

Green Pastures, Healthy Herd: The Intricate Interplay of Nutrition, Milk Yield, Reproduction, and Welfare in Dairy Cows

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Abstract

The study explores the intricate interplay between green pastures, nutrition, milk yield, reproduction, and welfare in dairy cows, emphasizing the multifaceted benefits of pasture-based systems. Green grass serves as a natural, nutrient-rich feed source that supports optimal dairy cow performance by providing essential nutrients, such as energy, proteins, vitamins, and minerals, which are crucial for high milk production. The natural grazing behavior associated with green pastures enhances rumen function, facilitating better digestion and nutrient absorption, which directly impacts milk yield and overall cow health. Furthermore, pastures play a critical role in improving reproductive outcomes by regulating energy balance, promoting hormonal stability, and reducing the risk of metabolic disorders that can impair fertility. Additionally, access to green grass promotes positive animal welfare by reducing stress, encouraging natural foraging behaviors, and offering a more stimulating and enriched environment compared to confined feeding systems. The study also highlights how pasture-based systems mitigate the risks of diseases, such as mastitis, support hoof health, and reduce the incidence of metabolic disorders like ketosis and acidosis. Overall, green pastures contribute significantly to sustainable dairy farming practices by enhancing milk yield, reproductive success, and the overall health and welfare of dairy cows. This research underscores the importance of incorporating pasture-based feeding systems in dairy management for improved productivity and animal well-being.

Keywords: Animal welfare, dairy cows, green pastures, milk yield, nutrition, reproduction, sustainable farming

INTRODUCTION

Green pastures have long been a cornerstone of sustainable dairy farming, offering a natural and nutrient-rich feed source for dairy cows. The role of green grass in enhancing milk production and cow health has been well-documented, with pasture-based systems providing essential nutrients, including energy, proteins, vitamins, and minerals. These nutrients not only contribute to higher milk yields but also support overall cow performance by improving rumen function, nutrient digestion, and feed conversion efficiency. Additionally, grazing on green pastures encourages natural behaviors that

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enhance both physical and psychological well-being, reducing stress and promoting positive welfare outcomes [1]. The connection between nutrition and health in dairy cows, particularly when fed on high-quality pastures, is fundamental for both productivity and sustainability in dairy farming systems.

The impact of green pastures extends beyond milk production, as pasture-based feeding systems are crucial for supporting dairy cow reproduction. Optimal energy balance achieved through pasture

grazing promotes hormonal regulation, facilitating better reproductive health and higher fertility rates [2]. Reduced risks of metabolic disorders, such as ketosis and acidosis further enhance reproductive success and overall cow longevity. In addition, pastures can play a significant role in reducing the incidence of common diseases in dairy cows, including mastitis and hoof issues, both of which are prevalent in confined feeding systems [3]. By providing an enriched environment, green grass supports the prevention of such diseases, improving both cow health and farm productivity.

This study introduces a novel perspective by examining the multifaceted roles of green pastures in dairy cow health, production, and welfare. While previous research has focused on individual aspects, such as milk yield or reproductive success, this study integrates these factors to present a holistic view of how pasture-based systems influence dairy farming outcomes. The novelty lies in addressing the intricate interplay between nutrition, reproduction, and welfare, exploring how green pastures can offer a sustainable solution to modern dairy farming challenges. This integrated approach provides new insights into how pasture utilization can optimize dairy cow performance and health, contributing to more sustainable and ethical dairy practices.

PERFORMANCE

Balanced Energy Source

Green pastures provide a natural, balanced source of energy, ensuring sustained milk production in dairy cows [4]. This steady supply of energy helps maintain optimal lactation levels and supports milk yield throughout the cow's productive lifespan. By offering an easily accessible source of energy, green grass helps improve productivity without the need for high-energy concentrate feeds.

Dry Matter Intake

The palatability of green pastures encourages higher dry matter intake in dairy cows. The freshness and aroma of the grass stimulate natural grazing behaviors, increasing voluntary consumption. This increased intake improves overall nutritional status, supporting higher milk production and cow health. Palatable grass plays a crucial role in maintaining consistent feed intake.

High-Quality Protein

Green grass is rich in high-quality protein, essential for muscle development and growth in dairy cows. The protein content supports optimal body condition and milk yield, while also enhancing reproductive performance [5]. Cows consuming high-protein pastures experience improved overall health, with protein playing a critical role in supporting metabolic processes and lactation.

Optimal Rumen Fermentation

The fiber in green grass supports optimal rumen fermentation, which is key for improving feed efficiency. Efficient rumen fermentation leads to better nutrient breakdown, allowing cows to extract more energy and nutrients from their feed [6]. This enhanced fermentation process is crucial for maximizing milk production and overall cow health in pasture-based systems.

Nutrient Digestibility

Green pastures improve nutrient digestibility, allowing cows to better absorb and utilize the nutrients in their feed. This results in enhanced productivity as the cow's body can make better use of the nutrients for milk production, muscle growth, and overall well-being. Improved digestibility also supports efficient feed conversion and reduces the risk of nutrient deficiencies.

Feed Cost Reduction

Pasture grazing significantly reduces feed costs by providing a natural, cost-effective source of nutrition compared to conventional concentrate-based diets. This sustainable feeding method lowers the need for expensive supplemental feeds while maintaining optimal cow performance. Green grass contributes to overall cost savings for dairy farms, improving profitability without compromising animal health.

Rumen Microbial Activity

The consumption of green pastures enhances rumen microbial activity, facilitating better fiber degradation and nutrient absorption [7]. Increased microbial activity leads to more efficient digestion of plant fibers, producing volatile fatty acids that contribute to improved energy availability. This microbial balance is essential for maintaining optimal digestion and overall cow performance on pasture.

Milk Fat Yield

Green pastures contribute to increased milk fat yield by enhancing the production of volatile fatty acids (VFAs) in the rumen. These VFAs are critical for energy metabolism and support the synthesis of milk fat [8]. The availability of high-quality forage improves the cow's ability to convert dietary nutrients into high-fat milk, enhancing milk composition.

Amino Acid Supply

Pasture grazing provides essential amino acids that are crucial for milk protein synthesis. These amino acids are vital for maintaining high milk quality and improving protein content in milk [9]. Adequate intake of amino acids supports optimal milk production while ensuring that cows maintain muscle mass and body condition.

Body Condition Scoring

Consuming high-quality pasture helps improve body condition scoring, which is directly linked to improved milk yield and overall productivity. Cows in optimal body condition are more likely to maintain healthy reproductive cycles and higher milk production. Proper body condition also enhances the cow's ability to recover after calving, promoting overall farm productivity.

Lactation Persistency

Green pastures support better lactation persistency, ensuring that cows maintain a consistent milk yield throughout their lactation cycle [10]. The steady availability of nutrients from pasture helps prevent drops in milk production, which is common with concentrate-based diets. This contributes to a longer productive lifespan and improved profitability for dairy farmers.

Rumen pH Regulation

Green pastures help maintain optimal rumen pH levels, reducing the risk of acidosis. By providing a more natural and balanced feed source, pasture grazing ensures that rumen fermentation occurs at an ideal pH, which supports overall rumen health and prevents conditions, like subclinical acidosis, that can affect milk production and cow health [6].

Nutrient Assimilation

Pasture grazing enhances nutrient assimilation, which directly contributes to higher milk yield. The improved nutrient absorption from green grass allows cows to more effectively utilize the nutrients available, resulting in more efficient milk production [11]. The natural fiber and nutrient composition of green grass help optimize metabolic processes and enhance overall cow performance.

Weight Gain in Heifers

Green pastures ensure sustainable weight gain in growing heifers by providing high-quality nutrients essential for muscle development and overall growth. The natural feed source supports healthy weight gain and proper skeletal development, ensuring that replacement heifers reach optimal size and health for future milk production, improving farm sustainability.

Metabolic Efficiency

Green pastures enhance metabolic efficiency by improving nutrient absorption and utilization. This natural feed source supports the cow's metabolism, allowing for better energy conversion and overall health [12]. Improved metabolic efficiency contributes to better milk production, reproductive performance, and a reduction in feed waste, benefiting both animal health and farm profitability.

Synthetic Feed Additive Reduction

Pasture grazing reduces the need for synthetic feed additives by providing cows with a natural and balanced diet. This contributes to healthier cows and reduces the reliance on chemical supplements, which can be costly and less sustainable. By promoting natural growth and productivity, green pastures help maintain cow health while lowering feed costs.

Bioactive Compounds

Green grass contains bioactive compounds that support metabolic functions in dairy cows. These compounds play a role in improving immune function, reducing oxidative stress, and enhancing overall cow health [13]. Pastures provide a natural source of antioxidants and phytochemicals that help improve the cow's ability to resist diseases and enhance overall farm productivity.

Omega-3 Fatty Acids

Green grass provides a natural source of omega-3 fatty acids, which improve milk quality by increasing the healthy fat content. These essential fatty acids not only enhance milk composition but also provide health benefits for consumers [14]. By grazing on pasture, dairy cows produce milk that is richer in omega-3s, contributing to higher nutritional value.

Feed Conversion Efficiency

Pasture grazing improves overall feed conversion efficiency by providing a more digestible and nutrient-dense feed source. Cows grazing on high-quality green grass are able to convert the nutrients more efficiently, leading to improved milk production and reduced feed waste. This enhanced feed conversion results in better farm economics and sustainable dairy production.

Skeletal Growth in Heifers

Green pastures contribute to better skeletal growth and conformation in replacement heifers, ensuring they develop the physical traits needed for future productivity. Proper growth in heifers is essential for long-term dairy farm success, as it supports better milk yield, reproductive health, and overall longevity in the herd. Grazing on nutritious pasture promotes healthy development.

HEALTH

Vitamins A, D, and E

Green pastures are a rich source of essential vitamins A, D, and E, which are crucial for supporting immune function in dairy cows [15]. Vitamin A aids in maintaining healthy mucous membranes and skin, vitamin D enhances calcium absorption for strong bones, and vitamin E acts as a powerful antioxidant, protecting cells from oxidative damage.

Antioxidant Defence

Green grass enhances antioxidant defence in dairy cows due to its high phytochemical content, including polyphenols and flavonoids. These antioxidants neutralize harmful free radicals, reducing oxidative stress and supporting the immune system [16]. By bolstering the cow's natural defences, pasture grazing helps maintain health and resilience, especially during challenging environmental conditions.

Metabolic Disorder Prevention

Pasture grazing reduces the risk of metabolic disorders, such as ketosis, which is common in cows on high-concentrate diets. The natural composition of green grass supports a balanced energy intake, reducing the likelihood of excessive fat mobilization and improving overall metabolic health. This leads to healthier cows and fewer complications during lactation.

Liver Function

Green pastures support liver function by reducing oxidative stress, which can impair liver performance. The high levels of antioxidants in green grass, such as vitamin E, help protect liver cells

from damage caused by free radicals [17]. This promotes better detoxification and overall metabolic health, ensuring cows maintain optimal organ function.

Gut Health

Green grass fosters a healthy gut microbiota, promoting the growth of beneficial bacteria in the rumen and intestines. The high fiber content in pastures supports the proliferation of fiber-degrading microbes, improving digestion and nutrient absorption [18]. A balanced microbiome enhances overall gut health and reduces the risk of gastrointestinal disorders in dairy cows.

Inflammation Reduction

The high polyphenol content in green pastures contributes to reduced inflammation in dairy cows. Polyphenols have anti-inflammatory properties that help manage chronic inflammatory conditions, such as mastitis or hoof problems [19]. Reducing inflammation improves overall cow health, milk production, and welfare, contributing to a more sustainable and ethical farming system.

Beta-Carotene for Health

Green pastures are rich in beta-carotene, an essential nutrient that plays a key role in ocular and reproductive health. Beta-carotene is converted into vitamin A, which supports vision and the function of the reproductive system in dairy cows [20]. This nutrient helps improve fertility and supports healthy eyesight, especially during early lactation.

Detoxification

The bioactive compounds found in green grass support the detoxification process in dairy cows. These compounds help neutralize and eliminate toxins from the body, reducing the burden on the liver and kidneys [21]. This natural detoxification process improves overall cow health, ensuring cows are better equipped to handle environmental and dietary stressors.

Hoof Health

Green grass supports hoof health by providing essential minerals like calcium, phosphorus, and magnesium. These nutrients are vital for strong, healthy hooves, reducing the risk of lameness and other hoof-related issues. Pasture grazing, with its rich mineral content, ensures cows have the proper nutrients to maintain optimal hoof condition.

Mastitis Prevention

Pasture-based systems help reduce the incidence of mastitis by enhancing immune modulation. The high levels of antioxidants, vitamins, and polyphenols in green grass improve immune function, making cows less susceptible to infections [22]. A robust immune system reduces the risk of mastitis, leading to improved milk quality and cow health.

Ruminal Bloat Prevention

Green grass helps prevent ruminal bloat by offering a balanced fiber content that promotes healthy rumen function. The natural fiber in pastures aids in proper digestion and fermentation, reducing the risk of gas buildup and bloating [7]. Proper fiber intake supports rumen health, ensuring cows can efficiently digest and absorb nutrients from their feed.

Mycotoxin Reduction

Green pastures reduce the risk of mycotoxin contamination compared to stored feeds, which are more susceptible to fungal growth and toxin production. Fresh pasture offers a cleaner, safer feed source for dairy cows, minimizing the potential for toxic substances that can impair cow health and milk quality.

Hydration Support

Green grass provides a natural source of hydration due to its high moisture content. This is particularly beneficial in hot weather or during lactation when cows need increased water intake [23].

The moisture content in pasture helps maintain proper hydration, supporting optimal milk production, metabolism, and overall cow health.

Skin and Coat Health

The essential fatty acids found in green grass, particularly omega-3 fatty acids, contribute to improved skin and coat condition in dairy cows. These fatty acids promote a shiny, healthy coat and support skin integrity, reducing the risk of dermatitis and other skin conditions. A healthy coat is also indicative of good overall health.

Respiratory Health

Green grass enhances respiratory health by reducing exposure to dusty feeds, which are often a concern with stored grains and concentrates. The natural, fresh quality of pasture reduces the inhalation of dust particles, supporting healthy lung function and reducing the risk of respiratory infections in dairy cows.

Bone Strength

Green grass supports bone strength by providing bioavailable calcium and phosphorus, essential for maintaining strong skeletal structures [24]. These minerals help prevent fractures and other bone-related issues, especially in high-yielding dairy cows. Adequate intake of calcium and phosphorus ensures cows maintain healthy bones throughout their lactation cycle.

Gut Dysbiosis Prevention

Green pastures help reduce gut dysbiosis by promoting a balanced microbiome in the digestive tract. The natural fiber and prebiotic compounds found in green grass foster the growth of beneficial bacteria, which in turn prevent the overgrowth of harmful microbes. This leads to better digestion, nutrient absorption, and overall gut health.

Hypocalcemia Prevention

Pasture grazing reduces the risk of subclinical hypocalcemia, particularly in transition cows [25]. The balanced mineral content in green grass supports calcium metabolism, preventing calcium deficiencies that can lead to issues, such as reduced milk production and poor cow health. Adequate calcium intake ensures smooth transition periods and optimal lactation.

Prebiotic Compounds

Green grass provides natural prebiotic compounds that support intestinal health by promoting the growth of beneficial gut bacteria [26]. These prebiotics improve digestion, nutrient absorption, and overall gut function, reducing the risk of enteric infections and promoting a healthy, balanced microbiome.

Oxidative Stress Reduction

Green grass helps reduce oxidative stress in high-yielding cows by providing antioxidants, such as vitamins C and E. These antioxidants neutralize free radicals, reducing cellular damage and supporting overall cow health [24]. By minimizing oxidative stress, pasture grazing helps cows maintain high production levels while minimizing the risk of disease and metabolic disorders.

FERTILITY

Phytoestrogens Regulation

Green pastures provide phytoestrogens, plant-derived compounds that mimic estrogen and regulate ovarian function in dairy cows. These compounds help balance reproductive hormones, supporting regular estrous cycles and improving fertility [24]. Phytoestrogens can enhance ovarian follicular development, leading to better ovulation rates and improved overall reproductive performance in cows.

Estrus Expression

By improving energy balance, green grass enhances estrus expression in dairy cows. A well-balanced nutritional intake supports overall metabolic health, making it easier for cows to express estrus at optimal times. This contributes to more consistent breeding cycles, leading to higher fertility rates and successful conception.

Embryonic Survival

Green grass helps reduce early embryonic losses by improving metabolic stability in cows. The rich nutrient profile of pasture contributes to better body condition and hormonal regulation, which supports a stable environment for the embryo, ultimately enhancing its survival chances [27]. Healthy cows with balanced nutrient levels are less prone to early pregnancy failure.

Conception Rates

Pasture grazing improves conception rates by supporting hormonal balance, which is crucial for successful fertilization [28]. The nutrients in green grass ensure that cows have sufficient energy, vitamins, and minerals to maintain optimal hormonal function. This supports the timely release of eggs and facilitates fertilization, improving overall reproductive success.

Postpartum Anestrus

Green grass reduces postpartum anestrus by providing enhanced nutrient availability, which helps cows regain reproductive function faster after calving. By meeting the cows' nutritional needs, pasture grazing promotes faster return to estrus, decreasing the time spent in anestrus and increasing the chances of a successful conception after calving.

Uterine Involution

Green pastures support uterine involution, the process of the uterus returning to its normal size after calving. Proper nutrition helps the cow's body heal more efficiently, ensuring better reproductive health [29]. Efficient uterine involution promotes faster return to estrus and better reproductive efficiency, ultimately shortening the calving interval.

Luteal Function

Green grass enhances luteal function by providing essential nutrients like vitamins, minerals, and fatty acids. These compounds support the corpus luteum, which is critical for progesterone production. Adequate progesterone levels help maintain pregnancy by ensuring proper embryo development and preventing early pregnancy loss.

Sperm Quality

Pasture grazing improves sperm quality in bulls by supplying essential micronutrients, including zinc, selenium, and vitamin E [30]. These nutrients play a key role in sperm motility, morphology, and overall fertility. Improved sperm quality leads to better fertilization rates, contributing to higher conception rates and improved herd reproduction.

Follicular Development

Green pastures enhance follicular development through better metabolic health. The balanced nutrition provided by pasture supports optimal ovarian function, promoting healthy follicle growth [28]. This ensures cows are more likely to have mature, viable eggs ready for ovulation, improving the chances of successful fertilization and conception.

Cystic Ovarian Disease

The nutrients in green grass help reduce the risk of cystic ovarian disease, a condition that affects fertility in dairy cows [31]. A well-balanced diet, including the right amounts of energy, protein, and essential vitamins, supports normal ovarian function and reduces the likelihood of cyst formation. This leads to more consistent and predictable breeding cycles.

Bioavailable Selenium

Green grass provides bioavailable selenium, an essential trace mineral that supports reproductive health. Selenium enhances fertility parameters by improving sperm quality, ovarian function, and immune system function [32]. Adequate selenium levels are crucial for maintaining healthy pregnancy outcomes and improving overall reproductive efficiency in dairy cows.

Retained Placenta

Green grass reduces the incidence of retained placenta by supporting overall health and nutritional status [33]. The rich nutrient profile of pasture helps improve uterine contractility, reducing the likelihood of placental retention after calving. Healthy cows with balanced nutrition are more likely to expel the placenta promptly, reducing the risk of postpartum complications.

Progesterone Synthesis

Green pastures enhance progesterone synthesis, crucial for maintaining pregnancy. The essential fatty acids found in pasture play a role in supporting the function of the corpus luteum, which produces progesterone. Adequate progesterone levels support embryo implantation and pregnancy maintenance, improving fertility outcomes.

Fatty Acids for Luteal Function

The essential fatty acids in green grass support corpus luteum function, which is essential for the synthesis of progesterone. These fatty acids contribute to the proper functioning of the reproductive system, enhancing pregnancy rates and improving overall reproductive health by maintaining hormonal balance.

Energy Balance

Green grass helps optimize energy balance, preventing negative impacts on reproduction. By providing a natural, balanced source of energy, pasture grazing helps avoid metabolic stress that can hinder fertility. Energy balance is crucial for maintaining regular estrous cycles, improving conception rates, and supporting overall reproductive health in dairy cows.

Fetal Growth

Green grass enhances fetal growth through an improved nutrient supply. The high-quality protein, vitamins, and minerals in pasture contribute to better fetal development, ensuring that calves are born strong and healthy [34]. Good maternal nutrition supports optimal fetal growth and improves the chances of a successful pregnancy and calving.

Stress-Induced Failures

Pasture grazing helps reduce stress-induced reproductive failures by providing a more natural and comfortable environment. By reducing metabolic stress and improving the cow's overall health, green grass helps minimize the negative impact of stress on fertility, ensuring better conception rates and healthier pregnancies.

Uterine Environment

Green pastures improve the uterine environment for better embryo implantation. The nutrients found in pasture help regulate hormonal levels and maintain a healthy, well-nourished uterine lining, providing an optimal environment for embryos to implant and develop. This increases the chances of successful pregnancies and reduces early embryonic losses.

Anti-Inflammatory Compounds

The natural anti-inflammatory compounds in green grass enhance reproductive health by reducing inflammation in the reproductive tract [13]. Chronic inflammation can impair fertility, but the polyphenols and other bioactive compounds in pasture help maintain a healthy, inflammation-free environment for optimal reproductive function and improved fertility.

Inter-Calving Intervals

Green grass reduces inter-calving intervals by improving reproductive efficiency. With optimal nutrition and energy intake from pasture, cows are more likely to return to estrus more quickly after calving. This reduces the time between calvings, improving herd productivity and ensuring more consistent milk production across the lactation cycle.

Heat Stress

Green grass minimizes the effects of heat stress on fertility by providing a more natural source of nutrition. High heat can disrupt hormonal balance and fertility in dairy cows, but pasture grazing helps reduce this stress by providing a cooler environment and reducing the need for supplementary feed sources that can exacerbate heat stress.

Puberty Onset

Green grass supports early puberty onset in heifers through enhanced hormonal regulation. The balanced nutrients in pasture help promote proper growth and hormonal development, leading to earlier and more consistent puberty. Early puberty is linked to better reproductive performance and higher lifetime productivity in dairy cows.

Postpartum Metabolic Disorders

Green grass reduces postpartum metabolic disorders that can negatively affect fertility. The balanced nutrition and high fiber content in pasture help cows maintain optimal energy and nutrient levels during the transition period, reducing the risk of conditions, like ketosis or fatty liver disease, which can hinder fertility [35].

Bioactive Peptides

The bioactive peptides found in green grass support reproductive physiology by promoting hormonal balance and improving overall reproductive function. These peptides regulate key reproductive processes, such as ovulation and luteal function, contributing to improved fertility and reproductive efficiency in dairy cows.

Oxidative Damage Reduction

Green grass helps reduce oxidative damage to ovarian tissues, which is crucial for maintaining fertility. The antioxidants found in pasture, including vitamin E and flavonoids, protect the ovaries from oxidative stress, preserving ovarian function and improving the chances of successful reproduction in dairy cows [36].

WELFARE

Natural Grazing Behavior

Green grass supports natural grazing behavior, allowing cows to express their instincts and reduce stress and boredom [1]. Grazing on pasture provides a more stimulating and enriching environment compared to confined feeding systems, leading to a significant improvement in overall welfare. Natural behavior is essential for enhancing the psychological and emotional well-being of dairy cows.

Reduced Aggression

Pasture grazing promotes a calmer environment, which helps reduce aggressive behaviors in dairy cows [37]. When cows have access to spacious outdoor areas, they are less likely to feel stressed or compete aggressively for resources. This peaceful environment fosters better social relationships, creating a more harmonious and productive herd.

Social Interactions

Green grass enhances social interactions among dairy cows through natural foraging activities. Grazing in groups allows cows to engage in social behaviors, such as grooming and forming bonds, which can reduce stress [38]. Positive socialization leads to improved herd dynamics and overall welfare, making for a healthier and more contented herd.

Physical Exercise

Grazing on green pastures provides cows with physical exercise, which is vital for improving locomotion and joint health. The freedom to move and forage naturally helps cows maintain muscle tone and mobility, reducing the risk of joint problems or lameness. This contributes to long-term health and comfort for dairy cows.

Stress Reduction

Green pastures minimize stress-related behaviors, such as tongue rolling, which are commonly observed in confined or barren feeding systems. Access to a natural, diverse diet and the ability to engage in normal foraging behaviors helps reduce anxiety and discomfort in dairy cows, fostering a more peaceful and well-adjusted herd [1].

Stereotypic Behaviors

Green grass reduces stereotypic behaviors, which are often linked to confined feeding systems. These repetitive, unnatural behaviors are a result of frustration and boredom. Grazing offers cows the opportunity to express natural behaviors, reducing the incidence of stereotypic actions and improving overall mental health [39].

Rumination Behavior

The availability of green grass enhances rumination behavior, which is essential for optimal digestive function. Cows that graze on pasture spend more time ruminating, which improves nutrient absorption and promotes better gut health [40]. A healthy digestive system contributes to overall well-being and reduces the likelihood of digestive disorders.

Stress Hormone Levels

Access to a natural diet of green grass lowers stress hormone levels in dairy cows [41]. Grazing allows cows to consume a balanced, varied diet, promoting a sense of satisfaction and reducing the physiological markers of stress. This reduction in stress hormones improves both physical and mental health.

Cooling Effect

In hot environments, green pastures provide a natural cooling effect, helping to reduce heat stress. Pasture grazing allows cows to regulate their body temperature more effectively, promoting comfort and reducing the physiological strain caused by heat [42]. This cooling effect is crucial for maintaining cow welfare during high temperatures.

Hoof Health

Green pastures reduce the risk of lameness by promoting even hoof wear. The natural surface of pastureland encourages proper hoof growth and wear, preventing the development of lameness that is commonly seen in confined systems [43]. Healthy hooves are essential for mobility and overall welfare.

Natural Immunity

Pasture grazing enhances natural immunity, reducing disease-related stress in dairy cows [44]. The nutrients in fresh grass, including vitamins, minerals, and antioxidants, support the immune system, helping cows fight off infections and maintain better health. A strong immune system reduces the reliance on medications and improves overall welfare.

Nutrient-Rich Feeding

Green grass provides a nutrient-rich diet that improves overall well-being and health in dairy cows. The natural nutrients found in fresh pasture contribute to better body condition, enhanced energy levels, and optimal metabolic function [2]. A well-nourished cow is a healthier and more productive cow, enhancing welfare outcomes.

Reduced Medication Use

By supplying a balanced, nutritious diet, green pastures reduce the need for synthetic medications and supplements. The natural nutrients in pasture help support cows' health and reduce the incidence of diseases, minimizing health complications. This not only enhances welfare but also lowers farm management costs.

Gut-Brain Axis

Green pastures support the gut-brain axis function, improving overall animal behavior. The natural fiber and nutrients from pasture help maintain a healthy gut microbiome, which in turn positively influences behavior and mood. A healthy gut-brain connection is essential for reducing stress and promoting overall well-being in dairy cows.

Maternal Behavior

Green grass promotes better maternal behavior during calving [45]. The reduced stress and improved physical health associated with pasture grazing support calmer, more natural maternal instincts. This encourages better bonding with calves and improves the success of the calving process, leading to better outcomes for both cow and calf.

Digestive Health

Green grass reduces the incidence of digestive upsets, often linked to high-starch diets in confined feeding systems. The high fiber content in pasture helps maintain a healthy rumen and digestive tract, reducing the risk of conditions like acidosis or bloat [6]. This improves overall digestive comfort and welfare.

Pasture Sustainability

Grazing on green pastures enhances pasture-based sustainability, which improves environmental welfare [46]. Managed grazing systems promote soil health and biodiversity, ensuring that pastures remain productive and ecologically balanced. This contributes to the long-term sustainability of dairy farming, benefiting both the environment and the animals.

Natural Enrichment

Green pastures provide a natural source of enrichment, which reduces boredom in dairy cows. Grazing offers cows the chance to explore, forage, and engage in natural behaviors, preventing the mental and physical stress associated with confinement [47]. This natural enrichment supports better overall welfare by addressing the cows' behavioral needs.

Resting Behavior

Green grass improves resting behavior by enhancing digestive comfort. The high fiber content of pasture allows cows to graze and ruminate at their own pace, reducing discomfort and promoting restful periods. Good resting behavior is essential for recovery and maintaining overall welfare.

Feedlot Health Risks

Green pastures reduce the risk of feedlot-related health issues, such as respiratory problems or digestive disorders, which are more prevalent in confined systems [48]. Grazing provides a cleaner, more natural environment, reducing the likelihood of diseases commonly seen in feedlot systems. This improves cow health and welfare in the long term.

Longevity

Green pastures support the longevity of dairy cows by preventing metabolic disorders. The balanced nutrition provided by grazing ensures that cows maintain optimal health throughout their lives, reducing the likelihood of diseases and improving their lifespan. This leads to more sustainable dairy farming practices and improved welfare.

Feeding Patterns

Green grass encourages natural feeding patterns, which reduce stress-related cortisol levels [41]. Grazing on pasture allows cows to eat at their own pace, leading to reduced competition for feed and a more relaxed feeding environment. This helps lower stress and improves the overall mental health of the herd.

Consistent Intake

Green pastures provide consistent nutrient intake, improving the daily welfare status of dairy cows [3]. By grazing on fresh pasture, cows have access to a steady supply of nutrients, supporting consistent milk production and overall health. Stable nutrition enhances both physical and mental well-being, contributing to better welfare outcomes.

Inflammation Reduction

Green grass minimizes inflammation-associated discomfort in high-producing cows. The natural anti-inflammatory compounds in pasture, such as polyphenols, help reduce the risk of conditions like mastitis and other inflammatory disorders [49]. This supports overall comfort and welfare by preventing pain and discomfort associated with inflammation.

Methane Emissions

Green pastures reduce methane emissions by improving fiber digestion efficiency. The high-fiber content of pasture encourages the growth of beneficial rumen microbes that break down fiber more effectively, reducing methane production [50]. This contributes to both animal welfare and environmental sustainability by minimizing greenhouse gas emissions.

Stable Diet

Green pastures provide a stable and familiar diet, reducing dietary adaptation stress. When cows are allowed to graze on consistent, natural pasture, they experience fewer digestive disturbances and stress caused by dietary changes. This stability promotes better welfare by supporting predictable, comfortable feeding patterns.

Reduced Feed Contaminants

Green pastures reduce exposure to harmful contaminants found in processed feeds. Pasture-based diets are less likely to contain mycotoxins or other toxins associated with stored feeds, improving the overall safety of the cows' diet. This reduces the risk of health issues related to feed contamination and enhances cow welfare.

Udder Health

Green grass improves udder health through enhanced immune support. The natural, nutrient-rich diet supports cows' immune systems, reducing the risk of mastitis and other udder-related issues [51]. Healthy udders contribute to better milk production and improve the overall welfare of dairy cows.

Intensive Housing Risks

Green pastures reduce risks associated with intensive housing systems, such as lameness, respiratory problems, and stress [52]. Grazing provides cows with more space, fresh air, and the opportunity to engage in natural behaviors, reducing the negative impacts of confinement and promoting better welfare outcomes.

Biodiversity

Green pastures promote environmental sustainability by maintaining pasture biodiversity. Grazing encourages a diverse range of plant species, which supports healthy ecosystems and promotes ecological balance [53]. This contributes to long-term environmental welfare by ensuring that pastures remain productive and biodiverse.

Low-Cost Feeding

Green pastures provide a cost-effective and low input feeding strategy, reducing economic stress on farms. Grazing reduces the need for expensive concentrate feeds, lowering overall feed costs [54]. This supports farm sustainability by making dairy farming more economically viable while also improving animal welfare.

Thermoregulation

Green pastures encourage thermoregulation, reducing the impact of extreme temperatures. Grazing allows cows to move freely, seek shade, and adjust their position to maintain an optimal body temperature. This natural form of thermoregulation helps reduce the physical and mental stress caused by extreme heat or cold conditions.

Dietary Transitions

Green grass reduces stress associated with abrupt dietary transitions. When cows are transitioned gradually onto pasture, they experience fewer digestive disruptions, and less stress compared to sudden changes in feed. This smooth transition helps improve their comfort and ensures better overall welfare during dietary changes.

Adaptability

Green grass improves adaptability to changing environmental conditions. Cows that graze on pasture are better able to cope with seasonal variations, such as temperature changes or variations in forage quality [55]. This adaptability supports the long-term welfare of the herd by reducing the stress associated with environmental fluctuations.

Farm Sustainability

Green pastures enhance overall farm sustainability through efficient resource utilization. Pasture-based systems reduce reliance on imported feed and synthetic inputs, lowering the carbon footprint of dairy farming [56]. Sustainable grazing practices contribute to environmental welfare while improving the health and well-being of dairy cows.

CONCLUSIONS

Green pastures play a vital role in enhancing the performance, health, reproduction, and welfare of dairy cows. The study highlights the multifaceted benefits of pasture-based systems, demonstrating their positive impact on milk yield, metabolic health, and reproductive success. Access to green grass promotes natural grazing behaviors, reduces stress, and supports overall animal welfare, contributing to healthier and more productive herds. Additionally, pasture grazing mitigates the risks of common diseases and metabolic disorders, further improving cow longevity and farm sustainability. By integrating nutrition, reproduction, and welfare into a cohesive framework, this study underscores the importance of green pastures in fostering sustainable and ethical dairy farming practices.

FUTURE DIRECTIONS

Future research should explore the long-term effects of green pasture-based systems on dairy cow productivity and health, focusing on optimizing pasture management practices for different climates and soil conditions. Investigating the specific types of pasture species that offer the highest nutritional value and best support for milk production and reproductive health will be essential for advancing sustainable dairy farming. Additionally, studies examining the genetic potential of dairy cows for improved pasture utilization could help identify breeds that thrive best in pasture-based systems, enhancing both productivity and welfare. Further exploration into the role of green pastures in reducing environmental impacts, such as greenhouse gas emissions and soil degradation, would provide valuable insights into their sustainability. Investigating the synergistic effects of combining pasture-based feeding with other natural management strategies, like rotational grazing or integrated pest management, could further optimize dairy farming systems while maintaining animal welfare and farm profitability.

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