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Cafeteria feeding systems and diet selection behaviour in ruminants: A comprehensive review

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Abstract

Ruminants possess a natural ability to select plant parts that meet their maintenance requirements when grazing on pasture. In contrast, animals in intensive systems are often restricted to consuming concentrate feed, hay or straw. Given their unique metabolic needs, ruminants require diets that are both nutritionally adequate and conducive to optimal rumen function and overall growth. Free choice feeding or cafeteria feeding enables sheep to select their own diet, potentially allowing them to meet their nutritional needs more effectively. However, determining individual feed preferences during various growth stages is important for optimizing nutrient intake. Voluntary feed intake is primarily influenced by feed quality, nutrient composition, and environmental conditions, while health status and management practices also play significant roles.

Keywords: Cafeteria feeding, Free choice feeding, Ruminants, Behaviour, Diet Selectivity

Introduction

Animals select feeds based on various motivations, aiming not only to maximise energy intake as proposed by optimal foraging theory. But also, to meet specific nutrient needs like proteins and minerals (Ceacero *et al.*, 2010) ^[10]. Ruminants exhibit 'nutritional wisdom', recognising beneficial or harmful feed components through sensory cues such as taste or smell (Duncan and Gordon, 1999) ^[23], enabling them to choose diets that support rumen health or alleviate illness (Cooper *et al.*, 1995; Villalba *et al.*, 2010) ^[14, 73]. Studies show that ruminants, whether housed or grazing, often select diverse and sometimes suboptimal diets beyond what optimal foraging theory predicts (Prache and Damasceno, 2006) ^[60]. However, modern feeding practices like total mixed rations or monoculture pastures may hinder natural foraging behaviour, leading to imbalances and health issues (Lynch *et al.*, 1992) ^[49].

Usage & Application

Choice feeding experiments evaluate an animal's willingness to consume specific feeds when offered separately or in combination, thereby helping to determine feed preferences and palatability. These experiments can be conducted either indoors or on pasture. The primary objectives (Meier *et al.*, 2012) ^[50] are to assess intake proportions, consumption rates and feeding behaviour.

According to Meier *et al.* (2012) ^[50], the term “cafeteria experiment” has two main applications:

1. To assess animal preference or the palatability of various feeds, and
2. To evaluate the animal's ability to meet its nutritional requirements, avoid harmful effects, or engage in self-medication to support health.

Intensions of Choice Feeding Experiments

Choice feeding experiments are employed to evaluate several adaptive abilities in animals. These include maintaining an optimal rumen environment by selecting feeds with varying energy densities (Cooper *et al.*, 1995) ^[14] or physical forms such as chopped, ground, or

pelleted feeds (Cooper *et al.*, 1996) ^[16]. Animals may also select feeds based on their nutritional requirements (Fedele *et al.*, 2002) ^[29] or engage in self-medication to counteract adverse health conditions (Villalba *et al.*, 2010) ^[73]. Additionally, such experiments investigate how prior experiences influence feed preferences (Catanese *et al.*, 2010) ^[12] and how physiological stages, such as growth or reproduction, affect feed selection (Parsons *et al.*, 1994) ^[57].

Theoretical Models Explaining Diet Selection in Ruminants

According to Milne (1991) ^[51], multiple factors influence the feeding behaviour and diet selection of ruminants, leading to the development of various models and theories to explain the mechanisms underlying these choices.

- a) **Euphagia:** The Euphagia model describes an animal's innate ability to select a diet that meets its nutritional requirements (Cooper, 1995) ^[14]. This concept is supported by the idea of nutrient specific appetite, exemplified by pica - an instinctive drive to consume specific substances to correct deficiencies (Rozin, 1976) ^[65]. Such behaviour suggests that most livestock species possess an inherent capacity to choose nutritionally appropriate diets. For instance, Danford (1982) ^[17] observed that phosphorus-deficient cattle may attempt to rectify the imbalance by consuming bones.
- b) **Hedyphagia:** Cooper (1995) ^[14] proposed the hedyphagia model, which suggests that animals select diets based on sensory appeal. Sensory-driven preferences are evident in sheep, which tend to favour young, soft, leafy forages over older, fibrous ones, often guided primarily by their senses (Milne, 1991) ^[51]. Animals learn to associate sensory traits like taste and smell with post-ingestive effects, shaping their food preferences over time (Distel & Villalba, 2018) ^[21]. While sight plays a key role in orientation (Kilonzo, 2003), sheep can still identify and select forage using smell, taste, and touch even when vision is impaired (Forbes, 1995) ^[30]. Secondary plant compounds also influence intake, either attracting or deterring herbivores depending on their sensory properties (Pfister, 1999) ^[59].
- c) **Optimal Foraging Theory (OFT):** This theory suggests that herbivores evaluate food based on its intrinsic quality and decide whether to consume or avoid it accordingly (Provenza *et al.*, 2002) ^[61]. Because foraging demands both time and energy, animals adopt strategies that maximize energy intake relative to effort. Natural selection favours behaviours that enhance survival, including efficient foraging (Cooper, 1995) ^[14]. Large herbivores, for example, tend to minimize foraging time and energy expenditure while selecting energy-rich diets (Norberg, 2021) ^[55], and may shift locations to sustain optimal energy intake as environmental conditions change (Bergman *et al.*, 2001) ^[8].
- d) **Morphophysiology:** Animal-related factors such as body size, sex, breed, and morphology significantly influence diet selection. Larger ruminants are more efficient at digesting fibrous feeds due to their greater rumen capacity, which allows longer retention and more thorough microbial breakdown (Milne, 1991; Cooper, 1995) ^[51,14]. In contrast, browsing species with smaller rumens tend to pass indigestible particles more quickly, as browse materials often contain highly lignified, less digestible cell walls.

- e) **e. Learning through consequences:** The model illustrates how dietary preferences are shaped by both pre ingestive experiences and post ingestive effects, often acquired through social learning or trial and error. Herbivores, when exposed to diverse diets, can learn the benefits of specific plant secondary compounds (Villalba *et al.*, 2010) ^[73] and natural selection has equipped them with the ability to acquire such knowledge. Sheep typically sample unfamiliar foods in small amounts and increase consumption if no negative consequences follow. Young lambs can develop taste aversions or preferences through observation and interaction with role models, particularly their mothers, although this does not ensure identical dietary choices (Kilonzo, 2003) ^[47].

Experimental Design for Choice Feeding Studies

- a) **Target Ruminant Species:** Most indoor choice feeding experiments with ruminants have focused on sheep (Alonso-Díaz *et al.*, 2009; Catanese *et al.*, 2010) ^[2, 12] and goats (Duncan *et al.*, 2006) ^[26]. Fewer studies have involved cattle, with some experiments conducted on heifers (Sandoval-Castro *et al.*, 2005) ^[67] and dairy cows (Van Dorland *et al.*, 2008) ^[72]. Cattle are more commonly used in outdoor feeding studies (Hirata *et al.*, 2010) ^[42], with sheep (Harvey *et al.*, 2000) ^[39] and goats (Penning *et al.*, 1997) ^[58] also being subjects of outdoor experiments.
- b) **Indoor Experiments:** Most indoor choice feeding studies house animals individually in pens (e.g., Alonso-Díaz *et al.*, 2009; Catanese *et al.*, 2009; Dikmen *et al.*, 2009) ^[2, 11, 20], though some use open-air enclosures for penned animals (Ben Salem *et al.*, 1994) ^[7]. Group housing with individual intake measurement requires advanced equipment, making it rare (Van Dorland *et al.*, 2008) ^[72]. As a result, intake is often recorded at the group level (Askar *et al.*, 2006; Kalio *et al.*, 2006) ^[3, 46]. Experimental feeds are typically offered separately in troughs (Scharenberg *et al.*, 2007) ^[68] or buckets (Kalio *et al.*, 2006) ^[46] to minimize losses. To prevent positional bias, feed locations are randomized daily (Van Dorland *et al.*, 2007) ^[71], since animals may show preferences for certain spots (Forbes, 2007) ^[31].

Methodologies and Measurements Used in Choice Feeding Experiments

Measurement of Individual Feed Intake: The primary variable for evaluating preference or palatability in choice feeding experiments is the intake of the specific feed item(s) tested. In indoor settings, intake can be measured manually or with computer-assisted systems that use feeding troughs equipped with weight scales (Forbes, 2007) ^[31]. These systems, when combined with electronic identification units and access-controlled feeding doors, allow preference assessments even in group housing and can detect diurnal feeding patterns (Van Dorland *et al.*, 2007) ^[71]. Outdoors, intake is typically estimated based on intake rate (amount per time) and grazing duration (Harvey *et al.*, 2000) ^[39], with intake rate derived from jaw movement or grazing time records (Prache and Damasceno, 2006) ^[60], alongside body weight changes and feed dry matter content. Alternative methods include using oesophageal fistulae to collect extrusa for bite weight estimation, while bite rate can be recorded using sound-based systems (Distel *et al.*, 1995) ^[22]. A simpler approach involves recording the forage offered and remaining, with biomass growth in protected areas

assessed using enclosure cages (Chapman *et al.*, 2009) [13], though this method limits the ability to collect data for individual animals.

Measurement of feeding behaviour

Feeding behaviour traits may include (i) eating time, rate and meal size per feed in indoor settings; (ii) grazing time, intake rate, meal size and position in pasture outdoors; and (iii) frequency of switching between feeds, applicable in both environments.

Behaviour can be assessed through direct observation (Chapman *et al.*, 2009; Rutter *et al.*, 2004) [13,66], video recording (Hirata *et al.*, 2006) [40], or photographic recording (Prache and Damasceno, 2006) [60]. Automated systems like the 'Ethosys' collar (Ginane *et al.*, 2003) [34], elastic noseband devices (Parsons *et al.*, 1994) [57], and the IGER recorder (Rutter *et al.*, 2004) [66] can track behaviour, including at night (Gordon, 1995) [36]. While direct observation is common outdoors, it can also be done indoors, though less frequently due to alternative methods. This method involves tracking animal location or specific behaviours over time, but observer presence must not influence behaviour, and observations may be made from outside the plot or a concealed elevated position (Prache and Damasceno, 2006; Rutter *et al.*, 2004) [60,66]. This method allows for detailed tracking of behaviour, detecting unusual events, and analysing temporal patterns in feed preference (Morand-Fehr, 2003) [52]. Scan sampling is often used to record group behaviour at intervals (Hirata *et al.*, 2008) [41], capturing traits like ruminating and lying. Video recording, useful for both short- and long-term behaviour analysis, allows for playback and manipulation with specialised software (Weigensberg and Fairbairn, 1994) [74].

Measurement of Secondary Response Variables

Feeding strategies are designed not only to maximize feed intake but also to influence secondary outcomes such as animal performance, digestion, metabolism, product quality, and gaseous emissions.

Key Aspects to Consider for the Successful Conduct of Choice Feeding Experiments

A. Animal-Specific Aspects

- 1. Importance of animal species:** Although ruminant species such as cattle, sheep, and goats share many behavioural traits and abilities (Ekesbo, 2011) [27], species-specific characteristics can influence outcomes in choice feeding experiments. For instance, sheep are highly social animals and may become distressed when isolated, potentially affecting feeding behaviour. Feed preferences can also vary with feeding type: cattle and sheep are primarily "grass and roughage eaters," whereas goats are considered "intermediate types" (Hofmann, 1989) [43]. Rogosic *et al.* (2006) [64] reported that goats consumed more shrubs than sheep, although the order of preference was similar between the species.
- 2. Physiological stage of the animals:** Individual nutritional needs (Dikmen *et al.*, 2009) [20] and physiological stages such as growth, pregnancy, lactation or the dry period can significantly influence feed preferences. Hunger is a major confounding factor in choice feeding studies, as hungry animals often consume the first available feed regardless of their actual preference (Scharenberg *et al.*, 2007) [68]. Newman *et al.* (1994) [53] reported that hungry sheep

grazed for longer periods and at a faster rate but exhibited less preference for clover compared to well-fed counterparts. Feed selection can also be shaped by specific macronutrient deficiencies; lambs fed imbalanced diets selected feeds that corrected the nutritional shortfall, regardless of physical form (pellets, rolled, or ground).

Fedele *et al.* (2002) [29] found that goats given free-choice access to six different feeds adjusted their intake across reproductive stages, indicating that diet selection was aligned with physiological demands. Similarly, Cooper *et al.* (1994) [15] showed that pregnant ewes displayed a greater preference for protein-rich feeds than non-pregnant ones, especially when energy availability was high. In contrast, Parsons *et al.* (1994) [57] observed minimal and inconsistent effects of lactation on feed preferences in sheep, and Morand-Fehr (2003) [52] reported no clear association between physiological stage and feed preference in goats.

Health status may also influence feed choice. Parasite-infected animals may alter their preferences if familiar with palliative or medicinal compounds. For instance, Villalba *et al.* (2010) [73] observed an increased preference for a tannin-alfalfa mixture in infected lambs. The role of sex in feed preference remains uncertain, with Rodríguez *et al.* (2008) [63] reporting inconclusive findings.

- 3. Number of animal replicates:** Individual animals may exhibit variation in feed preferences and their perception of palatability (Dikmen *et al.*, 2009) [20]. Due to the high resource demands associated with choice feeding trials, these studies often involve a limited number of animals per treatment group (Catanese *et al.*, 2009) [11].

In most indoor experiments, animals are either individually housed or tethered and treated as distinct experimental units. Common replication numbers include six (Rodríguez *et al.*, 2008; Van Dorland *et al.*, 2008) [63, 72] and eight (Dikmen *et al.*, 2009) [20]. Even when animals are group-housed (Van Dorland *et al.*, 2007) [71], intake measurements are frequently conducted using five to six individuals.

In pasture-based studies, group sizes vary widely from as few as two animals

(Rutter *et al.*, 2004) [66] to approximately 30 (Hirata *et al.*, 2008) [41]. Some studies use a single 'focal' animal for observation (Penning *et al.*, 1997) [58], while others treat the entire group (Rutter *et al.*, 2004) [66] as a replicate. However, statistical independence may be compromised in group settings due to the influence of social dynamics on feeding behaviour (Hirata *et al.*, 2008) [41], although other studies have observed relatively independent feeding actions (Ginane *et al.*, 2005) [35]. Latin square designs are often employed to enhance resource efficiency; nonetheless, the potential for carry-over effects between treatments may introduce bias.

Animal Adaptation and Consideration of Previous Experience

Adaptation Periods in Choice Feeding Studies: In indoor choice feeding experiments, adaptation periods to the experimental environment typically range from one week (Dikmen *et al.*, 2009) [20] to two weeks (Hadjigeorgiou *et al.*, 2003) [38], with Morand-Fehr (2003) [52] using 15–18 days for goats. A minimum of six days is considered necessary for animals to adjust to new feeds in terms of intake and digestion (Demarquilly *et al.*, 1995) [18], as initial neophobia may suppress intake, which gradually increases with

familiarization.

Young animals generally adapt more readily to novel feeds compared to adults

(Lynch *et al.*, 1992) ^[49]. For accurate palatability assessment, Kaitho *et al.* (1996) ^[45] recommended more than one day of feed exposure, while Kyriazakis *et al.* (1998) ^[48] suggested a 10-day period to allow animals to associate feed characteristics with post-ingestive effects.

In outdoor experiments, prior grazing experience is often assumed (Hirata *et al.*, 2006) ^[40], though some studies have implemented adaptation periods for instance, 12 days (Penning *et al.*, 1997) ^[58] or over 14 days (Newman *et al.*, 1994) ^[53]. Learning plays a crucial role, particularly when animals respond to post-ingestive feedback. For example, goats have been shown to recognise phenolic compounds within an hour (Papachristou *et al.*, 2003) ^[56] and parasitised lambs learned to prefer tannin-rich feeds over a few days (Villalba *et al.*, 2010) ^[73].

Influence of Prior Experience on Feed Preference: Prior exposure to experimental or similar feeds, especially during early life stages, significantly influences feed preference and intake behavior in choice feeding trials (Parsons *et al.*, 1994) ^[57]. Such exposures can even occur prenatally (Simitzis *et al.*, 2008) ^[69] or via social learning, where maternal influence tends to be stronger than that of peers (Lynch *et al.*, 1992) ^[49]. Early-life feed experiences can exert long-lasting effects on feeding behaviour.

Familiar feeds or forms, such as hay, may temporarily increase intake due to novelty when replacing a previous diet (Favreau *et al.*, 2010) ^[28], potentially biasing preference evaluations. However, prolonged exposure can lead to greater acceptance and intake of initially unpalatable feeds (Ngwa *et al.*, 2003) ^[54].

Assessments in Individually Housed Animals Versus Group-Housed Animals

Social dynamics within a flock can significantly influence grazing behaviour, potentially obscuring individual feed preferences in choice feeding experiments (Hirata *et al.*, 2008) ^[41]. The tendency to remain close to conspecifics may override feed selection, particularly in small groups. For gregarious species such as sheep, using group sizes larger than three to six individuals has been suggested to help mitigate social interference (Dumont and Boissy, 2000) ^[24].

On pasture, experimental designs should allow animals to express their preferences freely, without being constrained by social pressures. In indoor settings, providing individual access to feeders within group housing can help reduce dominance-related effects; however, limited feeder access may still result in intake suppression due to social hierarchies (Fraser and Broom, 1997) ^[32]. While individual housing effectively eliminates social influences, it may reduce feed intake in some species, such as cattle, due to isolation stress.

Feed-Specific Aspects

1. Number of Feeds Tested Simultaneously: In outdoor choice feeding studies involving ruminants, the number of feed options offered can vary widely from as few as two (e.g., Catanese *et al.*, 2009) ^[11] to as many as ten forages though most studies typically employ dual choice designs (Hirata *et al.*, 2008) ^[41]. While increasing the number of feed choices can complicate the decision-making process for animals, it may also lead to higher overall intake.

2. Characteristics of Experimental Feeds: The physical characteristics of experimental feeds can significantly influence animal preferences (Morand-Fehr, 2003, for goats) ^[52]. To avoid introducing bias into choice feeding trials, the physical properties of the feeds such as form, length and density should be as similar as possible, unless those traits are the variables under investigation. For forages, key considerations include dry matter content and particle length, with physical form being particularly important for feeds with low palatability.

Small ruminants may also show a preference for concentrates containing coarsely ground ingredients (Baumont *et al.*, 2000) ^[6]. The palatability of finely ground or dusty feeds can be improved through moistening or pelleting.

Sensory attributes such as odour and taste also play a crucial role in feed selection

(De Rosa *et al.*, 2002; Distel *et al.*, 2007) ^[19, 21]. Moreover, the quality and digestibility of experimental feeds can affect rumen fill and feeding behaviour (Ginane *et al.*, 2003) ^[34]. Fibre characteristics influence intake rate (Favreau *et al.*, 2010) ^[28], and feeds with different potential intake rates may lead to distinct choices. The presence of toxins or plant secondary metabolites can also impact intake.

Set-up Specific Aspects

Duration and Timing of Exposure to Experimental Feeds:

Access to experimental feeds in choice feeding studies can be provided either continuously throughout the day and night (Distel *et al.*, 2007) ^[21] or restricted to specific periods. Restricted access may vary in duration, from short periods of 30 minutes or less (Morand-Fehr, 2003) ^[52] to extended periods ranging from over 30 minutes to as long as 8 hours (Alonso-Díaz *et al.*, 2009) ^[2]. The decision regarding access duration may also be influenced by practical considerations such as resource availability. Extended exposure times are especially important when animals are offered multiple feed options, as they require sufficient time to evaluate and select the most suitable diet.

Short-term preference assessments may not reliably predict long-term feeding behaviour. Preferences observed during brief exposure periods may differ significantly from those seen over extended periods (Parsons *et al.*, 1994) ^[57]. Furthermore, the timing of feed exposure can influence feeding outcomes. Diurnal preference patterns have been documented when animals were given prolonged access to feeds (Catanese *et al.*, 2009; Van Dorland *et al.*, 2008) ^[11, 72]. Typically, animals show higher grazing activity during early morning and late evening hours (Lynch *et al.*, 1992; Albright and Arave, 1997) ^[49, 1], likely due to more favorable environmental conditions, such as lower solar radiation and temperatures.

Length of choice feeding periods

The duration of the choice period in feeding studies can be classified into short-term (less than one day; e.g., Distel *et al.*, 1995) ^[22], medium-term (one day to one week; e.g., Hirata *et al.*, 2006) ^[40], and long-term (several weeks; e.g., Hirata *et al.*, 2010) ^[42], often preceded by adaptation or learning phases. Some studies utilize a single exposure to experimental feeds over several days (e.g., Atwood *et al.*, 2006) ^[4], while others employ repeated exposures either within a single day (Distel *et al.*, 1995; Distel and Vallaba (2018) ^[22, 23] or across multiple days (e.g., Kyriazakis *et al.*, 1998) ^[48]. Short-term durations are commonly used for their cost-effectiveness,

particularly in assessing palatability or initial feed preferences (Morand-Fehr, 2003) [52].

Factors Influencing Diet Selectivity

- **Type of Livestock:** Bailey *et al.* (2019) [5] classified herbivores into grazers, browsers, and intermediate feeders based on anatomical traits and foraging behaviour. Large ruminants, such as cattle, possess broad muzzles and large rumens, enabling efficient utilization of grasses. The extended retention time of feed within the large rumen-reticulum complex supports microbial fermentation, enhancing nutrient extraction. Janis and Ehrhardt (1988) [44] observed morphological differences in muzzle shape between grazers and browsers, noting that grazers typically have broader muzzles adapted to consuming short grasses. Similarly, Coopers (1995) [14] emphasized that a large rumen volume enables effective digestion of fibrous plant materials.
- **Breed:** Frost and Mosley (2020) [33] noted that livestock breeds vary in body size and production characteristics, which in turn influence their nutritional requirements. Larger breeds typically require higher dry matter intake and possess greater digestive capacity. Breed-specific grazing behaviour also plays a role in feed selection and resource utilization. According to Brand (2000) [9], Dorper sheep are less selective grazers compared to Merino sheep, consuming a wider variety of plant species, including shrubs. This broader dietary adaptability allows Dopers to gain weight more rapidly, shortening the time to market and thereby potentially reducing greenhouse gas emissions associated with prolonged production cycles.
- **Age:** Grings *et al.* (2001) [37] reported that metabolic rate declines with age, resulting in reduced feed requirements in older animals, while younger animals exhibit more active foraging behaviour to satisfy their higher nutritional demands. Frost and Mosley (2020) [33] further observed that diet selectivity and tolerance to plant secondary metabolites diminish as animals age. Younger animals, due to their limited foraging experience, tend to explore a wider range of feeds, including those that may have previously caused discomfort.
- **Body Condition:** Body condition, an indicator of an animal's fatness or thinness, plays a significant role in regulating feeding behaviour and intake levels. Frost and Mosley (2020) [33] reported that animals in poor body condition typically exhibit increased feed intake as a compensatory response, whereas well-conditioned animals tend to reduce their intake. Similarly, Newman *et al.* (1994) [53] observed that undernourished or fasted sheep are more likely to consume greater quantities of available feed, including less preferred or even potentially toxic plants, in an effort to address nutritional deficiencies.
- **Stage in Production Cycle:** Animals adapt their dietary choices in response to changing nutritional demands across different life stages (Frost and Mosley, 2020) [33]. Lactating females, for instance, require higher levels of protein and energy to support milk production, with energy requirements fluctuating depending on the specific phase of production due to metabolic changes. However, certain plant species may be toxic during pregnancy and pose risks such as fetal harm or pregnancy loss, highlighting the importance of avoiding the consumption of such plants during gestation (Stegelmeier

et al., 2020) [70].

- **Selective Grazing:** Foraging animals meet their seasonal nutritional demands by selectively choosing plant species and parts that support digestion and provide comfort, while avoiding those that cause discomfort. Exposure to unpalatable or discomfort-inducing feeds can lead to avoidance behaviours and repeated consumption of poor-quality feed may suppress future intake.
- Provenza *et al.* (2002) [61] explained that when animals are exposed to a range of diets with differing nutrient and toxin levels, they regulate their intake to balance nutrient needs and minimize toxin ingestion. Toxins can impair physiological functions by reducing feed intake, hindering digestion, causing nutritional imbalances and negatively affecting reproduction and immunity.
- **External Plant Attributes (EPA):** Raufirad *et al.* (2015) [62] suggested that external plant attributes (EPAs) are the first features animals perceive while grazing, significantly influencing their preference and selectivity. Traits such as spines, inflorescence, stem structure, resistance to grasping, height, leaf position, succulence, leaf-to-stem ratio and branch density all play a role in determining plant selection by sheep.

Conclusion

Cafeteria feeding provides a practical method for meeting the dynamic nutritional needs of livestock and poultry through self-selection. Research indicates that animals have the ability to instinctively select balanced diets when given appropriate feed options. This approach can enhance nutrient efficiency and reduce protein overuse, contributing to more sustainable production practices. However, the success of cafeteria feeding depends on well-designed feeding systems and effective management practices. While initial costs and the learning curve may present challenges, the long-term benefits in terms of performance and feed economy are promising. Overall, cafeteria feeding serves as a valuable tool in advancing precision nutrition within modern animal agriculture.

Conflict of Interest

Not available

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Not available

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