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Review

Fodder Radish as a Potential Alternative Feed Source for Livestock in South Africa

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Abstract: The agricultural sector receives substantial support from livestock, which greatly contributes to the well-being of rural communities. Livestock offers animal-derived products, such as meat and milk, which serve as abundant protein sources for human consumption. While the majority of South Africa's agricultural land is suitable for livestock farming within the smallholder sector, these farmers often face a variety of challenges. Among these challenges, there is insufficient access to superior forage resources, resulting in the limited availability of high-quality feed. Traditional nutrient sources for ruminants, such as soybean meal, grain, sunflower meal, and fish meal, are employed as supplementary feeds to provide exceptional nutrition and improve animal performance. Nonetheless, they present logistical, economic, and environmental challenges. To circumvent these challenges, smallholder producers have turned to leguminous trees, including *Vachellia* species and other locally available feed resources. They are utilized as feasible and cost-effective alternatives to supplement livestock, especially during periods of extended drought. However, these locally available feed resources exhibit inherent limitations, including thorn presence, high fiber content, low digestibility, and the presence of anti-nutritional and toxic factors. Cool season forage crops such as fodder radish present promising alternatives as autumn and winter forages for these farmers. Despite being widely used globally as a supplement for livestock during winter, fodder radish remains relatively underutilized, particularly among smallholder farmers. There is a scarcity of comprehensive information regarding its chemical composition, nutrient utilization, and remarkable potential to revolutionize livestock production, especially within the smallholder sector. Most of the available literature demonstrates the positive effects of fodder radish on soil structure, soil carbon and nitrogen levels, weed suppression, and other benefits. This paper systematically reviews the current state of knowledge on the nutritive value, opportunities, and challenges associated with the utilization of this crop in the cooler eastern regions.

Keywords: cool season crops; *Brassica* crops; fodder radish; animal nutrition

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1. Introduction

The agricultural industry holds great potential for improving the welfare of rural communities on a global scale, with livestock farming being a fundamental component. For many years, livestock production has been recognized as the keystone of agriculture, playing a crucial role in supporting the livelihoods of people in rural areas [1,2]. The significance of livestock farming in the agricultural community cannot be overstated, given its essential contribution to food security and rural development worldwide [3]. Livestock plays a crucial role as a significant supplier of animal-derived food, including meat and milk, which serve as protein sources for human consumption [4]. The livestock sector accounts for about 40% of the global agricultural GDP and employs over one billion people worldwide [5]. Moreover, the industry provides employment opportunities for at least 1.3 billion individuals and serves as a significant source of income for one billion smallholder farmers living in impoverished areas of developing regions [6–8]. Livestock producers frequently face a variety of obstacles, with the utilization of low-quality animal feed being one of the foremost hindrances [9].

Commercially available supplemental feeds, such as soybean meal, yellow maize, sunflower meal, fish meal, and others, are used for high-quality nutrition to improve animal performance, especially in commercially managed herds [10,11]. These popular high-protein and energy supplements are extensively used in livestock production for several decades [11–13]. They are incorporated into feed formulations for poultry, swine, and ruminants, as they enable these animals to efficiently utilize dietary nutrients [14–18], making these feed sources well-rounded ingredients that have helped to support optimal animal growth, health, and productivity for years. Despite the obvious benefits, these commercially available feed ingredients confront smallholder livestock farmers with some logistical, economic, and environmental difficulties. For example, they place a significant financial strain on livestock producers, frequently surpassing 70% of their overall operational expenses [10]. The over-reliance of the animal feed industry on fossil fuels raises questions regarding the environmental sustainability of these ingredients [11]. These factors work in concert with many others, rendering commercially available feed ingredients inaccessible to smallholder farmers, who are the majority of livestock farmers in South Africa (SA) [11,12].

Smallholder farmers have utilized trees and browse species for centuries as a feasible forage alternative and nutritious supplement, especially during dry seasons when rangeland vegetation is dormant [13–15]. The incorporation of leguminous trees, like *Gliricidia sepium*, *Sesbania sesban*, and *Vachelia* species, and other locally available forage resources into livestock diets is gaining popularity in SA with the aim of not only boosting rumen digestion but also controlling internal parasites and reducing methane production in ruminants [16–18]. Nevertheless, several limitations restrict the use of locally available forage resources. For example, the presence of thorns and spines on *Vachellia karroo* and many other browse species may cause injury to the animals or make it difficult for them to consume the foliage [19,20]. Moreover, excessive fiber content and ant-nutritive factors like tannins and toxic compounds also negatively affect feed intake, organic matter digestibility, and net energy in locally available forage resources, especially in woody species [19,21].

Drought-tolerant forage crops can effectively address fodder shortages typically experienced in winter, either independently or when used alongside browse materials. Cool-season forage crops, particularly fodder radish (also known as Japanese radish), have been identified in the literature as an alternative forage option during autumn and winter for livestock farmers, providing high-quality forage biomass in situations where browse species fall short of supplying sufficient feed to livestock [22–28]. These crops alleviate the need for stored feeds during winter by offering abundant high-quality forage biomass [22,29]. Within the category of cool-season forage crops, *Brassica* crops stand out as highly valuable for ruminants due to their nutritional richness, adaptability to diverse soils and climates, and ability to fill the feed gap during fall and winter [29–31]. Common *Brassica* crops utilized for this purpose include turnips, rape, kale, swedes, and fodder radish [32]. Azo et al. [33] presented evidence supporting the viability of *Brassica* crops as alternative forage sources, enabling the extension of the grazing season to enhance ruminant productivity. Fodder radish, a pivotal annual or biennial vegetable crop within the *Brassicaceae* family, is commonly employed as animal fodder [34,35].

Fodder radish exhibits various cultivars that maintain high productivity, even in autumn and winter, with short growth cycles [36]. This productivity, combined with its ability to produce nutritious forage rapidly, has elevated it to a significant crop globally [37,38]. Fodder radish is used as a cover crop, a monoculture crop, and as part of mixed crops with small grains like winter wheat, oats, rye, and triticale, as well as warm-season annual crops, such as millet, sorghum, sudangrass, and sorghum-sudangrass hybrids [39]. Its potential as a stand-alone grazing fodder could empower farmers to improve livestock productivity and reduce feed costs, which is essential for sustainable and profitable livestock farming. Despite the demonstrated positive effects of fodder radish on soil structure, carbon and nitrogen levels, weed suppression, and other benefits, there remains a notable scarcity of comprehensive information concerning its chemical composition, nutrient utilization, and the significant potential to transform livestock production, particularly within SA's smallholder sector. This underutilization is in contrast to the notable forage breeding progress made in developing cultivars that were specifically tailored to flowers later in the dry season under SA conditions [22,23].

This review aims to offer valuable insights into the practical utilization of fodder radish, enhancing its recognition among livestock producers in SA. To achieve this objective, the paper systematically compiles a concise profile of this forage crop and updates its current and potential use as a cover crop. Additionally, this review explores the current understanding of the nutritive value, opportunities, and challenges associated with the utilization of this crop in the cooler eastern regions of SA.

2. Description, Origin, and Environmental Fit of Fodder Radish

Fodder radish (*Raphanus sativus*) is an annual or biennial vegetable crop belonging to the *Brassicaceae* family [24,25]. According to Fenwick et al. [26], this plant is categorized as a root crop because of its specialized structures known as hypocotyls, which allow the fodder radish to thrive either entirely or partially underground, resembling true roots in shape and facilitating the storage of starch and other compounds [27]. Fodder radish can display a range of surface colours, spanning from white in Asia to red in Europe, and encompassing shades like purple, green, and black [28]. However, the flesh of fodder radish found in the European and Asian cultivars is predominantly white [29]. It is a fast-growing plant with broad leaves and a large fleshy taproot that can absorb nutrients and roots measuring approximately 3–6 cm in diameter and 15–30 cm in length [30,31]. Although taxonomists consider the origin of fodder radish to be in China, certain studies have revealed that the greatest diversity of this crop can be traced back to the Eastern Mediterranean region and areas in close proximity to the Caspian Sea. [32,33]. Fodder radish is classified as a cool-season crop that thrives at moderate temperatures and can grow in different environments, from semi-arid to humid areas. Altman et al. [34] highlighted that fodder radish has the exceptional ability to withstand freezing temperatures and sustain growth, unlike many other grasses and legumes. In Figure 1, one can observe the large fleshy taproot of broad leaves in the fodder radish.

Before significant crop improvement, the Japanese radish that was widely grown in SA as a single graze forage [35,36] faced limitations due to commercially available cultivars lacking regrowth capacity after grazing. These varieties featured prickly leaves and stem trichomes, reducing the palatability of radish as forage [37]. Additionally, a significant hindrance to the use of fodder radish was its early flowering behaviour, which was recorded among the commercially available genotypes [38,39], leading to a rapid decline in forage quality as flowering progressed, limiting its flexibility for grazing later in the dry season. To address these challenges, extensive collaborative breeding and selection efforts were directed towards improving the traits of this forage crop [39]. After nearly two decades of research, radish genotypes with smoother leaves, the ability to recover from multiple grazing regimes, rapid development, and, crucially, late winter flowering were developed [22,23]. These genotypes are available in the market and present livestock farmers with a unique opportunity to access winter feed for their sheep, cattle, and goats while enjoying the additional benefits of fodder radish. Beyond its capability to thrive as forage in less fertile soils under dryland conditions, radish is utilized for purposes such as winter manure, crop rotation, and other agricultural uses.

(**a**) (**b**)

Figure 1. Leaf (**a**) and tuber (**b**) of fodder radish in Pietermaritzburg, Cedara Research Station, KwaZulu Natal Province, South Africa. Photos taken by L. Mbambalala.

3. Fodder Radish Benefits as Cover Crop

Fodder radish is used as a cover crop that helps to sustain the fertility and productivity of cropland soil by mitigating soil compaction, minimizing nitrate (NO_3) leaching, suppressing weeds, and controlling erosion [30,40]. In the winter season, fodder radish creates pores in the soil surface, which aids in water infiltration and reduces the occurrence of run-off [41]. The deep roots of fodder radish can help alleviate soil compaction and other cropland concerns by penetrating compacted soil layers with its thick taproot [42]. As fodder radish grows deeper, it can extract nitrogen (N) from deeper soil layers, thus potentially benefiting subsequent crops [43]. Fodder radish has a greater resilience under challenging conditions than other *Brassica* crops (rape and forage turnips) due to its ability to enhance root reserves by responding to high fertility levels [39]. Given the information presented on the benefits of using fodder radish as a cover crop to mitigate run-off, it is imperative for farmers to prioritize the cultivation of this crop. Table 1 provides a summarized overview of the key advantages of using fodder radish as a cover crop.

Table 1. Potential benefits of fodder radish as a cover crop.

Potential Benefits	Description	Reference
Effects on soil structure	Fodder radish roots exhibit superior capability for penetrating compacted soil in comparison to rapeseed and cereal rye. When radish cover crops are employed, corn roots penetrate compacted subsoil at a rate twice that of cereal rye, and both cover crops significantly enhance rooting when compared to leaving the land bare. This indicates that fodder radish could serve as a viable biological alternative to mechanical techniques such as deep ripping in order to alleviate soil compaction.	[44]

Table 1. *Cont.*

Potential Benefits	Description	Reference
Effects on weeds	Fodder radish reduces weed growth during and after their active growth periods. It is recommended to sow radish early, at least six weeks before frost, and at a relatively high density of more than five plants per square foot, into a well-prepared seed bed in order to complete weed control.	[45,46]
Effects on nitrogen leaching	During the fallow season in autumn and winter, agricultural soils are particularly susceptible to the danger of nitrogen (N) leaching. However, the use of fodder radish can be beneficial as it has a deep root system and quickly extends its roots, making it an excellent scavenger of residual N. This crop is capable of absorbing N from both topsoil and deeper soil layers.	[47,48]
Effects on mineral accumulation	Fodder radish has also been found to be excellent accumulators of both phosphorus (P) and potassium (K) due to their unique root system. As they grow, they absorb P and K from the soil and store them in their roots, making these nutrients readily available to other plants in the soil.	[42]
Effects on soil erosion and run-off	Fodder radish serves as an effective means to manage soil erosion and run-off by enabling water infiltration.	[49]
Effects on nematodes	Radish has also been found to control soil-borne diseases such as nematodes. For example, a recent study indicated that incorporating various brassica crops resulted in beneficial nematode population reductions. Some radish crops tested stood out, exhibiting the most significant reduction in root-knot nematode populations. During harvest, radish plots had fewer ring nematodes compared to bare plots, with the lowest reproduction rate among all treatments.	[50]

4. Fodder Radish Benefits as a Feed Source for Livestock Production

Inadequate and low-quality forage poses a major threat to livestock production by smallholder farmers in SA [51]. The utilization of dry-season forage crops becomes a feasible alternative when natural pastures fail to supply an adequate amount of forage [52]. Fodder radish, as one of the dry season plants, can produce nutritious forage in a period of 90 to 180 days depending on the cultivar [30,53]. Fodder radish exhibits adaptability across various climatic conditions and soil types, along with a short duration from sowing to reaching maturity [54]. The short growing period of fodder radish could play a pivotal role in reducing economic losses caused by diseases in fodder radish plants. Some pathogens survive in plant debris or soil, waiting for the next planting season to infect new crops [55]. With a short growing period of fodder radish, there is less time for the buildup of disease inoculum, which is essential for disease transmission. However, a rapid growth period could restrict the production of forage, thereby constraining its potential use as a livestock forage resource. This is due to the fact that, once a plant reaches maturity, its growth ceases, marking the conclusion of its development, and it subsequently dries up [56]. Research has been carried out on fodder radish across various regions globally to explore its potential for production, as well as its utilization as livestock feed [57,58]. The outcome of this study showed that the cultivar Ceres Graza established rapidly, was tolerant to the virus, produced relatively good quality forage, and was persistent in grazing as compared to Hunter and Paska cultivars grown in New Zealand [57]. This study also showed that cultivars (Hunter brassica and Graza radish) were able to produce 8.6 and 10.5 t/ha when grown in Mexico, respectively [57]. Furthermore, the study showed that cultivars (Hunter brassica and Graza radish) were able to produce 8.6 and 10.5 t/ha when grown in Mexico, respectively [58]. Biomass yield ranging from 4.2 to 7.3 t/ha on radish cultivars when grown in Canada are illustrated in Table 2. The chemical composition and mineral contents of different fodder radish cultivars evaluated under different agro-ecological zones are presented in Tables 2 and 3. Under simulated grazing conditions, the combined yield of forage rape, turnip, and forage radish reached an average of 4.4 and 5.7 t/ha across three harvesting dates [59]. This may be advantageous for the establishment of fodder radish, especially when used for grazing in zones with marginal growing conditions like SA, which are characterized by increasing aridity, while ambient temperature increases. Goats can consume both the leaves and tubers of fodder radish, which are highly edible with relative nutritive value [60]. The forage (i.e., leaves) of fodder radish cultivars contains relatively good (13.23–26.7%) crude protein content, which makes it a suitable alternative forage as a protein source for livestock ruminants in particular. Forage materials with protein content at this range are suitable to be utilized as protein source for animals, particularly in smallholder farming systems [61]. Protein in a feed plays a vital role in stimulating rumen microbes to ferment the ingested feed, and feed with a protein content below 70 g/kg negatively affects the functioning of rumen microbes, which leads to a reduction in feed digestibility [56].

Table 2. Chemical composition of different cultivars of fodder radish (% DM).

Cultivars	PP	Yield	CP	CF	NDF	ADF	Ash	TC	EE	Reference
NBH-White Queen	L		13.23	19.92	-	-	11.53	47.54	3.41	[48]
Giant white globe	L	-	23.5	-	-	-	27.7	-	3.1	[52]
Icheom Ge-Geol	T	12.22	1.35	1.11	-	-	1.55	-	0.27	[52]
Korean	T	8.55	0.75	0.71	-	-	0.65	-	0.19	[52]
Figl	L	-	26.7	28.4	-	-	16.7	16.7	3.5	[52]
Mino	T	-	8.79	23.75	-	-	23.42	-	1.43	[62]
Kwandong	L	7	19.52	30.22	-	-	19.73	25.40	2.70	[52]
Yongdong	L	7.4	21.79	33.13	-	-	20.60	24.05	2.81	[52]
Chongilpung	L	7.2	23.03	29.29	-	-	17.72	27.09	2.82	[52]
Tamsureum	L	7.1	20.84	34.34	-	-	18.73	23.29	1.62	[52]
Minongdanbaek	L	12.43	20.09	26.76	-	-	16.07	26.72	0.19	[52]
Hunter brassica	L	8.6	18.78	-	27.70	21.04	-	-	-	[58]
Daikon radish	L	7.3	15.9	-	32.9	24.6	-	-	-	[58]
Malwira turnip rape	L	4.3	18.1	-	24.7	17.3	-	-	-	[58]
Purple top turnip	L	4.2	21.5	-	28.9	21.1	-	-	-	[58]
Tillape radish	L	6.4	13.4	-	51.6	34.5	-	-	-	[58]
Winfred	L	6.8	19.3	-	29.8	21.7	-	-	-	[58]
Graza radish	L	10.5	19.84	-	45.66	28.07	-	-	-	[58]

PP: plant part, L: leaves, T: tuber, CP: crude protein, CF: crude fiber, NDF: neutral detergent fiber, ADF: acid detergent fiber, TC: total carbohydrates TH, EE: ether extract.

Table 3. Mineral composition of different cultivars of fodder radish (mg/kg DM).

Cultivars	PP	Ca	P	Mg	K	Na	Reference
Giant White Globe	T	4899	5838	2096	68,096	752	[52]
	L	18,724	3442	4036	5605	496	[52]
Mino	T	8700	-	6900	35,100	-	[62]
Jarola	T	157	-	103	2799	192	[63]
Miyashige	T	130	-	87	2621	238	[63]
Daikon radish	L	7700	3700	2500	23,100	400	[58]
Malwira Turnip rape	L	17,600	2900	3300	31,900	300	[58]
Purple top turnip	L	30,100	3300	5600	39,700	3100	[58]
Tillape radish	L	16,900	2600	5000	20,900	1900	[58]
Winfred	L	19,500	3500	7500	32,600	2500	[58]

PP: plant part, L: leaf, T: tuber, Ca: calcium, P: phosphorus, Mg: Magnesium, K: potassium, Na: sodium.

5. Animal Response on Fodder Radish Diets

Studies on the performance of animals when they are provided with fodder radish as part of their feed have yielded inconsistent outcomes. Feeding cover crops that contain fodder radish, such as *Raphanus sativus* L., *Brassica napus,* and *Brassica* rapa, did not have any effects on animals' performance in terms of feed intake and weight gain of Angus steers [64]. Nonetheless, animals that consumed a diet containing fodder radish had an impact on the colour of meat, causing it to shift towards a reddish tan/brown hue, which is considered an undesirable shade for meat appearance [64]. The animals' response to the radish fodder diet exhibited inconsistent outcomes in terms of their feed intake, milk production, and milk quality. The Holstein-Friesian dairy cows that were provided a diet comprising either forage radish or summer turnip experienced decreased feed intake, leading to a notable decline in feed conversion efficiency; as a result, there was no enhancement in milk yield [65]. However, interesting results were observed in animals that were fed a forage rape diet, where the acetic: propionic acid ratio significantly reduced compared to animals that were fed control or summer turnip diets [65]. These results are consistent with Johnston [38], who concluded that radish was more palatable than turnips for sheep. However, this did not translate into milk production since a lower acetic: propionic ratio indicates the availability of energy for production [66]. Nonetheless, a study by Keim et al. [67] showed an improvement in milk yield and feed use efficiency, whereas feed intake was unaffected in the Holstein-Friesian dairy cows that were fed a fodder radish (forage rape) diet.

On the other hand, Zhou et al. [68] reported a significant increase in feed intake and digestibility on Mediterranean x Nili-Ravi hybrid lactating buffaloes when fed a diet containing forage rape silage in replacement of corn silage. The increasing ratio of acetic: propionic acids in the rumen of the buffalos fed a forage rape diet means less energy was available for milk production; thus, milk did not improve compared to animals that were fed a control diet. However, milk quality increased linearly with increasing mono-unsaturated fatty acids (MUFA) and casein in milk [68]. Alternatively, the study recorded a linear increase in milk solids, whereas milk fat was not affected and that translated into more milk protein synthesis in buffalo milk [68]. In the various literature sources cited here, it is clear that incorporating fodder radish into animal diets did not negatively affect production, even though no significant improvement in production was recorded. Hence, incorporating fodder radish as a feed source for animals yields a positive outcome, as it maintains production levels while significantly lowering production costs. If farmers in SA can produce fodder radish by themselves, it will help in reducing the need to buy supplements, particularly during the dry season period, and that will contribute to lowering production costs.

6. Antinutritional Factors Associated with Utilization of Fodder Radish

Griffiths et al. [69] stated that most *Brassica* crops, including fodder radish, contain antinutritional factors (ANFs). A study conducted by Ehsen et al. [70] revealed that ANFs are biologically active compounds and are categorized as secondary metabolites in plants. The major ANFs found in fodder radish that have adverse effects on animals include s-methyl-L-cysteine sulfoxide (SMCO), glucosinolates, and nitrate [71]. The severity of complications caused by these compounds varies depending on the specific compounds formed when livestock graze on fodder radish [72]. The issues of the feeding value and safety of these compounds in fodder radish highlight the problems they present in ruminants. S-methyl-L-cysteine sulfoxide (SMCO) can degrade into dimethyl disulfide, which in turn accumulates within the tissues of animals [70]. This leads to loss of appetite, constipation, depression, and death of animals, depending on the amount consumed. D'mello [73] stated that SMCO also hinders protein digestion and digestion, which in turn reduces the growth rate and decreases milk production in dairy cows. Some studies highlighted that SMCO can have an impact on the taste and flavour of animal-derived food like meat and milk [74,75]. However, the concentration of SMCO differs among various *Brassica* species and cultivars, and there is significant genetic diversity within each species to enable the development of varieties with reduced SMCO levels through breeding [76].

Glucosinolates are known as a large group of plant secondary metabolites with biologically active compounds and nutritional effects and are mainly found in the *Brassica* family, including fodder radish [77]. Upon degradation by animals, glucosinolates release compounds, such as oxozolidene-2-thiones and thiocyanate, also known as goitrogens, which interfere with thyroid gland function [9,77]. These compounds reduce iodine secretion from the thyroid gland, which has a negative effect on the metabolic function of the animal [77].

Plants naturally contain nitrate, which serves as the primary nitrogen source in soil [78]. Nitrate toxicity is a serious problem that creates a health hazard for both humans and animals [79–81]. According to Rashid et al. [78], *Brassica* crops are known as the most notorious accumulators of nitrate. Furthermore, the study also noted that elevated nitrate levels exceeding 0.5% (5000 ppm) in animal feed can have adverse effects on the health and productivity of ruminants [78]. Nitrate toxicity in ruminants can lead to methemoglobinemia, which is characterized by the oxidation of iron in hemoglobin, reducing its ability to bind and transport oxygen [82]. Nitrates in ruminants are reduced to nitrite by rumen microbes, which act as a nitrogenous source by converting it into ammonia [83]. The reduction process of nitrate (NO_3) in the rumen follows a sequence of steps, leading to the formation of nitrite (NO_2), ammonia (NH_3), and finally microbial proteins [84]. Then, the accumulation of nitrite occurs, and it enters the bloodstream, where it combines with the ferrous ion (Fe^{2+}) present in hemoglobin (Hb) to create met-hemoglobin (met-Hb) [78]. This leads to various adverse effects, including unexpected mortality, termination of pregnancies, reduced lactation output, disruption of carotene-to-vitamin A conversion, and impaired growth rates [85]. Therefore, ruminants should be gradually introduced to fodder radish and given restricted daily access, preferably not exceeding 70% of their total diet dry matter [72]. Effective grazing management practices that encompass proper strategies can help mitigate nitrate poisoning in cattle [86,87]. Likewise, farmers should prioritize prevention over treatment since, once an animal displays symptoms of nitrate toxicity, there is a limited timeframe to rescue the animal due to rapid deterioration in its health [87].

7. Conclusions

In conclusion, the agricultural industry's essential livestock component has a significant potential to enhance rural well-being globally, including food security and rural development. Drought-tolerant forage crops, such as fodder radish and other cool-season *Brassica* crops, offer high-quality biomass during autumn and winter, addressing fodder shortages and reducing reliance on stored feeds. This review increases the recognition of fodder radish among South African livestock producers, providing insights into its utilization, nutritive value, opportunities, and challenges, especially in the cooler eastern regions. Fodder radish's adaptability, unique root structure, and late-flowering, re-growth-capable genotypes address the limitations associated with fodder trees, offering a valuable winter feed option and additional agricultural benefits. This is a promising solution to address inadequate and low-quality forage in South African livestock production. With its fast growth, adaptability, and high nutritive value, fodder radish offers significant potential to improve livestock feeding efficiency, enhance animal performance, reduce economic losses, manage soil-borne diseases, and promote sustainable agricultural practices. More comprehensive research and data are required to fully unlock the benefits of fodder radish in the context of South African livestock production.

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