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Leguminous Cover Crops Increase the Biomass and Nutritive Value of Grasses in South African Soils: A Review

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ABSTRACT

Due to the expansion of farming, many agricultural systems now depend more on chemical pesticides and inorganic fertilisers to boost farm output. Leguminous cover crops are used to improve soil fertility and to increase nitrogen availability for crop production. This review focuses mainly on evaluating the role of leguminous cover crops on soil's physical, chemical and biological properties. Furthermore, it focuses on the role of cover crops in crop biomass, grass nutritive value and crop-livestock grazing systems. This review used the Web of Science, Scopus and Google Scholar databases (accessed between January 2003 and December 2022). To find publications in the scope of the study, the authors combined different groups of keywords. The reviewed literature revealed that leguminous cover crops significantly increase yield due to an increase of nitrogen through nitrogen fixation. In addition, leguminous cover crops boost the forage's nutritional value, lowering feed costs and increasing livestock productivity. As a result of these findings, farmers can reap the benefits of leguminous cover crops in various ways, including enhancement of soil health, biomass, yield and reducing overall production costs.

Keywords: Biomass Production, Grass Nutritive Value, Legumes, Livestock Production, Soil Properties

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1. INTRODUCTION

The intensification of agriculture has led to many agricultural systems relying more on inorganic fertilisers and chemical pest control methods for increased productivity on farms (Altieri *et al.,* 2012). However, inorganic input costs are growing, and land degradation and environmental pollution have become a concern (Steinfeld *et al.,* 2006). As a result, the demand for affordable agricultural practices is growing (Ricker-Gilbert, 2020). Soon, the sustainability of crop production will rely on managing primary resources (soil and water), which will be directed towards environmentally friendly practices, especially for the topsoil. The term 'topsoil' refers to the soil's organic matter and nutrient-rich component in the first 5 to 20 centimetres (Mills & Fey, 2003). The topsoil is crucial for plant growth due to its high fertility, moisture retention, support for root systems and microbial activity. About 60% of South African topsoil is susceptible to degradation due to losses in organic matter (Mills & Fey, 2003). Among other factors, losses in organic matter from the topsoil can be caused by intensive tillage, monocropping, overgrazing, poor crop residue management, soil erosion, and poor irrigation practices. Land degradation is one of the primary causes of low crop yields, especially among South African subsistence farmers, primarily located in marginal areas (Parwada & Van Tol, 2020). In arable land, low crop yields could be due to soil acidification, compaction, crusting, erosion, and nutrient decline. As a result, soil regenerative management strategies are required. It is a known fact that comprehensive soil preparation practices, such as tilling or mowing, combined with crop residue removal, exacerbate arable land degradation and soil deterioration by depleting soil organic matter and leaving the soil exposed to climate-related risks such as water and wind erosion (Lötter, 2017). One of the management strategies to overcome these challenges is the incorporation of cover crops within cropping systems for improved soil health and crop productivity (Ricker-Gilbert, 2020). Generally, legumes are some of the cover crops grown to safeguard and enhance soil quality (Teasdale *et al.,* 2007). They are primarily used for their ability to fix nitrogen (N) from the air and store it in nodules in their roots. Nitrogen fixation is a biological process through which atmospheric nitrogen is converted into a form that plants can utilise (Selim *et al.,* 2019). Legumes can be applied to the soil as living or dead mulch and incorporated into the soil as green manure (Teasdale *et al.,* 2007). The biological N fixation by leguminous cover crops can decrease the requirement for N fertilisers in the follow-up crop. In addition, leguminous cover crops can aid in pest and weed control in cropping systems (Baligar & Fageria, 2007).

Cover crops are commonly cultivated during the dormant season between the preceding year's primary crop and the establishment of the subsequent primary crops (Teasdale *et al.,* 2007). However, productive cover cropping necessitates planning, selecting appropriate cover crops, and planting and terminating them at the appropriate times (Roesch *et al.,* 2018). Thus, cover crops could be most beneficial if they are managed as an integral part of the cropping system rather than as an afterthought. Acceptable cover crop species that offer adequate biomass generation to protect the outermost area of the soil and introduce other advantages to enhance the production of subsequent cash crops need to be identified (Mahama, 2015). The overall objective of this paper is to summarise the prospective effect of leguminous cover crops on the increase of biomass and nutritional value of companion plants.

2. MATERIALS AND METHOD

A literature review that focused on the effects of leguminous cover crops on the biomass of grasses and nutritional value in South African soils was carried out using the Web of Science, Scopus and Google Scholar databases (accessed between January 2003 and December 2022). Additionally, reputable online repositories and institutional websites were accessed to gather relevant information. To find publications in the scope of the study, the authors combined different groups of keywords: “legumes”, “leguminous cover crops” “biomass production”, “grass nutritive value”, “soil properties”, “livestock production”, “chemical properties”, “physical soil properties", “crop integration”, “livestock grazing”, “cover crops and their success in South Africa”, “integrated crop-livestock system” and “inorganic fertilisers”. Moreover, the keywords were combined with Boolean operators (such as AND, OR) to refine the search and ensure the retrieval of relevant literature. The search results were screened based on the titles and abstracts to assess their relevance to the research topic. Non-relevant or duplicate articles were excluded at this stage. The remaining articles were selected for a full-text review. The authors also checked the references in the collected papers to broaden the search. The key findings, concepts, and insights from the reviewed literature were summarised and synthesised. The information was then used to address the research objectives, subtopics, and research gaps identified in the review.

3. POTENTIAL EFFECT OF LEGUMINOUS COVER CROPS ON SOIL PROPERTIES

Leguminous cover crops have received a lot of interest in environmentally friendly agriculture because of their ability to enhance soil properties (Fróna *et al.,* 2019). Among others, these cover crops include plants like clover (*Trifolium repens*), vetch (*Vicia sativa*), peas (*Pisum sativum*), and beans (*Phaseolus vulgaris* L.) (Fróna *et al.,* 2019). Understanding the prospective influence of leguminous cover crops on soil properties is critical for their management and maximising their uses based on their advantages. One of the possible advantages of leguminous cover crops is their capacity to improve soil structure (Devereux *et al.,* 2012). The extensive root systems of leguminous cover crops can loosen the soil, forming channels and pores that improve soil aggregation (Demir, 2020). Additionally, cover crops are a vital factor in environmentally friendly agriculture because of their unique ability to fertilise soil, prevent soil erosion, increase nutrient availability, and encourage organic matter accumulation (Adetunji *et al.,* 2020). Recognising and exploiting these effects allows farmers and land managers to use leguminous cover crops as a valuable tool to advocate environmentally conscious and productive agricultural systems (Blanco-Canqui *et al.,* 2015).

3.1. Soil Biophysical Properties

Soil bulk density, porosity, texture, water retention, and soil temperature are the primary physical soil properties that impact soil quality and are significantly affected by cover crops (Blanco-Canqui & Ruis, 2020). Some factors that influence soil's physical properties are the number of particles, particle distribution, and circulation of gases and liquids underneath the soil (Blanco-Canqui *et al.,* 2012). According to Horn and Smucker (2005), these factors collectively influence the shape and structure of the soil. Likewise, the complicated root systems of leguminous cover crops provide outstanding ground cover for improved water retention (Bergtold *et al.,* 2019) and reduce the possibility of soil erosion (Sharma *et al.,* 2018). When cover crops are harvested and incorporated into the soil, they add to the organic matter pool and improve the accessibility of additional vital nutrients (Hubbard *et al.,* 2013). Moreover, covering crops encourages microbial activity and nutrient cycling in soils and helps to improve long-term soil fertility and endurance by encouraging organic matter build-up (Steele *et al.,* 2012). Generally, cover cropping practices can assist in decreasing soil degradation, enhancing soil health, and increasing productivity in the long term.

3.2. Soil Chemical Properties

Incorporating and degrading crop residues into the soil can modify soil chemical properties (Coppens *et al.,* 2006). Work done by Dabney *et al.* (2010) shows that cover crops are a cost-effective and practical approach to increasing soil organic matter and overall soil quality. A study by Dube *et al.* (2014) found that soil organic matter contains almost all the nitrogen necessary for optimal crop growth and a significant amount of phosphorus and sulphur. Furthermore, Newman *et al.* (2007) demonstrated that soil organic matter is crucial in enhancing soil's cation exchange capacity (CEC), enabling it to retain and store essential macronutrients effectively. Additionally, cover crops may change soil pH by balancing organic acids and alkaline compounds (Harasim *et al.,* 2016). Preserving a suitable pH balance in the soil is critical for effectively accessing nutrients and microbial growth. As most cover crops decompose, they generally ameliorate soil acidity and discharge nutrients back into the soil, restoring the nutrient pool and enhancing nutrient accessibility to subsequent crops (Harasim *et al.,* 2016).

Worth noting is that certain cover crops, such as rye or oats, emit organic acids throughout their decomposition, which may temporarily decrease soil pH (Garrigues *et al.,* 2012). This acidification process may be advantageous for crops that favour slightly acidic environments, such as radishes (*Raphanus sativus*), sweet potatoes (*Ipomoea batatas*), and tea (*Camellia sinensis*) (Mukumbareza *et al.,* 2016). Conversely, due to their nitrogen fixation process, leguminous cover crops release alkaline compounds that can raise soil pH levels (Yu *et al.,* 2014). By regulating soil pH, cover crops create an environment conducive to nutrient uptake and microbial activity, ultimately enhancing soil fertility (Latati *et al.*, 2016). Farmers can optimise the accessibility of nutrients, enhance soil fertility, and decrease the need for artificial fertilisers by integrating cover cropping practices into their agricultural systems. Thus, covering crops benefits the general resilience and sustainability of farming systems.

4. LEGUMINOUS COVER CROPS AND SUCCESSIVE CROP BIOMASS PRODUCTION

Through nitrogen fixation, leguminous cover crops can influence vegetative growth and crop productivity of succeeding crops (Kocira *et al.,* 2020). Research carried out in Brazil found that using sunn hemp *(Crotalaria juncea*) as a cover crop increased the biomass generated by maize (*Zea mays)* by 66% compared to a fallowed treatment (Barros *et al.,* 2020). Similarly, Maris *et al.* (2021) found a 58% biomass increase in maize due to soybean (*Glycine max)* cover cropping. A study by Daniel *et al.* (2021) compared leguminous cover crops with non-leguminous cover crops and found that planting leguminous cover crops that included cowpea (*Vigna unguiculata*) and hyacinth bean (*Lablab purpureus*) (similar to the bean) elevated maize biomass production by 60%. Comparably, research undertaken in the United States by Muhammad *et al.* (2022) discovered that utilising hairy vetch (*Vicia villosa*) and crimson clover (*Trifolium incarnatum*) substantially boosted the biomass production of maize and soybean crops.

Furthermore, Li *et al.* (2021) ran a meta-analysis of 88 studies on legume cover crops and discovered that they raised the biomass production of subsequent crops by an overall of 24.6%. The meta-analysis also found that the effect of leguminous cover crops on biomass production differed according to several variables, including the type of legume used, the length of time of the cover crop, and the management practices used. Another important factor is the higher soil nitrogen content (due to symbiotic nitrogen fixation), which encourages faster mineralisation of incorporated leguminous plant residues, facilitated by the lower C: N ratio of legumes' biomass (Toom *et al*., 2019). This is advantageous to the succeeding crop as a large C: N ratio (80:1 to 100:1, typically from stalks of cereal plants) can result in reduced N mobilisation and lower N availability.

The findings of the most recent research on the effects of using different leguminous cover crop species on the biomass production of various crops grown in different environments are summarised in Table 1. However, the species should be selected and managed efficiently to obtain the maximum benefits from leguminous cover crops. Some factors to consider when choosing leguminous cover crop species are their ability to adjust to local climates and soil conditions and the intended purpose of soil management. The management purposes may include the species' capacity to grow quickly enough to protect the soil and provide enough biomass (Khatri-Chhetri *et al.,* 2017). Additionally, most cover crops that thrive in tropical areas may be unable to endure harsh winters. Some commonly used cool season cover crops include winter hairy vetch, medics and red clover; however, sunn hemp, cowpea and soybean are widely used for the warm season (Ruis *et al.* 2019).

Vol. 53 No. 1, 2025: 61-85
10.17159/2413-3221/2025/v53n1a17571

TABLE 1: Recent Studies on Legume Cover Crops and Their Effect On Subsequent Crop Biomass Production

Reference	**Legume Cover Crop**	**Subsequent Crop**	**Soil type**	**Results** (compared to control plot) Yield increase (%)
Abd-El-Mageed *et al.* (2022)	Cowpea and Peanut	Maize	Sandy soil	38 and 42
Akintoye *et al.* (2023)	Velvet Bean	Cassava	Loamy sand soil	87
Zhang *et al.* (2021)	Faba Bean and Hairy Vetch	Wheat	Degraded sandy loam soil.	40 and 34
Gaihre *et al.* (2020)	Cowpea & Sunn Hemp	Maize	Sandy soil	12 and 8
Vann *et al.* (2019)	Hairy Vetch & Pea	Soybean	Sandy loam soil	17 and 10
Tyagi *et al.,* 2018	Chickpea & Berseem Clover	Wheat	Sandy loam soil	27 and 18
Adnan *et al.* (2022)	Cowpea and Mung Bean	Maize	Sandy soil	13 and 8
Nadeem *et al.* (2021)	Hairy Vetch and Faba Bean	Maize	Loamy sand soil	14 and 11

5. ROLE OF LEGUMINOUS COVER CROPS IN COMPANION GRASS NUTRITIVE VALUE

Using legumes as a cover crop can enhance forage yield and quality and decrease dependence on external sources of nitrogen (Scholberg *et al*., 2010; Stagnari *et al*., 2017). Fernandez *et al.* (2021) conducted a study that looked at the consequences of four distinctive leguminous cover crops (clover, vetch, cowpea, and peanut [*Arachis hypogaea*]) on the yield and nutritional value of Bermuda grass (*Cynodon dactylon*) hay. It was discovered that all four legume cover crops enhanced the crude protein content of the hay, with cowpea being the most effective. Furthermore, it was found that the leguminous cover crops increased the digestibility and energy content of the hay. Additionally, a study by Fernandez *et al.* (2019) found that using legumes improved the crude protein content of lucerne (Medicago sativa)/grass mixtures and the accessibility of nitrogen and phosphorus in the soil. Crude protein content is directly influenced by the plant absorption of nitrogen (da Silva Santos *et al.,* 2021). A study by Balehegn *et al.* (2020) discovered that the integration of legumes in mixed grass pastures elevated the consumption of the forage and improved its digestibility by cattle. An additional potential benefit of leguminous cover crops is the expansion of the grazing season, which may lead to an increased supply of livestock forage. Phillips *et al.* (2021) also found that establishing leguminous cover crops after harvesting maize silage offered more forage for grazing cattle while improving the overall nutritional value of the forage. In another study, Bruce-Smith (2020) investigated the consequences of integrating lucerne as an additional crop to grass in grazing systems. It was discovered that lucerne boosted the protein content of the forage and the rate of forage accumulation, which led to a raised carrying capacity and stocking rate for grazing animals. A similar trend of increased nutritive value (crude protein and digestible energy content) was also observed with other legume cover crop species, such as red clover, when established for a more extended period (Khatiwada *et al.,* 2020), vetch and clover (Sharma *et al*., 2018) and lucerne, which improved the weight gain of beef cattle grazing on the pasture (McDonald *et al*., 2021). These results were similar to those of Corleto *et al.* (2019), who discovered that legume integration elevated the grass's forage yield and protein content.

Ball *et al.* (2020) found that incorporating legume cover crops into a mixed sward of grasses reduced nitrogen leaching and increased soil organic matter content compared with pure grass swards, which was beneficial to soil and plant nutrient management. The literature demonstrates that integrating leguminous cover crops into companion grass systems may enhance forage nutritional value and efficiency, benefiting farmers and livestock producers by decreasing the requirement for purchased feed and improving animal performance. Additionally, by decreasing the need for synthetic nitrogen fertilisers and strengthening soil health, using legumes as cover crops may benefit the environment.

6. LEGUME SPECIES USED AS COVER CROPS AND THEIR SUCCESS IN SOUTH AFRICA

Leguminous cover cropping has been used successfully in various farming methods throughout South Africa, including conservation agriculture, smallholder farming, and commercial agriculture (Swanepoel *et al.,* 2018). The hyacinth bean (the dolichos bean) is a popular legume cover crop in South Africa (Muzangwa *et al.,* 2017). Mupangwa *et al.* (2017) assessed four legume species as cover crops in maize production; apart from the hyacinth bean, the other species were cowpea, soybean, and velvet bean (*Mucuna pruriens*). The study confirmed that leguminous cover crops increased soil fertility, decreased weed populations, and improved maize yields by up to 24%.

Otto *et al.* (2020) investigated the efficacy of hyacinth bean, cowpea, and velvet bean in sugarcane production *(Saccharum officinarum).* Their research found that the legumes enhanced soil health, decreased weed populations, and elevated sugarcane yield by up to 22%. These findings aligned with an earlier study by Thierfelder et al. (2013), who found enhanced soil fertility, minimised weed density, and elevated maize yield (up to 31%). In a maize-based cropping system in KwaZulu-Natal, Sebetha (2015) examined the efficacy of four legume cover crops—hyacinth bean, cowpea, soybean, and pigeon pea (*Cajanus cajan*). Sebetha (2015) found that all four legume cover crops raised soil fertility and maize yields. Hyacinth bean and cowpea were the most successful at weed suppression (Sebetha, 2015).

In South Africa's Eastern Cape province, a study by Phophi *et al.* (2017) compared the growth and yield of maize crops planted after various legume cover crops, such as hyacinth bean, cowpea, and velvet bean. The research found that maize established after legume cover crops produced substantially greater yields than maize planted without a cover crop. In addition, soil fertility was enhanced, as demonstrated by increased soil organic matter and plant-available nitrogen levels. Table 2 shows some legume species grown as cover crops in South Africa, as well as how well they perform in different soil types. This data provides an idea of the ideal soil conditions for each legume species. These findings indicate that legume cover crops can

Vol. 53 No. 1, 2025: 61-85
10.17159/2413-3221/2025/v53n1a17571

be useful for enhancing soil health and crop yields in South Africa. However, the effectiveness of leguminous cover crops differs based on soil type, climate, and farming practices, so site-specific research is necessary to tailor cover crop selection and management to local conditions.

TABLE 2: Common Species of Legume Cover Crops and their Success in South Africa's Various Soil Requirements

Legume species	**Success in South Africa**	**Soil type requirements**	**Reference**
Cowpea	High	Well-drained, sandy loam	Caradus *et al.,* 2023
Hyacinth bean	Moderate	Well-drained, loamy soil	Ema *et al*., 2022
Peanut	High	Well-drained, sandy loam	Bertino *et al.,* 2023
Lucerne	High	Well-drained, loamy soil	Nguyen *et al*., 2022
Clover	High	Well-drained, sandy loam	Caradus *et al.,* 2023
Lupins	High	Well-drained, sandy loam	Mupambwa & Wakindiki, 2012
Hairy vetch	High	Well-drained, sandy loam	Fourie *et al.,* 2021
Sunn hemp	High	Well-drained, sandy-loam	Gura *et al.,* 2023
Medics	Moderate	Well-drained, sandy loam	MacLaren *et al.,* 2021

7. COVER CROP INTEGRATION WITH LIVESTOCK GRAZING

Soil erosion, nutrient depletion, and greenhouse gas emissions are all major issues confronting agricultural systems worldwide. In recent years, there has been an increasing interest in sustainable farming practices to address these issues, including incorporating cover crops with livestock grazing (Scholberg *et al.,* 2010; Stagnari *et al.,* 2017). Scholberg *et al.* (2010) reported that cover crops and livestock grazing are two agricultural practices that have received much focus because of their potential for environmental and economic benefits. In grazing fields, cover crops are planted to boost soil health, prevent erosion, and enhance nutrient cycling. Integrating cover crops with livestock grazing is a promising approach for long-term agriculture (Roesch-McNally *et al.,* 2018). It offers various environmental and agronomic benefits, including soil erosion management, nutrient cycling, weed suppression, and enhanced soil health (Stagnari *et al.,* 2017). Properly managed grazing on cover crops may offer excellent forage, which might improve livestock performance while decreasing the need for supplementary feed (Hedley, 2015). Overgrazing, on the other hand, can harm both forage production and soil health. Williford *et al.* (2019) found that as animals move and graze, they can compact topsoil layers and improve soil structure, infiltration, and root penetration. Livestock add organic matter through manure deposits and enhance soil health by boosting organic carbon content and promoting microbial activity (Ewing, 2020). Gaskin et al. (2021) found that grazing animals successfully restricted weed growth by trampling, uprooting, and eating weed species. Likewise, combining livestock grazing and cover crops reduced the need for herbicides while providing an alternative, long-term weed management strategy (Gaskin *et al.,* 2021). Some cover crops have allelopathic properties or physical characteristics that inhibit weed growth. The allelopathic properties of such cover crops may cause growth challenges for the follow-up cover crop if volunteer plants are not carefully managed. Therefore, encouraging the usage of cover crops in conjunction with livestock grazing is critical for expanding sustainable agricultural systems.

8. LEGUME COVER CROPS' ECONOMIC BENEFITS UNDER INTEGRATED CROP-LIVESTOCK SYSTEMS

Integrated crop-livestock systems (ICLS) are growing in popularity owing to their capability to improve agricultural sustainability, productivity, and profitability (Cortner *et al.,* 2019). Knowledge of the economic benefits of legume cover crops is critical for farmers seeking to implement sustainable and profitable farming practices. Roesch-McNally *et al.* (2018)

investigated the economic advantages of legume cover crops in a maize-soybean rotation incorporated with cattle foraging. They found that incorporating legume cover crops decreased nitrogen fertiliser costs and enhanced livestock feeding efficiency, resulting in a projected net return increase of R3378.97/ha. Similar research conducted by Macholdt *et al.* (2021) pointed out that incorporating legume cover crops minimised the need for synthetic nitrogen fertilisers, which resulted in cost savings of R1126.33/ha and a 10% increase in wheat yields. Furthermore, legume cover crops supply high-quality forage for cattle, lowering feed costs and increasing livestock productivity. Blanco-Canqui *et al.* (2022) performed a meta-analysis to assess the economic benefits of incorporating legume cover crops into maize and soybean systems. Their findings implied that including legume cover crops resulted in a 27% decrease in nitrogen fertiliser costs and a 5% increase in crop yields, resulting in an average net economic benefit of R2342/ha. A similar study by Qin *et al.* (2021) revealed that incorporating legume cover crops reduced nitrogen fertiliser costs by 52% while increasing soybean yields by 7%. Karthik *et al.* (2021) reported the economic gains of incorporating legume cover crops into a mixed farming system that included cereal crops and sheep grazing. Their results suggested that including legume cover crops reduced synthetic nitrogen fertiliser costs by 30% and increased lamb growth rates by 15%.

Moreover, Vázquez-Espinosa et al. (2020) concluded that incorporating legume cover crops (such as cowpea and soybean) improved soil fertility, decreased the need for chemical fertilisers, and increased maize yields, resulting in higher economic returns for farmers. Furthermore, incorporating pigeon peas and hyacinth beans reduced pests and weeds, leading to higher maize yields (Daryanto *et al.,* 2018). Research shows that legume cover crops improve cost-effectiveness by lowering fertiliser costs, suppressing weed growth, and reducing the need for herbicides. Also, legume cover crops provide high-quality forage for livestock, increasing animal productivity and lowering external feed costs.

9. LIMITATIONS

Several abiotic and biotic factors can reduce legumes and nitrogen-fixing bacteria's ability to fix nitrogen (Kasper *et al*., 2019). Therefore, it is necessary to inoculate legume seeds with *rhizobia* strains before planting them. Adequate soil moisture is required for legume cover crops to fix nitrogen effectively. Hence, leguminous seeds should be planted when the soil is moist e.g., during the rainy season or under irrigation (Kasper et al., 2019). A deficiency of nutrients such as molybdenum and phosphorus can seriously affect nitrogen fixation and nodulation, while high nitrogen levels in the soil inhibit nitrogen fixation (Kasper *et al*., 2019). Some cover crops may serve as hosts for insects and pathogens; therefore, it is important to carefully select cover crop species, considering the pests that affect main crops (Lu *et al*., 2015). Other limitations include the cost of purchasing and establishing leguminous cover crops, especially for smallholder farmers, due to possible cash flow constraints. Increased labour costs for managing cover crops and purchasing the appropriate machinery to plant, harvest and terminate cover crops can increase production costs. The required cover crop farming machinery includes mowers, no-tillage seeders and transplanters (Lu *et al*., 2015). Because harvesting the main crop is the priority, cover crops are typically planted later rather than earlier (Kaspar, 2008). Lastly, covering crops does not yield results immediately, which may increase production costs as the farmer needs to spend money on operational costs (Hoorman, 2009; Silwana *et al.,* 2023).

10. CONCLUSION AND RECOMMENDATIONS

Leguminous cover crops can significantly increase grasses' biomass and nutritional value in South African soils. They have special qualities in establishing mutually beneficial partnerships with *rhizobia*, which are nitrogen-fixing bacteria. There are several advantages to incorporating leguminous cover crops into grassland systems. These include the ability of legumes to contribute to the general biomass of the system by supplying organic matter to the soil. Furthermore, the increase in organic matter benefits grass growth by improving soil structure, moisture retention, and nutrient cycling. Leguminous cover crops also have greater nutritional value than grasses since they comprise higher protein levels and other vital nutrients. Including legumes as cover crops can be particularly advantageous in South African soils, which mostly have low fertility and restricted availability of external inputs. It is essential to remember that the efficacy of legume cover crops for improving biomass and nutritional value may vary based on various factors, including the legume species used, soil conditions, climate, management practices, and crop rotation approaches. To maximise the advantageous effects of cover crops in South African soils, it is suggested that suitable legume species be chosen and cover crops be managed in accordance with the specific circumstances.

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Vol. 53 No. 1, 2025: 61-85
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