Review

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Effects of Defoliation Frequency on Biomass Production on Selected Drought Tolerant Forage Legumes Intercropped with (*Chloris gayana*): Drought Mitigation Strategy and Solutions Review

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Review

The Effects of Defoliation Frequency on Biomass Production on Selected Drought Tolerant Forage Legumes Intercropped with (*Chloris gayana*): Drought Mitigation Strategy and Solutions Review

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Abstract: Incorporating knowledge of indigenous forage legumes or associated nutritional attributes in cultivated pastures has the potential to improve grazing conditions, rangeland conditions, and cattle productivity. Climate change and other site-specific factors such as land sizes and other grazing management practices play a significant role in food security, job creation, and environmental health. Several research results have reported that the utilization of forage legumes in most farming systems has proved to increase herbage yield and soil fertility. The major aim of this review is to elucidate the potential benefits of intercropping indigenous forage legumes such as cowpea (*Vigna unguiculacta* L.Walp) and Dolichols (*Lablab purpureaus*) intercropped with *Chloris gayana*, this is to assesses the principal advantages, productivity, and overall performance of forage legumes grown in conjunction with grasses. Moreover, this review seeks to provide insights into the optimal management practices for intercropping forage legumes with grasses. The promising feature of intercropping South African pastoral systems must target the ability of forage legumes in terms of performance and utilization of agro-symbiotic relationships of N_2 fixation symbiotic relationship in pastures. Moreover, this review aims also to address this knowledge gap by assessing the effects of defoliation frequency on the biomass production of selected forage legumes when intercropped with *Chloris gayana* in different growing seasons. By examining how varying defoliation frequencies influence biomass production, this review aimed to provide practical recommendations for optimizing forage management practices and promoting sustainable forage production systems. Through this investigation, we can gain insights into the complex dynamics between the defoliation frequency, intercropping systems, and biomass production.

Keywords: Defoliation frequency; biomass production; forage; legumes; intercropping

1. Introduction

1.1. Introduction

Intercropping, the practice of growing two or more plant species together in proximity, has gained significant attention in agriculture because of its potential to enhance productivity, resource utilization, and ecosystem sustainability [1]. South African pastoral farming system is vulnerable to water scarcity as it reduces biomass and livestock productivity. There so many forage species grown in the South African pastoral farming system and around the world which include Napier grass (*Pennisetum purpureum*), *Brachiaria*, and *Panicum species*[2]. A promising feature of intercropping combination involves the integration of forage legumes with *Chloris gayana*, a warm-season perennial grass which matches drought tolerant herbaceous legumes. *Chloris gayana* is a robust forage grass and known for its high productivity and adaptability to various environmental conditions. Forage legumes, such as alfalfa, clover, and soybean, can fix atmospheric nitrogen and improve soil fertility,

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while *Chloris gayana* provides a valuable grass component that contributes to overall forage biomass production. Many smallholder farmers in South Africa are challenged by an increase in protein shortages, especially during the dry season [3].

The management of defoliation frequency, or the frequency at which plants are cut or grazed, plays a crucial role in determining the growth, yield, and quality of forage crops [4] . Proper defoliation management is essential to balance the removal of aboveground biomass with the plant regrowth capacity and resource allocation, ensuring sustained productivity over time. However, the optimal defoliation frequency for maximum biomass production of forage legumes intercropped with *Chloris gayana* may vary depending on several factors, including species characteristics, environmental conditions, and growing seasons. Understanding the effects of defoliation frequency on biomass production during different growing seasons is of immense importance for optimizing forage management strategies and improving livestock feed availability[5]. Investigating the relationship between defoliation frequency and biomass production can provide valuable insights into the manipulation of intercropping systems to maximize forage yields and enhance overall agricultural sustainability. Previous studies have explored the impact of defoliation frequency on various forage crops, but there is still a need for more specific research focusing on the intercropping of selected forage legumes with *Chloris gayana*[6,7].

This review aims to address this knowledge gap by assessing the effects of defoliation frequency on the biomass production of selected forage legumes when intercropped with *Chloris gayana* in different growing seasons. By examining how varying defoliation frequencies influence biomass production, this review aimed to provide practical recommendations for optimizing forage management practices and promoting sustainable forage production systems. Through this investigation, we can gain insights into the complex dynamics between the defoliation frequency, intercropping systems, and biomass production. The findings of this review will contribute to a better understanding of the ecological and agronomic interactions within intercropped systems, helping farmers, researchers, and agricultural stakeholders make informed decisions regarding forage management practices, livestock nutrition, and sustainable intensification of forage production. Overall, the assessment of the effects of defoliation frequency on biomass production of selected forage legumes intercropped with *Chloris gayana* in different growing seasons has significant implications for optimizing forage production systems, enhancing livestock feed availability, and promoting sustainable agricultural practices in diverse agroecological contexts.

Importance of forage legumes on pastoral farming systems

Forage legumes play a vital role in feeding animals, increasing dry matter production, and enhancing cost-effective feeding practices in the livestock sector (Dinsa and Yalew 2022). Forage legumes are known to possess a wide range of potential benefits, which often result in the improvement of vegetation cover, soil fertility levels, and reduced methane gas emissions. The intercropping of legumes with natural grasses can yield positive results for herbage yield and nutritional composition in cultivated pastures. Cowpea *(Vigna unguiculatca. L Walp)*, *Dolichos(Lab lab)* are the common forage legumes that in most rural livelihoods in Africa. Moreover, the identification and inclusion of indigenous forage legumes play a significant role in addressing protein-related challenges and they provide huge amount N_2 fixation. Currently, knowledge of indigenous feeding strategies has increased over the years, which has encouraged the utilization of forage plants that adapt very well under unpredictable climatic conditions. The growth of the livestock industry and population demands have resulted in the adoption of different coping mechanisms for feed scarcity.

To ensure adequate forage quality and quantity, different forage legumes should be incorporated under different grazing conditions to optimize forage production. Climatic changes result in increasing temperatures that adversely affect vegetation production and cause a decline in livestock productivity.

1.2. Effects of Intercropping on Forage and Forage Utilization Efficiency.

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Traditionally, intercropping forage legumes and grasses often creates more room for more nutrients to improve soil fertility and crop utilization and to provide sufficient feed quantities to livestock during periods of feed scarcity. From this, livestock feeding will be improved when the practice is achieved because of the variety of legumes in providing a balanced diet for livestock. The major advantage of intercropping during grazing is the efficient use of biomass production and improved livestock performance compared to single-crop cultivation. A study conducted in Brazil showed that grass-legume intercropping can improve the dry matter yield of mixtures compared to that of sole grasses[8] . Therefore, intercropping legumes with grasses assists farmers in optimizing their quantity and quality. Furthermore, forage legumes encourage improved hay and silage production. During periods of feed scarcity, especially the dry season, forage legumes are likely to produce nutritious fodder in large quantities.

In a study conducted by [9] most of the herbaceous legumes in grazing areas can replace expensive proteins and provide the cheapest source of protein in winter. Legumes have been reported to play a significant role in fixing atmospheric nitrogen for crop production, thereby reducing the use of chemical fertilizers [10],[11] . The intercropping of legumes is very beneficial to most livestock farming systems in South Africa, due to their ability to rehabilitate nutrients in depleted soil[12] .

Nonetheless, the type of response to nitrogen fertilization can vary depending on the environmental conditions, genotype, cultivar, type of fertilizer applied, and time during the plant's growth cycle. Furthermore, perennial herbaceous legumes can be used in most livestock production systems in South Africa to restore grazing areas where grazing management is poor. It has recently been reported that grass-legume pastures form an extraordinarily powerful base for improving soil fertility. They are also regarded as the backbone of milk and beef production in southern Cape, South Africa.

1.3. Effect of Defoliation Frequency on Biomass Yield of Individual Forage Legume Species.

Intercropping systems that combine forage legumes with *Chloris gayana* have gained considerable attention in agriculture owing to their potential to enhance productivity and provide sustainable forage options. Proper defoliation management is critical for maximizing biomass production and maintaining the long-term sustainability of intercropped systems. Understanding the effect of defoliation frequency on the biomass yield of individual forage legume species, such as alfalfa, clover, and soybean, when intercropped with *Chloris gayana*, is essential for optimizing forage management practices and improving livestock feed availability. Defoliation frequency, defined as the frequency at which plants are cut or grazed, is a crucial factor that influences the growth and yield of forage crops. Different defoliation frequencies, including high, medium, and low, can have varying effects on biomass production, depending on the species and environmental conditions [13]. By exploring the response of individual forage legume species to different defoliation frequencies, we can gain insights into optimizing their biomass yields in intercropped systems. Alfalfa (*Medicago sativa*) is a widely cultivated forage legume that is known for its high biomass production and nutritional value. When intercropped with *Chloris gayana, the* biomass yield of alfalfa was significantly influenced by the defoliation frequency. Studies have shown that a moderate defoliation frequency, such as every 4–6 weeks, promotes vigorous regrowth and maximizes biomass yield in alfalfa. However, excessively frequent defoliation can reduce overall biomass production because of the limited time available for regrowth. Clover species, including red clover (*Trifolium pratense*) and white clover *(Trifolium repens*), are widely used as forage legumes in the intercropping systems. The effect of defoliation frequency on clover biomass yield varies depending on the species and management practices. A moderate defoliation frequency, such as every 4–5 weeks, has been shown to increase biomass production in clover species. However, it is essential to consider the growth habits and recovery ability of different clover species when determining the optimal defoliation frequency.

Soybean *(Glycine max)*, is a legume crop that uses both forage and grain, can potentially contribute to biomass production in intercropping systems. The effect of defoliant frequency on soybean biomass yield is influenced by a range of factors, such as growth stage, cultivar, and

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management practices. Soybeans are more sensitive to defoliation during reproductive stages, and excessive defoliation can negatively affect biomass production and seed development. Therefore, a lower defoliation frequency, such as every 6–8 weeks, may be more appropriate for maximizing soybean biomass yield in intercropped systems[6]. Understanding the effects of defoliation frequency on the biomass yield of individual forage legume species in intercropped systems is crucial for optimizing forage management practices and ensuring sustainable livestock feed availability. By comparing the performance of legume species, such as alfalfa (*Medicago sativa*), clover(*Trifolium spp),* and soybean(Glycine max) , under varying defoliation frequencies, we can identify optimal defoliation management strategies to maximize biomass production. This knowledge will contribute to the development of more efficient and sustainable intercropping systems, which will benefit both forage producers and livestock farmers.

1.4. Biomass Quality under Different Defoliation Frequencies.

Forage quality is defined to how well animals consume a forage and how efficiently the nutrients in the forage are converted into animal products [14]. However,[15] defines forage quality as concept that is based on the characteristics that affect consumption, nutritional value, and the resulting reduction of animal performance. It is therefore essential that the rangelands producers ensure that there are the highest levels of nutrient requirements to reduce the decrease of animal production such as beef, milk, and weight and reproductive efficiency and diseases (Fulgueira *et al.,* 2007). Forage quality information plays a crucial role in designing balanced rations formulations and bring solid foundation for fodder management plans.

Proper defoliation management, including the frequency at which plants are cut or grazed, is a key factor in optimizing the biomass quality. Defoliation frequency can significantly influence the nutritional quality of forage biomass. Different defoliation frequencies, including high, medium, and low, can affect parameters such as crude protein content, fiber content, digestibility, and energy value, thus affecting livestock nutrition and performance[5][16]. Understanding these effects is crucial for optimizing forage management practices and ensuring high-quality livestock feed. Crude protein content is a key indicator of forage quality, as it directly affects an animal's protein intake and subsequent growth or production.

Several studies have shown that defoliation frequency can affect the crude protein content in forage biomass. A moderate defoliation frequency, such as every 4–6 weeks, tended to maintain optimal crude protein content. Excessive defoliation frequency may lead to lower crude protein content because of reduced regrowth time and nutrient assimilation[17]. According to [17] the increase of defoliation intervals for 30-45 days, will also increase the productivity as well as morphological traits. Conversely, longer defoliation intervals might result in increased crude protein content due to plant maturity and the accumulation of structural proteins. The fiber content, including neutral detergent fiber (NDF) and acid detergent fiber (ADF), influences forage digestibility and intake. Defoliation frequency can affect the fiber content of forage biomass. Studies have shown that a higher defoliation frequency tends to decrease fiber content, particularly NDF and ADF, in forage biomass. Frequent defoliation allows for the harvest of younger, more tender plant materials with lower fiber content. However, an excessively high defoliation frequency may lead to reduced overall biomass production and compromised regrowth, which can adversely affect forage quality. Forage digestibility is a crucial factor in animal nutrition because it determines the efficiency of nutrient utilization. Defoliation frequency can affect forage digestibility by altering factors, such as plant maturity, lignification, and cell wall composition. Research has suggested that moderate defoliation frequencies, which allow for sufficient regrowth, tend to promote higher forage digestibility. However, excessive defoliation can reduce digestibility owing to an increased proportion of lignified tissues and reduced nutrient availability. Longer defoliation intervals may lead to decreased digestibility as the plant matures. The energy value of forage biomass, expressed as total digestible nutrients (TDN) or net energy, is a critical parameter in livestock diet. Defoliation frequency can affect the energy value of forage biomass by influencing crude protein content, fiber content, and digestibility[2]. Optimal defoliation frequencies, which promote a balance between

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biomass yield and quality, tend to maintain favorable energy values in forage biomass. High defoliation frequencies may result in a slight decrease in the energy value due to increased fiber content, whereas low defoliation frequencies might lead to higher energy values due to lower lignification and increased nutrient availability. The effect of defoliation frequency on forage biomass quality may vary in different growing seasons owing to environmental factors and plant growth dynamics[18]. Factors such as temperature, precipitation, and solar radiation can influence plant physiological processes and nutrient availability, thereby affecting the biomass quality. It is crucial to consider these seasonal variations when assessing the effects of defoliation frequency on forage quality. During certain growing seasons, such as spring or early summer, rapid plant growth and optimal environmental conditions may enhance the ability of forage crops to compensate for frequent defoliation[2]. This compensation may result in consistent or even improved biomass quality compared to other growing seasons. However, in seasons with limited growth potential or challenging environmental conditions, excessive defoliation frequencies may lead to reduced biomass quality, including lower crude protein content and increased fibre content. Assessing the effect of defoliation frequency on the nutritional quality of forage biomass is essential for optimizing livestock feed management and animal performance[19]. It is evident that defoliation frequency influences parameters such as crude protein content, fibre content, digestibility, and energy value, thereby shaping the overall forage quality. Moderate defoliation frequencies tend to maintain optimal biomass quality, while excessive or infrequent defoliation can have negative consequences. Furthermore, seasonal variations should be considered when evaluating the effect of defoliation frequency on biomass quality, as different growing seasons can influence nutrient availability and plant growth dynamics. By understanding these effects, farmers and livestock producers can implement appropriate defoliation strategies to maximize forage quality, improve animal nutrition, and enhance overall livestock productivity.

1.5. Interaction between Defoliation Frequency and Intercropping Patterns

Explore the combined effects of defoliation frequency and intercropping patterns on biomass production. Compare different intercropping arrangements (e.g., row intercropping, strip intercropping) and analyse how varying defoliation frequencies influence biomass production within these systems.

Table 1. Defoliation frequencies and biomass production in comparison.

Author	Defoliation frequency	Cropping systems	Effects
[8]	---	Grass legume intercropping	Cowpeas yielded 24% more soybeans than grasses single cropped.
(Sarabia-Salgado *et al.*, 2020)	35 and 50 days	Silvopastoral system	*Leucaena leucocephala* and *Panicum maximum* yields

			higher forage than monoculture pastures
(Garcia-Favre *et al.*, 2021)	250, 500, and 1000 growing-degree days	Mixed cropping system	biomass fraction of *Bromus valdivianus* (Bv) and *Lolium perenne* in the mixture was greater than (Bv) plants in monoculture
(Munyasi *et al.*, 2015)	4, 8, and 12 weeks	------	Napier grass cv Ouma yielded significantly higher than *Panicum maximum* and *Guatemala tripsacum* at all the three frequencies
(Iqbal *et al.*, 2017)	---	Row intercropping	Sorghum intercropped with cowpea had a 41% biomass increase

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			compared to sole cropping
(Ahmad *et al*., 2007)	--	Strip intercropping	A biomass yield of 32% increase was observed in intercropping *Sesbania snow* and Sorghum
(Maman *et al*., 2017)	------	Mixed cropping	biomass increment of 23-30% in mixed cropping was obtained at subsequent harvest in comparison to solo sorghum

1.6. Constraints on Livestock Productivity

1. South African livestock sector is dominated by smallholder farmers limited resources and less affordability to purchase fertilizers. South Africa falls under the rainfed agriculture and most rain fed livestock production are vulnerable to climate changes. The increasing temperatures results in production of low forages, thus reduces livestock productivity. However, there is also an increasing demand for nutritional feeds remains a challenge for livestock performances. Current researchers have reported that by 2050 the population numbers will be doubled by 9.7 billion[2], and animal protein demand will also increase. Therefore, the livestock sector is compelled to find different strategies that addresses dietary protein shortages. There is tremendous research work that has been done on legumes regarding soil improvement practices rather than animal feed production (Dube & Fanadzo, 2012), (Ncube & Twomlow, 2007). Forage legumes are capable to fix atmospheric Nitrogen. However, the knowledge on potential benefits indigenous legumes in the livestock sector is still extremely limited forage legumes have been used over the years increasing forage production, decrease the diseases and weed infestation rates ((Mfeka *et al.*, 2019).

2. Moreover, due this lack of reliable information warrants further investigation on the clear knowledge on formations of stable, sustainable fodder flow plans that will meet nutritional demands, and generate more profits particularly for resource poor farmers. According to (Venter et al.2020 reported that the plant responds differently at different of defoliation frequencies, but they are seldom studied and their interaction between defoliation frequency and soil nutrient content is reduced. (Del-Val & Crawley, 2005) reported, an understanding the effects of environmental

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conditions on plant vigour requires the study that will focus on wide range of range of activities more different vegetative stages. For instance, on the report prepared by (WRC,2016) suggested that there is a need for research that prioritizes the full focus on the best prospects of underutilized, drought tolerant, heat stress-tolerant, and nutrient-dense crops. This will further assist to address the poverty-unemployment inequality that focuses on all crop categories that will benefit the marginalized production areas[20] . [21]reported that there is wide array of legumes in Africa that have been used by indigenous people for centuries, however their full potential has never been realized. The potential benefits associated with indigenous forage legumes is also less realized in different South African agro-ecological zones (temperate and semi-arid regions) [22,23] . On the other hand, some studies have focused on the chemical composition such as chemical fertilizers in different environment growing conditions but there is still limited information that evaluate the nutritional profiles of local adapted forage legumes that can be used to supplement during period feed scarcity. Similar studies in Turkey have also confirmed that major technical constraint in livestock production is feed availability during dry season, is therefore critical that farmers looking new warm season plants that will meet these challenges. The defoliation frequency most suited forage legumes often produce positive benefits to on the species composition , the competitive abilities and increased persistence when grazed with other species [24,25].

1.9. Forage Plants Use for Intercropping Systems in South Africa

9. The potential legume species

10. *The Dolichos (Lab Lab purpureus*) is reported as multipurpose legumes with high herbage yield and good protein content, a valuable source of forage for improving growth performance during hot and dry periods. *Lablab purpureus* possess wide range of great qualities and it can be grown different environmental conditions. Dolichos *(Lablab purpureus*) is a high-yielding legume which adapt very well with minimum rainfall and management [26]. Dolichos belongs to *Fabaceae* family and has protein content which ranges from 13% to 24% depend on forage management practice such growing conditions and stage of harvest. Despite its adaptability, highly digestible biomass, abundant availability, and high nutritive value, especially, Lablab can also conveniently be used in ethno-veterinary medicine, to treat eye problems in sheep and lung problems in sheep, cattle, and goats. to have a higher in vitro digestibility than the legume forages [27]

13. *Dolichos purpureaus* Lablab (High worth) is Lablab a summer-growing annual legume, a high yielding forage legume which mostly cultivated for grazing, forage conservation in the sub-tropical and tropical farming systems. It is annual aggressive, drought tolerant summer legume grown for grazing, hay, and silage production. It is suitable for production of green manure and soil improvement. t is targeted for this research as a potential nitrogen fixer, based on its characteristics to be used as fodder for grazing animals, even suitable for zero grazing systems, producing better hay and silage for livestock feeds.

14. Cow pea (*Vigna unguiculacta* L. Walp) is an essential fodder for livestock that belongs to Fabacae family . [28]and often used as an alternative protein source during winter and dry season [29]. Cow pea is an important herbaceous legumes rich in crude protein content (27–43% and 21–33% [28] .In most rural livelihoods of South Africa , cow pea is a major source of food, cash, manure .Cowpea is also an important multi-purpose forage legumes which is largely consumed as grain in Africa. This crop has limited information and nutritive value, it is under-utilized in the value chain[29,30] , . It widely known for its ability very admirably and adapt in harsh environmental conditions such as drought prone areas and other biotic stressors.

16. The *Chloris gayana*, is typcal example of one of the local available especially in South Africa. The *Chloris gayana* belong to the *Poacae* family, which is also termed an excellent tropical grass is which originates and found another parts continent of Africa[31] . The Rhodes is summer grasses and is reported to suitable to be intercropped with the cover crops and produces highest dry matter. It has strong ability to protect against soil erosion. *C. gayana* is an important tropical grass widespread in tropical and subtropical countries. It is a useful drought tolerant plant that can used for pasture

establishment and hay production. These selected grasses are widely recognized for their characteristics adapting very well under harsh different condition.

17. *Choris gayana* respond very well at short grazing interval, and recovery after defoliation. The performance of *Chloris gayana* depends on different climatic conditions, herbage utilization efficiency, environmental conditions, and soil fertility. The *C. gayana* can produce 18 t DM (Dry Matter). Chloris gayana is tolerant under heavy grazing and suitable for hay production.Most grazing areas in South Africa more vulnerable to climate changes, of which some instances can tremendously impact on forage quality[32,33].

19. Effect of the climatic variability on grazing pattern and vegetation structure

20. Climatic and soil conditions are prime determinants of the adaptations of herbage species to any area, and climatic variations in form of seasons largely determine herbage quality[27] . Soil fertility degradation is also common problem in Africa which negatively affects the food production systems and causing severe losses of top soils and important plants many African countries, causing the loss of topsoil[28]. In the year 2015 and 2016, South Africa has experienced drought spells and increase rainfall variability [20] which led increase feed shortages and increased cull rates, high mortality rates, animal diseases during drought period which has adversely affected the livestock sector. Some research studies have reported that drought prevalence has become a topical subject for most livestock farmers in South Africa due to sporadic events of dry spells and low rainfall distribution. Drought stress reduces plant productivity, mineral absorption , assimilation rate ,net CO_2, transpiration rate and photosynthetic efficiency[34] .The droughts period also affect food security, and results into escalating food prices and livestock farmers resort to reducing livestock numbers[35] . Some research findings have also articulated that forage legumes play a very crucial role in livestock production productivity through improving soil fertility, particularly in rotation systems and can assist to mitigate the infestation of pests, diseases, and weeds [14].

21. On the other hand, South Africa is described as water stressed country, which is vulnerable to drought prevalence, which attributed by El-Lino (Muyambo et.al.;2016), characterised by the rainfall distribution that is erratic and unpredictable[36,37] . South Africa is under rain fed agricultural systems and the rain fed agriculture is extremely sensitive to sporadic events on climate changes. The climate changes calls famers need to be aware of the effects on livestock productivity and adaptation measures that should be employed to curb the negative effects of climate change that can have adversely effect on livestock productivity, feed availability and pasture yield [38]. Therefore, there is dire need for extensive research to profoundly investigate the nutritional attributes, species richness of indigenous forage legumes and associated potential benefits for production fodder banks during critical periods of feed scarcity.

23. As the same time, a sound knowledge and information for smallholder farmers and legislative approaches on indigenous forage is critical and must be revitalized with better understanding of the cost-effective feeding practices.

24. Concurrently, the effects of grazing pattern of livestock often vary among different soil types, pasture species, due to timing and intensity of defoliation and nutrient status of the pastures. The competitive ability of herbage plants needs to accurately be evaluate the grazing pattern, as well as the mechanisms of individual plant, and their response to defoliation and must be evidence-based data which can easily extrapolated to the affected the population and community levels[39] . [27] studied that these interactions often analysed on the basis competition of forage species and habitat space. [27] also suggeste the range or pasture producers must consider the optimal species mix, stocking and harvesting rates when integrating wildlife into livestock production system.

26 According to [40] reported that there are challenges facing the imported hay- producing cultivars and leguminous pastures that are less drought tolerant in South Africa grazing conditions a. Forage legumes can enhance carcass quality when fed to livestock [26] . [41] also confirms that it is crucial to assess the forage potential benefits of different legume that associated digestibility and animal performance, as to improve livestock feed shortage and protein security.

27. [42](reported that the seed of certain legumes has become an expensive input. For example, soya bean and dry bean seed which can cost up to R2 250/ ha and R3 307/ha respectively. Similar

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studies have reported that the nitrogen fertilization on grass plants is estimated to yield about 100kg N- ha-1 which can cause plant improvement with 50 % legume sward.

28. Effects of intercropping forage legumes in biomass production

29. The distinct benefit of intercropping pastures with the herbaceous legumes is to improve the nutritive value, biomass production and animal productivity[43] . The Intercropping as a traditional farming tool that increases species diversity which its core functions to reduce chemical inputs and minimizing negative environmental effects of crop production. For instance, the intercropping of baby maize and legumes is capable to enhance legume nodulation to of legume. The nodule biomass and ground cover have been reported to substantial quantities when intercropped with forage legumes as compared monoculture systems. However, the grazing behaviour of livestock, canopy structure and morphological traits of the plant will influence the preference or promotion of selection over other species.

Several researchers have reported on more established work on different forage plants intercropping with variety of that cereal/legume intercropping that an enhance N_2 fixation ability of legume for the intense competition of intercropped cereal for soil mineral N_2, as well as the increased dependence on symbiotic N2 fixation with great positive results in growth patterns in plants.

1.9. Forage Legume and Potential Benefits

Several studies have reported there is limited information that evaluates the potential benefits of indigenous forage legumes [29,44,45] . Most famers in South Africa are grappling the sustainable feeding strategy which cost effective that can benefit the resource-poor farmers for all production stages of livestock production. It is critical that, knowledge on indigenous forage legumes is extremely limited in South Africa[23] . Most smallholder farmers in South Africa are often negatively affected by many drought spells which often cause the spatial distribution of vegetation [46] . This research will provide the any opportunity of livestock farmer with cheapest source of protein. It is expected that the outcomes result of the field experiment will generate knowledge and information of the forage legumes nutritive could help livestock keepers with rapid decision making that will project the importance of timing and intensity of grazing to achieve the desired livestock commodities. The defoliation frequency is an important management that tool that affects dry matter production and nutritive value, and bring changes on the morphological traits and physiology of forage species[47].

On the other hand, some the familiar challenges that face livestock farmers due to the lack of the cheapest form protein. The stable and sustainable pastoral farming in South Africa is seeking for adaptive and coping strategies to produce food security and alleviate poverty during unprecedented climatic changes and seasonal variability. Currently, are reported livestock farmers are seeking new innovative solutions and current information on forage conversion. The innovative approaches must be directed the interest towards the agronomic practices of fodder conversion plays a have valuable contribution in lowering the risk on feed scarcity and generate more economic returns in the livestock sector.

The Western Cape is typically found under the Mediterranean climate[29] , which makes it no different from any Mediterranean region which is characterized by warm, dry summers and mild, moist winters and low summer rainfall prevail, which of often results s limited dry matter production during summer and winter from many pasture plants. However, the feed demands by animals are constant throughout the year. An alternative way for reducing the imbalances between supply and demand is to favour plant growth outside of the normal growing season [47]. Some studies have reported that many hays producing plants that are imported are less resistant to the harsh climatic conditions in South Africa. It is thus imperative that sound knowledge and understanding locally adapted forage legumes can offer better opportunities in pasture establishment and improvement in different agro-ecological zones, agro-biodiversity in South African pastoral farming system [20] . [47] suggests that the improvement of forage production outside the growing season, plant breeding should be considered in the Mediterranean area.

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The forage legumes are known to play vital roles in improving soil fertility [45] and have been widely used as source of supplying nitrogen, thus improving vegetative characteristics. This review will also assist to generate information that will improve the nutritional status, herbage yield and quality of nitrogen forages legumes. Furthermore, the benefits of forage legumes intercropped with grasses, will ultimately contribute towards improving food security, poverty alleviation and generating income for resource-poor smallholder farmers and assist reducing fodder imports in South Africa. Concurrently, there is need for extensive research that depict the role indigenous forage legumes its terms of their nutritional attributes, potential and production efficiency, and ultimately improve the understanding of defoliation response in harsh climatic conditions. Information on the nutritional status of indigenous is essential in the grazing management, fodder flow planning and allocation of feed resources. This information will further assist policy formulators, range ecologists, researchers, pastoralist in designing a sustainable fodder flow plan in the livestock sector. This information is also essential in developing countries. The recommendations that emanate from extensive research of indigenous forage legumes will increase the adoption of cultivars that are adapted to the local environmental conditions. Moreover, these innovative approaches must be considered to provide solutions to the socio-economic conditions for resource poor farmers. Moreover , defoliation frequency of legume seedlings can potentially help minimize stress and improve seedling establishment.[47] also confirms that the information on defoliation is limited in the traditional Mediterranean area and there is less research documented on effect of defoliation frequency , biomass production herbage value through intercropping of forage legumes in different times of the year.[4](suggested that also indicated that it is important the timing of defoliation must be controlled the herbage production , this done in balance the production and herbage utilization efficiency as highly affected by climatic conditions and morphogenesis in plants. Some research studies have also reported that the sward structure and response to defoliation are not only influence species adaptation, but the controlled defoliation practices can also improve sward productivity but can also assist in determination of herbage utilization efficiency by animals. [4] reported that defoliation can also affect the morphogenetic components of species composition, depend on the frequency and its intensity. This behaviour is driven by direct and indirect physiological and environmental conditions, which generates the carbon and nitrogen reserves. Therefore, it is imperative that clear understanding of the respective roles of these various physiological and environmental processes where defoliation, photosynthetic active radiation and light signals are discussed.

Conclusion

Climate variability continues to influence vegetation in many grazing conditions, which cause nutrient depletion and low forage production. The concerted efforts of forage producers should design and adopt cost effective feeding strategies that encourage availability of nutritional balanced forages to livestock. Based on several studies has shown that the understanding of defoliation management and forage production through intercropping is crucial in the improvement of the amounts of protein and dry matter production. Moreover, the understanding of climatic variation and growing of summer grasses and summer growing forage legumes serve a significant role in sustainability of fodder supply, ecosystems particularly during periods of feed scarcity.

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