies and Tourism, Vojvode Putnika 56, Šabac, Republic of Serbia, s.knezevic@akademijasabac.edu.rs

**Coresponding author:** Suzana Knežević, Academy of Applied Studies Šabac, Unit for Agricultural and Business Studies and Tourism, Vojvode Putnika 56, 15000 Šabac, Serbia, s.knezevic@akademijasabac.edu.rs

## ABSTRACT

Ecological conditions play a crucial role in the success and sustainability of free-range animal farming. Factors such as climate, vegetation, water availability, and terrain directly influence not only the feasibility of managing animals in open or semi-open systems but also the quality of their welfare. In restrictive environments like cages or small enclosures, animal welfare is often compromised due to lack of space, limited stimulation, and inability to express natural behaviors. Although such systems allow for easier management and safety, they rarely meet the animals' biological needs. In contrast, free-range and semi-free systems offer animals access to more natural habitats, promoting physical health, mental stimulation, and natural behaviors such as grazing, roaming, and social interaction. However, these systems require careful ecological planning, as poor environmental conditions can lead to health issues, resource scarcity, and increased human–animal conflict. Ensuring animal welfare in free-range farming depends on aligning management practices with environmental conditions and species-specific needs. Proper oversight, sufficient resources, and ecological compatibility are essential to create systems that are both ethically responsible and practically viable. Ultimately, ecological factors are foundational to designing humane, functional, and sustainable free-range animal farming systems.

**Keywords**: ecological conditions, free-range animal farming, animal welfare, feasibility, natural behaviors.

## INTRODUCTION

Animal welfare encompasses the physical and mental state of an animal in relation to the conditions in which it lives and dies (Fraser, 2008). In modern production systems, where the emphasis is often on cost-effectiveness and productivity, animal welfare may be compromised. However, numerous scientific findings indicate that there is a clear link between animal welfare, health and performance, as well as the quality of their final product (Broom, 2011).

Animal welfare is one of the key issues in modern livestock production, veterinary practice, and the ethical relationship of society towards animals. This paper addresses the concept of animal welfare, its ethical, economic, and legal aspects, as well as its significance for animal health, the quality of products of animal origin, and the sustainability of agriculture. Based on a review of relevant references, it is concluded that ensuring a high level of welfare is of essential importance not only for animals, but also for humans and the broader environment. Animal welfare encompasses the quality of life and a harmonious relationship between the animal and its environment, and it is becoming an increasingly important topic in conventional production, as well as a key and indispensable element in organic livestock farming.

The aim of this paper is to highlight the importance of welfare from multiple aspects and to point out the need for its improvement in practice.

## THE IMPORTANCE OF ANIMAL WELFARE

In modern production systems, where the emphasis is often on cost-effectiveness and productivity, animal welfare may be compromised. Animal welfare encompasses the physical and mental state of an animal in relation to the conditions in which it lives and dies (Fraser, 2008). However, numerous scientific findings indicate that there is a clear link between animal welfare, health and performance, as well as the quality of the final product (Broom, 2011).

The aim of this paper is to point out the key role that welfare plays in modern livestock production and sustainable development. Special emphasis is placed on identifying the existing challenges in implementing legal and professional standards in practice, as well as on the need for a systematic improvement of the approach to animal welfare.

### Definition and components of animal welfare

According to the World Organization for Animal Health (OIE, 2023), animal welfare encompasses five freedoms:

- Freedom from hunger and thirst
- Freedom from discomfort
- Freedom from pain, injury, and disease
- Freedom to express natural behaviour
- Freedom from fear and distress

These freedoms form the basis for assessing and improving the conditions in which animals are kept in households, farms, transport, and slaughterhouses (Manteca et al., 2021). This definition is known as the Five Freedoms concept; they are species-specific, apply to all animals, and are valid in all situations.

### Ethical aspects of welfare

Caring for animal welfare represents a fundamental expression of human ethical responsibility towards beings capable of feeling pain, fear, pleasure, and other emotional states. Ethical approaches to animals have developed over the centuries, and modern philosophical reflections have significantly contributed to understanding and promoting the moral duty towards animals. Philosophers such as Peter Singer (1975) and Tom Regan (1983) emphasised the moral obligation of humans to minimise animal suffering. They advocated minimising suffering and maximising the welfare of all sentient beings, which has had a revolutionary impact on animal rights and protection movements worldwide. These philosophical foundations form the basis of modern animal protection legislation in many countries, including international protocols and recommendations such as those issued by the World Organization for Animal Health (OIE). In legislation, ethical aspects are reflected in regulations requiring humane conditions for keeping, transporting, and handling animals, with the aim of reducing unnecessary suffering and improving quality of life. The preservation and enhancement of animal welfare, therefore, represent not only a matter of legislation and science, but also a profound ethical imperative of modern society, which strives to establish a harmonious relationship with the animal world and nature as a whole.

### Welfare and production

Numerous studies show that poor housing conditions lead to increased disease incidence, reduced fertility, and slower growth in animals (Grandin, 2015). On the other hand, improving welfare can enhance performance, the quality of meat, milk, and eggs, as well as the economic results on farms (Hemsworth & Coleman, 2010). For example, cows that have access to pasture and lying areas with soft bedding or flooring show higher daily milk yields (Fregonesi et al., 2007).

Stadig et al. (2017) point out that access to outdoor runs can positively impact the welfare of broiler chickens, as it allows them to stay in a more natural environment and provides more opportunities to express innate behaviors compared to indoor poultry housing systems. Additionally, increased space and the presence of enrichment elements in the system where they are kept can contribute to better leg health and reduced fearfulness in poultry. However, in

practice, outdoor runs are often used only to a limited extent. The key reasons for this are likely the lack of shelter and unfavorable weather conditions.

Numerous studies have analyzed the use of outdoor runs on free-range layer farms, finding that the percentage of poultry using the run at any given time rarely exceeds 50% of the total flock and sometimes is below 10%. Defining the optimal level of run use is challenging due to the lack of detailed knowledge about the duration of birds' time spent outdoors under ideal conditions (Pettersson, Freire, & Nicol, 2016). Although poultry in free-range systems have access to outdoor areas, not all birds use them to the same extent (Singh & Cowieson, 2013).

It has been proven that factors such as current weather conditions, flock size, and availability of shelter in the outdoor run significantly affect the percentage of run usage. Additional elements, including the design of entry/exit openings (pop-holes), internal and external stocking density, as well as the overall concept of the housing system, can also have an impact, although their effects are not yet sufficiently researched or clearly defined. Therefore, further scientific analysis is needed to better understand their relevance. Factors influencing the distribution of birds within the outdoor run itself are also being considered (Pettersson et al., 2016).

Animal welfare primarily represents their physical health, where the production results of animals are far better when welfare is achieved — meaning they are provided with enough movement, social interaction since they are social beings, and access to quality, well-managed pasture.

A group of authors studied the literature with the aim of gathering information on the sustainability of free-range pig farming systems, including management, performance, and pig health in these systems (Miao, Glatz, & Ru, 2004). Modern free-range systems require simple, portable, and flexible facilities with low-cost fencing. Local pig genotypes adapted to external conditions are generally more suitable for free-range systems. Free-range farms should be located in areas with low rainfall, while the plots should be relatively flat with a shallow topsoil layer, free of sharp stones that could cause leg injuries. Shelters or huts are essential to protect pigs from direct exposure to sunlight and heat stress, especially when there is no natural shade such as trees or other structures. Access to mud wallows satisfies their behavioral needs and helps overcome the negative effects of high temperatures on feed intake.

Miao et al. (2004) state that with proper management, pig production in free-range systems can be comparable to that of pigs kept indoors, although litter growth rates vary depending on the season. Piglets raised indoors grow faster during the cold months compared to those raised outdoors. Pigs raised outdoors exhibit calmer behavior. Aggressive interactions during feeding are less frequent than in indoor pigs, while sows outdoors are more active. Diseases can be partially controlled by pasture management. Frequent rotation of plots is necessary, although many farmers keep pigs in the same area longer before moving them. Plants that can be locally grown and used as part of the regular diet are likely to be acceptable to farmers, especially organic producers.

However, one of the main public concerns regarding free-range pig systems is their environmental impact. In the past, pigs were kept on the same plots with large numbers of animals in a small area, which led to vegetation damage, excessive soil nutrient saturation, nitrate leaching, and gas emissions. To avoid this, outdoor pigs should be integrated into soil and pasture management systems, and the number of animals adjusted to the amount of available feed, with herd mobility (Miao et al., 2004).

Kvesić (2016), in her research on pig behavior in outdoor and indoor housing systems, concludes that pigs kept outdoors have complete freedom in their feeding. Pigs root in the soil, satisfying their strong exploratory behavior, and find food present in pastures or forests to feed on. On the other hand, in indoor systems, pigs have more readily available food and do not display natural behaviors associated with foraging outdoors, which leads to frequent aggressive interactions due to a lack of space for feeding.

Abnormal behaviors are those not typical in natural conditions and most commonly occur in indoor housing systems. These include tail and ear biting, cannibalism, and aggression, which are most pronounced due to overcrowding, poor environmental conditions, inadequate nutrition, and

similar factors. One of the major problems in modern pig housing systems is the appearance of stereotypical behaviors, which are a direct indicator of poor welfare (Kvesić, 2016).

Regarding mental stimulation, it is important to allow animals to express natural species-specific behaviors, which in turn ensures high animal welfare by providing space for normal body postures, especially of the legs, wing spreading, dust bathing, and more, as well as for feeding and necessary rest.

Supporting this, Rodríguez-Estévez et al. (2010) found that pigs in free-range systems divided into smaller subgroups during grazing, maintaining these divisions even during daytime rest, while at night they regrouped into a single unit and behaved as one cohesive herd. In this way, large groups formed in intensive farms could be considered natural, provided that overcrowding does not occur, which would help avoid stress (Rodríguez-Estévez et al., 2010).

Social interaction, contact with other members of the same species, and a stimulating environment are necessary to prevent boredom. When bored, animals may exhibit unwanted behaviors that disturb the peace on the farm—especially in conventional production systems or on outdoor runs—disrupting welfare as well as the quantity and quality of the products obtained. Common behavioral disorders include food overturning and scattering, tongue playing, bar biting, object licking, sucking on other animals, tail biting in pigs, feather pecking in poultry, aggression, cannibalism, and more.

Petersen, Recén, and Vestergaard (1990) studied the behavior of sows and piglets during farrowing in free-range conditions and concluded that, despite domestication, pigs are still well adapted behaviorally to successfully cope with the challenges of farrowing in free-range systems.

In organic production, animals must be raised in accordance with their basic needs — that is, in a way that allows them to express most of their normal behaviors (both innate and learned) while respecting fundamental principles of welfare and protection.

Recognizing the importance of behavior, welfare, and animal protection, organic production, as an alternative to conventional farming, is precisely aligned with the natural needs of animals (Petrović et al., 2018). Good health status should always be a priority.

Animals have the ability to respond to changes in the external environment (so-called stressors). If an animal is unable to adapt to these changes, stress occurs. Stress usually has a negative impact on animals and their productivity and can be measured by changes in blood parameters, hormonal status, and behavior. Prolonged stress leads to suffering.

Proper management, sufficient resources, and ecological compatibility are key to creating systems that are both ethically responsible and practically sustainable. Ultimately, environmental factors form the foundation for designing humane, functional, and sustainable free-range animal farming systems.

**Environmental Factors as Determinants of Animal Welfare and Successful Rearing**

Environmental factors play a crucial role in shaping the conditions of animal housing, behavior, and productivity, especially in extensive and free-range farming systems. Climate, vegetation, water availability, and terrain characteristics directly affect the quality of life and welfare of animals, as well as the efficiency of livestock management. Adapting farming systems to the specifics of the local ecosystem forms the foundation for a sustainable and ethically acceptable livestock approach.

*Climate* – Climatic conditions, including temperature, precipitation, wind, and seasonal changes, are crucial in determining the availability of natural food throughout the year, as well as the conditions for animals to stay outdoors. Extreme temperatures (cold or heat), high humidity, or frequent changes in weather can negatively affect the health, behavior, and productivity of animals, requiring adapted protective measures—such as shelters, natural or artificial shade, and supplemental feeding during periods of scarcity.

*Vegetation* – Natural vegetation provides essential resources for feeding, shelter from adverse weather, and space for free movement and expression of natural behavior. The biodiversity and structure of plant cover directly affect the quality of nutrition, as well as protection from stress and

parasites. Preserved vegetation also serves an ecological function by preventing erosion, maintaining soil quality, and regulating micro climatic conditions in pastures.

*Water* – The availability of clean and fresh water is a fundamental prerequisite for animal survival, proper physiological functioning, and hygiene maintenance. In free-range farming, water sources must be easily accessible, safe, and reliable throughout the year. Lack of water, whether due to drought or difficult terrain access, can lead to serious health issues, reduced production performance, and compromised animal welfare.

*Terrain* – The topography of the land affects pasture accessibility, the ability to control animal movement, and overall farm management. Steep, slippery, or overly rocky terrain can pose physical obstacles and injury risks, while flat or gently sloping land allows easier management, better distribution of food and water, and safer animal movement. Additionally, soil characteristics influence water absorption, vegetation growth, and habitat formation.

Environmental factors form the foundation of every successful and sustainable livestock production system. Understanding and respecting local ecosystem characteristics is essential for planning farming practices that ensure high welfare standards, minimal negative environmental impact, and long-term economic sustainability.

**Legal framework**

In the European Union, animal welfare is regulated by a series of legally binding regulations, including directives and regulations, among which one of the key pieces of legislation is Council Directive 98/58/EC on the protection of animals kept for farming purposes. These regulations set minimum standards for housing, feeding, care, and health protection of animals, with an emphasis on preventing suffering and ensuring natural behavior.

In the Republic of Serbia, the legal framework for animal welfare protection is defined by the Animal Welfare Act (Official Gazette of RS, No. 41/2009), which clearly stipulates the obligations of animal owners and keepers, as well as the authority of inspection bodies to ensure conditions that prevent pain, suffering, and stress in animals.

However, despite the existence of appropriate legal regulations, significant deviations in their implementation often occur in practice. These deviations most commonly arise from a lack of expert knowledge and education, limited financial resources, as well as inadequate or inconsistent supervision by the relevant authorities. Consequently, the actual conditions in which animals live frequently fail to meet the prescribed standards, highlighting the need for improved institutional support, education, and enforcement of legal measures in the field of animal welfare.

Routine welfare assessment is important for the application of animal welfare laws and regulations in practice, which in many countries around the world govern the provision of welfare in areas such as farming technology, housing and accommodation, transport, and slaughter of animals (Hristov & Relić, 2009).

Welfare assessment systems are based on the fact that welfare can be measured (Broom, 1991), and welfare indicators include parameters that can be qualitatively and quantitatively evaluated (Hristov et al., 2006).

Assessment is particularly important under different housing and accommodation conditions, as well as for various species and categories of farm animals, taking into account their specific characteristics (Fregonesi, 1999).

Despite growing social and professional awareness of the importance of animal welfare, its consistent implementation in livestock practice still faces numerous challenges. One of the fundamental problems is the discrepancy between scientifically based recommendations and the real conditions in which production takes place. Although science provides clear guidelines on optimal housing, nutrition, health care, and animals' need to express normal—natural—behavior, their implementation is often hindered by limited resources, insufficient technical support, or structural barriers at the production system level.

Economic pressures on farmers, especially in intensive production systems, pose an additional obstacle to achieving high welfare standards. Maintaining better conditions for animals often requires greater investment in infrastructure, labor, and veterinary care, which can be

discouraging under conditions of low purchase prices and market instability. In this context, welfare is often perceived as a cost rather than an investment that can, in the long term, contribute to greater productivity, product quality, and market competitiveness.

Besides economic factors, a significant challenge is insufficient education and low motivation among employees who work directly with animals. A lack of expert knowledge about animals' behavioral needs and the ethical aspects of husbandry often leads to inadequate care, stress, and reduced performance. For this reason, it is essential to implement continuous professional development programs, mandatory training, and certification for farmers and personnel in the livestock sector.

To overcome these challenges, a comprehensive and integrated strategy is needed that unites multiple sectors — from education and science, through agricultural policy, to market mechanisms. Key components of such a strategy include:

- *Education and empowerment of producers* through training, access to advisory services, and dissemination of scientific knowledge;
- *Implementation of legal and voluntary standards* with clear guidelines and measurable welfare indicators;
- *Effective inspection oversight* with consistent enforcement of regulations and sanctioning of violations;
- *Economic incentives and support*, including higher purchase prices for products meeting high welfare standards, subsidies for improving housing conditions, and access to markets with special requirements (e.g., the EU market, certified organic production, Halal and Kosher production and certification, etc.).

Additionally, *consumer awareness* plays an important role, increasingly shaping demands regarding product quality and production conditions. Educating consumers and transparent product labeling based on welfare criteria can create additional market pressures that motivate producers to make changes.

Therefore, animal welfare cannot be viewed in isolation but as part of a broader system where education, legislation, economics, and ethics are interconnected. Only through a coordinated approach is it possible to ensure lasting improvements in practice and create production systems that are ethically acceptable, economically sustainable, and socially responsible.

## CHALLENGES AND POTENTIAL SOLUTIONS TO MANAGING ECOLOGICAL FACTORS IN ANIMAL FARMING

Livestock management in accordance with ecological conditions faces a range of challenges that can negatively impact animal welfare and system sustainability. Identifying these issues and applying appropriate, scientifically based solutions are crucial for improving production performance and protecting animals.

Drought as a Limiting Factor and Irrigation Systems — One of the most common and damaging climatic challenges is drought, which directly affects the availability of food and water. According to the University of Saskatchewan – Livestock and Forage Centre of Excellence (2023 and 2024), prolonged periods without precipitation reduce forage yields on pastures, making natural feeding difficult for animals and threatening their physiological stability. Drought can also cause soil degradation and reduce biodiversity, further damaging the ecosystem. An effective solution to this problem is the implementation of irrigation systems, which help maintain optimal soil moisture levels, increase pasture yields and quality, and thus improve food availability. Modern irrigation methods, such as drip irrigation, offer efficient and economical ways to conserve resources and adapt production to climatic conditions. Managing pastures during drought periods requires adjusting grazing regimes and protecting vegetation to preserve soil productivity and animal health. Rotational grazing, the use of alternative feed sources, and alleviating pressure on plant biomass during drought are recommended practices (Mississippi State University Extension Service, 2023). Deficit irrigation has proven to be an effective approach under conditions of limited water availability. This practice allows significant resource conservation without seriously

affecting pasture yields, which is crucial in drought-prone climates (Utah State University Extension, 2023).

Lack of Vegetation and Sustainable Pasture Management — Vegetation degradation, caused by overgrazing, adverse climatic conditions, or human activities, presents a serious challenge to the sustainability of livestock systems. Insufficient plant cover reduces the potential for natural feeding, disrupts microclimatic conditions, and can lead to soil erosion. Sustainable pasture management involves practices such as rotational grazing, mowing vegetation in accordance with natural cycles, restoring degraded areas, and preserving biodiversity. These measures enable the long-term conservation of pastures as a fundamental resource in extensive livestock farming, while simultaneously increasing their productivity and resilience to climatic stresses, according to research from leading global universities (Bastani, 2023; Hou et al., 2024). Milazzo et al. (2023) note that grasslands are at risk of degradation due to unsustainable management practices and ongoing climate change. A sustainable approach to pasture management contributes to providing ecosystem services and strengthening the resilience of grassland systems to anthropogenic changes.

Predator Threat and Protective Measures — The presence of predators can have a significant negative impact on the safety and welfare of domestic animals, causing stress, injuries, and even losses (Linnell et al., 2008; Gehring et al., 2011). Traditional protection methods, such as physical fencing, are not always sufficient or economically viable, especially on large or inaccessible pastures. Modern approaches include a combination of protective fencing adapted to local conditions, the use of electric or other innovative systems, as well as continuous monitoring through technological solutions like cameras and sensors. Additionally, the involvement of shepherds and livestock guardian dogs can greatly contribute to preventing predator attacks. Together, these measures enable effective animal protection, reduce losses, and improve overall welfare (Van Eeden et al., 2018).

Plokhikh et al. (2023) developed a methodology for ecological auditing and impact assessment of pasture agro-landscapes, using a landscape-ecological and indicator-based approach, aimed at improving sustainable land management in central Kazakhstan. Reliable ecological audits and environmental impact assessments are crucial for the efficient use of pastures and ensuring the production of high-quality livestock products.

Successfully overcoming ecological challenges in livestock farming requires an integrated approach that combines technical solutions, sustainable management practices, and the application of innovative technologies. This approach can achieve a balance between conserving natural resources, protecting animal welfare, and ensuring the economic sustainability of production.

## CONCLUSIONS

Animal welfare is a multidisciplinary concept encompassing ethical, economic, health, and sustainability aspects, and it plays an increasingly important role in modern livestock production systems. Improving welfare not only benefits the physiological and psychological condition of animals but also positively impacts the quality and safety of animal-derived products, enhances consumer trust, and strengthens the market position and reputation of producers.

Numerous scientific studies confirm that systems based on welfare principles—such as providing adequate space, access to pasture, environmental enrichment, and the expression of natural behaviors—have a positive effect on animal health, productivity, and resilience. Accordingly, the development of animal welfare protection policies must be accompanied by continuous investment in farmer education, technological advancement, and strengthening institutional support to ensure consistent implementation of science-based practices.

In free-range or extensive farming systems, the successful implementation of high welfare standards depends on ecological compatibility, quality management, and understanding the complex relationships between animals, their environment, and the production system. Only under conditions that meet the biological needs of animals and allow for stable production can such an approach be both ethically justified and economically sustainable.

In this context, animal welfare should not be viewed solely as a normative or moral obligation, but as a key element of sustainable livestock development and the long-term stability of the food system.

Through education, technical and technological innovations, better regulatory enforcement, and broader social awareness, this work aims to contribute to understanding animal welfare not only as a humane responsibility but also as a factor that directly impacts product quality, human health, environmental protection, and the sustainability of the entire agroecosystem.

## DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

## LITERATURE

Bastani, M., Sadeghipour, A., Kamali, N., Zarafshar, M., & Bazot, S. (2023). How does livestock graze management affect woodland soil health? *Frontiers in Forests and Global Change, 6*, 1028149. https://doi.org/10.3389/ffgc.2023.1028149

Broom, D. M. (1991). Animal welfare: Concepts and measurement. *Journal of Animal Science*, *69*(10), 4167–4175. https://doi.org/10.2527/1991.69104167x

Broom, D. M. (2011). A history of animal welfare science. *Acta Biotheoretica, 59*(2), 121–137.

Council of the European Union. (1998). Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes. *Official Journal of the European Communities*, L221, 23–27. DOI: 10.1002/wsb.6

Fraser, D. (2008). *Understanding animal welfare: The science in its cultural context*. Wiley-Blackwell.

Fregonesi, J. A. (1999). *Production and behaviour of dairy cattle in different housing systems*. Doctoral dissertation. University of London.

Fregonesi, J. A., Tucker, C. B., & Weary, D. M. (2007). Freestall housing: Effects on dairy cattle behavior. *Journal of Dairy Science, 90*(9), 3879–3884.

Gehring, T. M., VerCauteren, K. C., & Landry, J. M. (2011). Utility of an Electric Fence for Reducing Livestock Depredation by Coyotes and Wolves. *Wildlife Society Bulletin, 35*(3), 291-298.

Grandin, T. (2015). *Improving animal welfare: A practical approach*. CABI.

Hemsworth, P. H., & Coleman, G. J. (2010). *Human-livestock interactions: The stockperson and the productivity and welfare of intensively farmed animals*. CABI.

Hou, D., Liu, J., Li, N., Han, B., Liu, C., & Wang, Z. (2024). Grazing exclusion is more effective for vegetation restoration and nutrient transfer in the heavily degraded desert steppe. *BMC Plant Biol*, *24*(1), 408. https://doi.org/10.1186/s12870-024-05127-z

Hristov, S., Vučinić, M., Relić, R., & Stanković, B. (2006). Uslovi gajenja, dobrobit i ponašanje farmskih životinja. *Biotehnologija u stočarstvu*, *22*, 73–84.

Hristov, S., & Relić, R. (2009). Ocena uslova smeštaja sa osvrtom na dobrobit krava. *Zbornik naučnih radova*, *15*(3–4), 79–84.

Kvesić, M. (2016). *Ponašanje svinja u otvorenom i zatvorenom sustavu držanja*. Master's thesis. Zagreb: University of Zagreb, Faculty of Agriculture. Retrieved from https://urn.nsk.hr/urn:nbn:hr:204:558422

Linnell, J. D. C., Salvatori, V., & Boitani, L. (2008). Guidelines for Population Level Management Plans for Large Carnivores in Europe. A Large Carnivore Initiative for Europe Report. Retrieved January 20, 2025 from https://ec.europa.eu/environment/nature/conservation/species/carnivores/pdf/LCIE_management_guidelines.pdf

Manteca, X., Main, D. C., & Temple, D. (2021). Animal welfare: New opportunities for animal production in the 21st century. *Frontiers in Veterinary Science, 8*, 630299.

Milojević, M., et al. (2025). The role of ecological factors in free-range animal farming: implications for feasibility and animal welfare. *STED Conference 14*(2), 21-27.

Miao, Z. H., Glatz, P. C., & Ru, Y. J. (2004). Review of production, husbandry and sustainability of free-range pig production systems. *Asian-Australasian Journal of Animal Sciences, 17*(11), 1615–1634. https://doi.org/10.5713/ajas.2004.1615

Milazzo, F., Francksen, R. M., Abdalla, M., Ravetto Enri, S., Zavattaro, L., Pittarello, M., Hejduk, S., Newell-Price, P., Schils, R. L. M., Smith, P., & Vanwalleghem, T. (2023). *An overview of permanent grassland grazing management practices and the impacts on principal soil quality indicators*. *Agronomy, 13*(5), 1366. https://doi.org/10.3390/agronomy13051366

Mississippi State University Extension Service (2023). Pasture and Grazing Management Under Drought Conditions. Retrieved January 20, 2025 from https://extension.msstate.edu/publications/pasture-and-grazing-management-under-drought-conditions

OIE – World Organisation for Animal Health. (2023). *Animal welfare*. Retrieved January 20, 2025, from https://www.woah.org/en/what-we-do/animal-health-and-welfare/

Petersen, V., Recén, B., & Vestergaard, K. (1990). Behaviour of sows and piglets during farrowing under free-range conditions. *Applied Animal Behaviour Science, 26*(1–2), 169–179. https://doi.org/10.1016/0168-1591(90)90090-Q

Pettersson, I. C., Freire, R., & Nicol, C. J. (2016). Factors affecting ranging behaviour in commercial free-range hens. *World's Poultry Science Journal*, *72*(1), 137–150. https://doi.org/10.1017/S0043933915002664

Petrović, M., Rakonjac, S., Bogdanović, V., Bogosavljević-Bošković, S., Đoković, R., Dosković, V., & Petrović, M. (2018). Ponašanje, dobrobit i zaštita životinja u organskom stočarstvu. U *Zborniku radova XXIII savetovanja o biotehnologiji*, 573–578.

Plokhikh, R., Shokparova, D., Fodor, G., Mamedov, A., Kökböev, E., Grekov, I., Bagirov, B., & Brechko, O. (2023). Towards sustainable pasture agrolandscapes: A landscape-ecological-indicative approach to environmental audits and impact assessments. *Sustainability, 15*(8), 6913. https://doi.org/10.3390/su15086913

Regan, T. (1983). *The Case for Animal Rights*. University of California Press.

Singer, P. (1975). *Animal Liberation*. New York: HarperCollins.

Singh, M., & Cowieson, A. J. (2013). Range use and pasture consumption in free-range poultry production. *Animal Production Science*, *53*(11), 1202–1208. https://doi.org/10.1071/AN13199

Stadig, L. M., Rodenburg, T. B., Ampe, B., Reubens, B., & Tuyttens, F. A. M. (2017). Effect of free-range access, shelter type and weather conditions on free-range use and welfare of slow-growing broiler chickens. *Applied Animal Behaviour Science, 192*, 15–23. https://doi.org/10.1016/j.applanim.2017.02.005

Sustainable Food Systems Journal (2024). Enhancing irrigated forage crop production through water and nutrient management in the Ethiopian sub-humid highlands. Retrieved January 20, 2025, from https://www.frontiersin.org/journals/sustainable-food-systems/articles/10.3389/fsufs.2024.1373698/full

United for Land - Regenerative Grazing to Combat Desertification - CGIAR (2023). Retrieved January 20, 2025, from https://www.cgiar.org/news-events/news/united-for-land-regenerative-grazing-to-combat-desertification/

University of Saskatchewan – Livestock and Forage Centre of Excellence (2023). *Managing through Drought*. Retrieved January 20, 2025, from: https://lfce.usask.ca/managing-through-drought.php

Utah State University Extension (2023). Deficit Irrigation of Pastures. Retrieved January 20, 2025, from https://extension.usu.edu/crops/research/deficit-irrigation-of-pastures

Van Eeden, L. M., Eklund, A., Miller, J. R. B., Lopez-Bao, J. V., Chapron, G., Cejtin, M. R., ... & Treves, A. (2018). Carnivore conservation needs evidence-based livestock protection. *PLOS Biology, 16*(9), e2005577. DOI: 10.1371/journal.pbio.2005577

Zakon o dobrobiti životinja. (2009). Službeni glasnik Republike Srbije, br. 41/2009.