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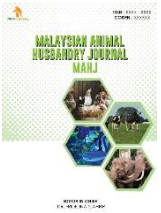

REVIEW ARTICLE

A REVIEW ON COGRAZING OF SHEEP AND GOAT

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ABSTRACT

Sheep and goats are frequently co-grazed all over the world and have done so for a long time. It's possible that its advantages are underappreciated, and strategies for maximizing them haven't been well-researched. The advantages of grazing sheep and goats are primarily due to their varying tastes in plant species and parts, their capacity or willingness to eat highly unpopular forages, which would have a greater negative impact on other species, and their physical accessibility to vegetation types. Therefore, as plant diversity grows and foraging overlap decreases at the same time, the carrying capacity of grasslands, or total stocking rate, surpasses that of monoecious species. When it comes to co-grazing, appropriate stocking rates are arguably the most important management decision. With mono-species grazing, the botanical composition and available forage mass, along with variables influencing nutrient requirements like body weight and production state, preference for or willingness to consume forages present, and intended grazing duration, are significant determinants of the number of sheep and goats. Predicting mono-species stocking rates will be made easier by prior knowledge of grazing practices and animal circumstances. When co-grazing, estimates of dietary overlap should be based on the most precise technique that is currently available, which is frequently experienced or visual observation at different times of the day and in different seasons. It makes a false assumption that all animal species have an identical capacity to ingest forages, which is not necessarily the case. Moreover, stocking rate interactions that occur when the two species graze together vs separately are not considered. However, the method's simplicity may make it useful in field settings, and it serves as an example of the significance of browse plant species in many grazing systems and the reasons management measures are often used to preserve or enhance their prevalence and vegetation variety.

KEYWORDS

Sheep; Goats; Co-grazing

1. INTRODUCTION

Grazing two or more species of cattle simultaneously on the same plot of land during a single growing season is known as common use, dual usage, or multi-species grazing (Byington, 1985). Two alternatives for multi- or mixed-species grazing systems include sequential grazing, which involves grazing by one species after another at various times, and co-grazing, which involves grazing by two or more species of cattle and/or game animals at the same time. These techniques have the most effects on feed efficiency on land with a diversity of plant species (Walker, 1994). The findings show that one important element influencing the benefits of multispecies grazing is the extent of dietary overlap in the consumption of particular plant species and components.

Similar to co-grazing, but far more common when cattle are present, is the consumption by sheep and/or goats of plants harmful to or avoided by another ruminant species present (Walker et al., 1994). The ability, tolerance, and/or desire of different ruminant species to graze on different topographies and terrains varies. Multi-species grazing can lead to greater product variety compared to single-species grazing. The higher biological efficiency of multi-species grazing, meaning more continuous output from the system, can improve overall profitability and sustainability of the operation.

Despite these potential benefits of co-grazing, it is not yet widely adopted. There seem to be some drawbacks limiting its uptake. One issue is simply a lack of knowledge about the approach. The extra inputs like fencing and protecting animals from predators, plus greater management skills needed for multiple versus single species, may also deter farmers. There could also be lower production efficiency in some cases. For instance, buying smaller quantities of health supplies at higher cost for a few co-grazing species versus one species in mono-grazing. However, these challenges appear much less significant for co-grazing sheep and goats than cattle with one or two small ruminant species.

2. NUTRIENT REQUIREMENTS

Nutrient needs are one of several elements that impact how sheep and goats respond to grazing together versus alone. When given the chance, Forbes and Provenza postulated that ruminants ingest varying amounts of one or more feedstuffs to repair or limit nutritional deficits and avoid excesses to reach low levels of metabolic discomfort (Forbes and Provenza, 2000). Furthermore, ruminants' 'experiment' with varied quantities of certain feedstuffs, and maybe plant parts, in response to variations in the mix of available feedstuffs and fluctuating nutritional demands.

2.1 Energy

Sheep have a lower ME requirement for maintenance (MEm) in relation to body weight0.75 than goats (NRC, 2007). NRC reviewed evidence that suggested there were no or minor variations across sheep breeds in MEm. In contrast, variations in MEm appear to exist between broad kinds (i.e., biotypes) of goats selected for certain productive objectives (e.g., dairy > Boer and indigenous) (NRC, 2007). Many additional parameters, such as

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historical or current feed consumption, age, gender, body composition, grazing activity, and acclimation, affect MEm. It is unknown if such elements have different effects on sheep and goats. Though the methodologies for describing energy requirements for growth in sheep and goats differ (e.g., NRC, 2007), the requirements per unit of gain appear to be similar when tissue accretion is taken into account. Sheep have had a higher ratio of average daily gain (ADG) to DM intake (DMI) than goats in some cases (Al Jassim et al., 1991; Mahgoub and Lodge, 1998). However, this might be due to the goats' relatively modest growth potential or comparisons with dairy goat breeds with greater MEm than other genotypes (Urge et al., 2004; NRC, 2007). A group researcher found that Boer goats and Khatadin sheep fed mixed forage concentrate diets had comparable ADG: DMI (Animut et al., 2006). Other productive tasks including lactation, fiber growth, and pregnancy are assumed to be equivalent between sheep and goats in terms of output, milk composition, birth weight, and so on, just as they are for growth.

2.2 Minerals and vitamins

Goats' mineral and vitamin needs have not been as thoroughly researched as sheep's, and recommendations for goats are frequently based on research done on other ruminant species. But one important distinction that should be taken into account while cograzing is that goats have a higher demand for copper and a higher dietary copper threshold at which poisoning may develop than does the sheep (NRC, 2007).

2.3 Voluntary feed intake

A crucial factor to take into account when comparing small ruminant grazing species is their voluntary feed consumption. For instance, developed feed intake prediction equations for goats of various genotypes, genders, stages, and levels of production using a database of treatment mean observations from the literature (Luo et al., 2004). They took into account the influence of requirements by assuming constant efficiency of whole-body energy metabolism (Tolkamp and Ketelaars, 1994). According to research given by NRC, there is either no difference in feed consumption by sheep and goats, or the goats have a greater intake (NRC, 2007). Based in part on SCA, it was determined that there is insufficient data to support the recommendation of broad dietary variations between sheep and goats (SCA, 1990).

3. Ingestive Behavior

According to their physical eating patterns, ruminant species can be categorized as concentrate pickers, consumers or grazers of grass and roughage, or as mixed feeders or those with intermediate characteristics (NRC, 2007). Goats are typically included in the intermediate category, with sheep and cattle falling into the grazer category. Designed for maximum grass intake at low biomass, grazers have large muzzles, cornified tongue tips, and relatively small lips (Van Soest, 1994; NRC, 2007). Goats can collect certain plants and plant components, such leaves and twigs of woody plant species, because of their deep, narrow mouth opening and their ability to move their lips and tongue (Hofmann, 1989; Van Soest, 1994; NRC, 2007).

Compared to cattle and sheep, goats are remarkably nimble animals that often walk on two feet and climb to reach noteworthy plants (Sanon et al., 2007). Intermediate feeders have larger salivary gland weights in relation to body weight than grazers (Hofmann, 1989; Robbins et al., 1995). More thin, proteinaceous serous saliva is produced by these glands, which may help counteract some plant defense compounds like tannins (Hofmann, 1989; Robbins et al., 1995). Similarly, a thicker abomasal mucosa and a comparatively high number of HCl-producing parietal cells are found in intermediate feeders and concentrate selectors. These traits may be adaptations to plant secondary metabolites, such as complete release of proteins bound to condensed tannins in the reticulo-rumen (Hofmann, 1989).

Domingue et al. conducted research on the comparative chewing efficiency (CE) of goats and sheep in 1991. The percentage of particles less than 1.0 mm in reticulo-ruminal boli that are present immediately after swallowing is known as ingestive CE, while the percentage of particles larger than 1.0 mm in size after rumination is known as ruminative CE. Whereas ruminative CE tended to be higher for sheep, ingestive CE was higher for goats than for sheep. Goats with higher ingestive CE may chew more often, have teeth with a larger grinding surface area (mm2/kg body weight0.75), or have different jawbone and skull structures that affect the forces used when eating (Ulyatt et al., 1986). Greater chewing frequency seems to be the most significant of these characteristics, since both ingestive and ruminative CE were equal across sheep and goats after accounted for chewing frequency (Domingue et al., 1991).

Sheep and goats' feeding habits are influenced by the vegetation on their pasture. According to research, sheep bit more frequently when non-browse species predominated, whereas goats bit more frequently when browse plants dominated. As forage levels reduced, the biting rate fell more abruptly in goats than in sheep, indicating that goats are more adaptable. Animals adjust by biting more often and grazing for longer periods of time as their bite size decreases in order to maintain intake. Even though sheep typically have larger biting masses, higher goat bite rates can result in ingestion rates that are comparable. Bite size, however, can have a big influence on how long grazing takes. Because grazing time and activity energy expenditure have a significant correlation, bite mass may have an impact on animal performance through this pathway. Overall, goats appear better adapted to varied pasture conditions versus sheep.

4. Forage Selectivity and Preference

4.1 Plant species

There have been mixed results regarding the dietary preferences and selectivity of sheep and goats when it comes to grass-legume mixes. There have been sporadic reports that sheep prefer legumes over goats, some researchers observed the opposite in a tropical grass–legume pasture (Collins and Nicol, 1987; Norton et al., 1990). Similarly, a group researchers found that goats preferred forbs over sheep and that sheep preferred grasses over a range of forbs and several varieties of grasses (Animut et al., 2005b). A sward characteristic that might account for these disparate results is the vertical distribution of various plant species with respect to the majority of natural or possibly favored harvesting techniques.

That is, according to some study, sheep seem to have a desire and make an effort to graze in the lower stratum or well below the sward horizon (Collins and Nicol, 1986; Gong et al., 1996a,b,c). Goats, on the other hand, often bite from a higher point on the sward or horizon down, moving their heads side to side or horizontally while biting. They also typically have a smaller depth of bite. Supporting this is the finding that goat DM intake declines with decreasing pasture height at a faster rate than sheep intake (McCall and Lambert, 1987; Penning et al., 1997). Consequently, rather than being ascribed only to the existence of plant species, changes in preference or selectivity across species may be connected to the vertical distribution of different plant species and plant sections.

Another way to think about goats' more diversified botanical composition in their meals than sheep's is that they are more flexible. For instance, a group researcher discovered that when the amount of different grasses fell, so did the goats' choice for rushes (Juncus effusus) in a combination (Grant et al., 1984). Similarly, the botanical makeup of goat diets changes according on the time of year. Accordingly, during the winter, when browse availability was high, feral goat diets consisted of 90% browse, 4% forbs, and 6% grass; during the summer, when grasses and forbs grew quickly, the ratio was 8% browse, 18% forbs, and 74% grass (Coblentz, 1977).

Although it is evident that stocking rate affects the amount of fodder that is available, it has not received much attention when it comes to co-grazing sheep and goats. A group researchers noted that while preference values for forbs varied across sheep and goats, preference values of both species for the most common forb, ragweed (Ambrosia artemisiifolia), rose when stocking rate increased and fodder mass declined (Animut et al., 2005b). For more favored forbs, the preference value dropped, while it remained constant for grasses.

4.2 Plant parts

When grazing on the same field, research shows that sheep and goats choose different diets. Live, green plant material is often preferred by both species over dead herbage (Hamilton et al., 1973; Gurung et al., 1994). Goats, however, could occasionally consume less dead stuff than sheep (Collins and Nicol, 1987). Though the nutritional content of leaves is frequently higher than that of stems, and legume leaves are better than grass leaves, the selection is influenced by factors other than nutrition. According to one research, sheep chose more grass leaves and less legume and grass stems, while goats strongly favored legume leaves but shunned grass and legume stems (Norton et al., 1990b). This implies that selectivity is impacted by the plants' spatial distribution throughout the sward. Goats, however, were found to prefer green stems over leaves in different research (Collins and Nicol, 1987).

Goats may leave more grass stem material behind in grass-legume combinations, suggesting a low preference, whereas sheep choose both grass leaf and stem (Norton et al., 1990a). Overall, research indicates that sheep and goats have different preferences for different plant parts;

however, results vary throughout studies and may be influenced by the particular content and structure of the vegetation.

4.3 Chemical composition

Both sheep and goats select diets higher in digestible organic matter and CP than the average of all available pasture, according to many studies (Hadjigeorgiou et al., 2003). The inconsistent species variations in the chemical makeup of the meals that have been chosen may not come as a surprise, considering the substantial influence that some plant species have on selection. Furthermore, due to the significance of feed intake level and the relationship between nutrient consumption amounts and needs, species variations in dietary nutritive value are not always correlated with corresponding changes in performance (Wilson et al., 1975; Gurung et al., 1994). In certain cases, sheep have been shown to have higher dietary CP content than goats, however the converse has also been seenDietary digestibility was comparable for sheep and goats in grass-clover pastures and forest grazing environments (Hughes et al., 1984; Gurung et al., 1994; Gurung et al., 1994; Animut et al., 2005a; Wilson et al., 1975; Pfister and Malechek, 1986b).

With tropical grass–legume pasture and semi-arid forests, sheep chose diets with higher in vitro digestibility than goats, whereas Papachristou discovered that goats had higher dietary in vitro digestibility than sheep (Norton et al., 1990b; Squires, 1982; Papachristou, 1997). Goats' dietary nutritive value has been higher than sheep's when browse plant species are available due to their preference and more effective harvesting and browse's generally high nutritive value, which varies less with time or season than that of grasses and forbs (Wilson et al., 1975; Bartolome et al., 1998; Fadel Elseed et al., 2002). The nutritional content of meals for sheep and goats can vary significantly depending on the season. Wet seasons often have higher dietary CP contents than dry ones (Kronberg and Malechek, 1997). The availability of browse has a significant effect on dietary CP levels, especially during the dry season. As a result, the differences between sheep and goats that arise rely on the availability of other plant species as well as the characteristics of the particular browse plants in terms of species preferences and physical harvesting abilities.

5. Grazing Behavior

Sheep observed grazing for longer periods in some situations, but not in all, based on goats and sheep co-grazing together. It is impossible to determine why grazing duration varied or did not vary between species given the inconsistent study circumstances stated. According to ruminants exhibit diurnal patterns in their time spent grazing as well as in other behaviors including rumination, idleness, and laying (Fierro and Bryant, 1990; Sharma et al., 1998). There isn't enough data to conclude that sheep and goats differ much in their daily grazing activity patterns. On the other hand, variations would be expected given the unique environmental circumstances and genotypes under study. A sheep breed more suited for temperate conditions, such one chosen for wool production, may be predicted to graze substantially less throughout the day in high temperatures than a genotype of goats acclimated to hot climes.

Sheep and goat grazing habits are greatly influenced by the season. While some researchers found the contrary, Kronberg and Malechek reported longer grazing times during the dry season compared to the rainy one (Sanon et al., 2007; Kronberg and Malechek, 1997). In the research by Kronberg and Malechek, sheep spent more time foraging during the rainy season than goats did, but the amount of time spent during the dry season was comparable (Kronberg and Malechek, 1997). It was suggested that both animal species' need on browse plant species was the reason for their comparable dry-season grazing and rumination periods. In contrast, goats consumed comparatively more forage during the wet season. A group researcher discovered that goats and sheep covered less ground during the dry season than during the wet season (Schlecht et al., 2006).

Similar to the variations between wet and dry seasons, stocking rate can influence grazing behavior, albeit generalizations are once again challenging due to the dearth of accessible data and the multitude of affecting factors. Available fodder mass and nutritional value declined with increasing stocking rate in one specific co-grazing research (Animut et al., 2005 a,b) with pastures comprising a range of grasses and forbs. Both sheep and goats responded to these changes by traveling greater distances, spending more time grazing and standing, and spending less time sleeping, ruminating, and laying down.

5.1 Energy used in an activity

The most recent research and NRC have examined the extent and significance of MEa to small ruminant performance as well as the most likely causes or strongly associated components (Lachica and Aguilera, 2003; 2005; Sahlu et al., 2004; NRC, 2007). However, the impact of co-grazing sheep and goats on MEa has not gotten much attention, mostly because it is challenging to measure energy consumption. Some researchers observed that co-grazing sheep on grass-forb pastures used more energy than goats, while the difference in energy use might be attributed mostly to the higher growth rate of sheep (Animut et al., 2005a, 2007). One may hypothesize that unless co-grazing significantly affected the preferred fodder species and plant sections that could be harvested, mono-species grazing would not have a significant influence on MEa. In such cases, it would be reasonable to anticipate either a reduction in grazing duration or an increase in nutrient intake while maintaining grazing duration, since both would lessen the amount of MEa in relation to calorie intake and/or animal performance. On the other hand, opposing effects appear plausible when there is a large overlap in the plant material that is eaten by the two species and there is a noticeable amount of competition.

6. The Performance of Animals and Financial Gains

6.1 Animal performance

The impact of small ruminant co-grazing on performance can be observed at the animal or land area level. Per animal performance does not increase with co-grazing unless certain circumstances are met. Each species' stocking rate has to be as low as possible to avoid dietary overlap and competition for specific plant species and plant components. Additionally, eliminating food from one animal species should encourage the growth of forage that is highly nutritious or desired by other animal species. Taylor examined 20 years of data from the Texas Agricultural Experiment Station, which included a variety of grasses, forbs, and browse plant species (Taylor, 1985). She discovered that co-grazing with Angora goats and cattle improved the performance of the sheep (measured by ADG, wool production, and lamb crop percentage), but had no effect on the goats or cattle.

Conditions are frequently unfavorable to animals doing better individually as a result of co-grazing. For instance, in pastures containing oats (Avena sativa) and ryegrass (Lolium rigidum), Similar ADG by sheep and goats grazing together and apart was found (Norton et al., 1990a). Rarely, co-grazing has caused a species' performance to decline. According to review, mixed grazing of sheep and cattle improved sheep performance the most and sometimes decreased cattle performance (Walker et al., 1994). This led to the conclusion that, in situations where there was a shortage of forage, sheep were more competitive in their consumption of forage than cattle. Furthermore, co-grazing sheep and goats on grass-clover pastures enhanced the performance of the former but not the latter when compared to separate grazing.

Due to specific plant materials chosen and possibly a decreased ability to avoid areas high in sheep excreta compared to goats, a factor potentially involved in such findings with non-browse forages might be a greater internal parasite burden in goats when co-grazing with sheep than when grazing alone (Jallow et al., 1994). Accordingly, unsuitable conditions for the practice—such as higher than ideal populations of one or more species and/or a poor species selection—account for the negative performance impacts of co-grazing, which result in high levels of dietary overlap and fodder competition. Similarly, goats are frequently held responsible for the deterioration of grazing pasture.

6.2 Economic returns

Even though biological features of multi-species grazing are well studied, economic considerations are crucial when making this decision. Since land is an expensive input, forage systems need to produce enough per unit of land in order to yield a profit that is acceptable. Carrying capacity and overall productivity are increased by well-managed co-grazing (Glimp, 1985). According to one study, multi-species grazing raised carrying capacity, which resulted in a 15-20% increase in offtake per land area (Glimp, 1985). Multi-species grazing can increase economic returns even in cases where one species is less lucrative (Meyer and Harvey, 1985). Benefits such as immediate income increases and long-term range expansions need to be taken into account (Ospina, 1985; Schuster, 1985). Although larger inputs are also available for co-grazing, small ruminants raising cattle are more likely to benefit from them due to the greater similarity in demands between sheep and goats. Co-grazing has the potential to increase profitability and overall productivity, but input costs must increase proportionately to the increase in production.

3. Summary

Goats and sheep are different in several aspects that influence how they graze. When it comes to consuming particular plant species and components, as well as tolerance or readiness to eat less ideal forages, various species have distinct preferences and skills. These variations may

be utilized for co-grazing to increase production per unit land area across a range of vegetation conditions, most notably the presence of a wide diversity of plant species. However, because of the intricacy of the study and the variety of potential production scenarios, careful thought and reflection by knowledgeable advisors, along with feedback from producers, will be necessary for the successful field application of co-grazing, both at the beginning and throughout the grazing season.

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