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Research Article

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Improving the productivity of fallow land through evaluation and demonstration of legume forages over-sowing

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ABSTRACT

The study was conducted to enhance the productivity of fallow land through the demonstration of legume forage over-sowing in the Gerese district of Southern Ethiopia. Common vetch (*Vicia sativa*), Greenleaf desmodium (*Desmodium intortum*), and Silverleaf desmodium (*Desmodium uncinatum*) were tested for their performance in biomass yield, dry matter production, and contribution to pasture cover and species composition. The experimental design was a randomized complete block with four treatments, including farmer-practice as acontrol for a replication, and the participant farmer as a replication. Data on biomass, and dry matter yield were analyzed using ANOVA. Results showed that *V. sativa* significantly outperformed the other treatments, yielding 2.95 t/ha of dry matter and achieving the highest basal cover (75%). Botanical composition after over-sowing showed a significant increase in legume contribution from 3.25% to 28.5% and a reduction in low-palatable weeds from 32.25% to 19.5%, indicating ecological and productivity benefits. Farmers expressed a strong willingness to adopt and recommend legume over-sowing, highlighting its practicality and perceived benefits. The study concludes that legume over-sowing, especially using *V. sativa*, is an effective, low-cost strategy to improve the productivity of fallow land and improve livestock feed availability in smallholder farmers of the current study area.

KEYWORDS: Common vetch, Desmodium, Dry matter yield legume over-sowing, Fallow land, Farmers' perception

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INTRODUCTION

Livestock feed in the country is based on natural pastures, fallow grazing, stubble grazing, and crop residues. The natural pasture resource consists of a wide range of grasses, legumes, and other herbaceous species. More than 90% of the livestock feed in Ethiopia comes from crop residues and natural pasture (Lemma & Alemu, 1991), out of which 37-43% estimated to be from private grazing land, as in the case of Southern Ethiopia (Tegene *et al.*, 2015). Legumes provide many benefits to a pasture system. Legumes do not need any nitrogen fertilization. They improve the seasonal distribution of forage dry matter by boosting summer production, and they improve protein levels and overall digestibility of the forage. If a pasture mainly comprises unproductive native grasses, there may be a benefit of introducing improved grass species and varieties (Alemayehu, 2002). Over sowing is the simplest among forage development strategies and can be undertaken at very low cost. It involves broadcasting or sowing improved forage species into common grazing lands, native pastures, and degraded areas without any cultivation or other inputs with minimum soil disturbance or minimum tillage. Feed shortage in quality and quantity is the limiting factor for livestock production and the productivity of the region.

Although livestock play a decisive role in rural and urban areas, the sector is not only constrained by feed in terms of both quantity and quality, but it is also characterized by food insecurity, land degradation, land shortage, and poor soil fertility. In addition to this, the rapidly increasing human population-imposed pressure on farmland size, which lead to expansion at the expense of grazing areas that eventually leading to a shortage of livestock feed. As a result, animals cannot satisfy their nutrient requirements and very often lose weight and productivity. As climate change becomes more variable, niches for different species alter. This may modify animal diets and compromise the ability of smallholders to manage feed deficits. Changes in the primary productivity of forage crops, and rangeland effects will depend significantly on location, system and species.

Although the study area has high potential contribution to the smallholder's livestock production, poor productivity of the grazing lands, both in quality and quantity of the grazing resource, poses a great problem in livestock farming of the Gerese district. So this problem necessarily calls for improving the productivity of degraded grazing lands in the district.

The objective of this study is 1) to identify and demonstrate adapted legume species for over-sowing and investigate their role in improving the productivity of degraded grazing land and 2) to document the perception of farmers on legume species for over-sowing technology on the natural pastureland enhancements.

MATERIALS AND METHOD

Site and Farmers Selection

The study was carried out on the Godoro sub-watershed in Gerese district, which was chosen for CALM project implementation during phase I of the requirement assessment survey. Based on factors such as land availability, road accessibility, private pasture ownership, which has low yield, and willingness, four farmers were chosen. Before beginning the research project on forage over sowing, enhanced forage types, and their significance or advantage over the current indigenous grass species in their private grazing land, selected farmers received training during site preparation.

Planting Material Selection and Collection

Forage material was selected based on its compatibility with the same agro-ecology, seed availability. For this study, common vetch (*Vicia sativa*), Desimodium Greenleaf (*Desmodium intortum*), and Desmodium Silver leaf (*Desmodium uncinatum*) were used as treatments. The planting materials were collected from the Kulumisa Agricultural Research Centerand Wondogenete Agricultural Research Center. Germination test for the forage seeds was conducted at Arbaminch research center before sowing in the field/pasture.

Treatments and Experimental Design

Treatments were selected based on previous adaptability to similar agro-ecology and potential to enrich the quality of the forage herbage. Recommended seed rate of varieties were used. Over-sowing was implemented during the onset of the main rain season. After sowing, the plots will be left to grow naturally without any intervention. Three treatments were used T1 common vetch (*V. sativa*), T2 green leaf Desmodium (*D. intortum*), T3 silver leaf desmodium (*D. uncinatum*), and T4 was control of farmers practice and simple fallowing without over-sowing any forages. Randomized complete block design with four replications was be used, and participant farmers were used as replications. The plot size was 5 m by 5 m. Space between plots was 2 meters.

Data Collection and Data Analysis

Forage sampling

Forage sampling was done at peak biomass and the time when forage legumes flowered above 50%. Quadrat area of 1 m^2 was randomly thrown three times at each treatment to take a representative sample. Above-ground/soil surface/biomass was harvested, and fresh biomass weight was recorded in the field. 300 g of fresh sample taken from the total biomass yield was subjected to an oven at 65 °C for 72 hours, and the constant weight was recorded. Dry matter yield recorded per square meter and extrapolated to tons per hectare. Collected data was subjected to ANOVA to assess differences in biomass yield, dry matter yield, and botanical composition Tukey's test at 5% significance level.

Botanical composition and basal cover estimations

Botanical composition of species before and after intervention was recorded as frequency at each quadrat, and the contribution to the botanical composition for each species was converted to in percentage by using the following formula.

$$\text{Percent Composition} = \frac{\text{Frequency of Species} \times 100}{\text{Total frequency}}$$

Basal cover was estimated by visually by using the quadrats

Farmers' perception data collection

Purposive sampling was done to study the farmers' perception. Selection of farmers was based on their active participation/involvement/during action research, and farmers participated in the field day visit and presentation. Mixed-method approach was implemented to triangulate the farmer's perception. Closed and open-ended questions were prepared, which mainly focused on biomass yield, growth nature, labor implications, and voluntary intake by animals. Collected data were presented in a table, and the discussion was narrated.

RESULT AND DISCUSSION

Biomass Yield, Dry Matter Yield, and Basal Cover

The data presented in the Table 1 show significant differences ($p<0.001$) among the four treatments for all measured parameters: biomass yield, dry matter yield, and basal cover percentage. These results suggest that legume species have varying abilities to improve fallow land productivity when used for over-sowing.

T1 (Common vetch) stood out in every aspect, delivering the highest total biomass (19.63 t/ha), dry matter yield (2.95 t/ha), and the most extensive basal cover (75%)These results suggest that common vetch is especially effective at covering the soil, boosting forage output, and potentially suppressing weeds.

Table 1: Mean dry matter yield, fresh biomass yield and basal cover

Treatments	Variables		
	Biomass tone/ha	Dry matter tone/ha	Basal cover (%)
T1 (Common vetch)	19.63[a]	2.95[a]	75[a]
T2 (Greenleaf Desimodium)	15.25[b]	1.85[b]	58[b]
T3 (Silver leaf Desimodium)	14.5[b]	1.72[b]	50.4[c]
T4 (Control, Farmers practice)	11.26[c]	1.46[c]	46.25[d]
Standard error of mean	1.70	0.329	6.39
p-value	0.001	0.001	0.001

Mean values bearing different superscript in column letters indicate statistically significant differences

Its outstanding performance might be due to its fast growth, strong adaptability, and dense ground coverage, making it a valuable option for improving fallow land. Dry matter yield of Vetch over-sown was slightly lower than the result reported by Atsbha *et al.* (2017).

Desmodium varieties performed significantly better than the control (T4) but were statistically lower than T1. Greenleaf Desmodium had a dry matter yield of 1.85 t/ha and basal cover of 58% (Table 1), slightly higher than Silverleaf Desmodium (1.72 t/ha and 50.4% respectively) While both Desmodium species contributed positively, their slightly lower performance may be due to slower establishment or differences in growth habit compared to vetch. T4 (Control - Farmers' Practice) recorded the lowest biomass (11.26 t/ha) and dry matter yield (1.46 t/ha), as well as the least basal cover (46.25%), highlighting the clear benefit of legume over-sowing in enhancing pasture productivity and land rehabilitation.

Botanical Composition

Botanical composition for the degraded pasture in the current study is was presented in the following Table 2 in this sections proportion of different plant species or groups like native grass, legume and weed (unpalatable species).

The proportion of legume species (natural+improved) increased remarkably from 3.25% to 28.5% (Table 2), which is slightly lower than that reported by Tesfaye *et al.* (2017). This rise indicates successful establishment of the introduced legumes, which not only improved plant diversity, but this might be due to soil fertility through nitrogen fixation by legume forages. The mean percentage of low-palatable weeds declined from 32.25% to 19.5% (Table 2). This reduction suggests that over-sown legumes effectively competed with and suppressed weed species, likely due to improved ground cover and more aggressive growth of the legumes. It also reflects better pasture management and resource utilization after intervention. There was a native decrease proportion the proportion was decreased from 64.5% to 52% (Table 2).

The mean percentage of low-palatable weeds declined from 32.25% to 19.5%. This reduction might be due to over-sown legumes effectively competing with and suppressing weed species, likely due to improved ground cover and more aggressive growth of the legumes due to improved soil fertility which was similarly reported by Regassa and Elias (2023) for Ethiopian highlands. Prior to over-sowing legume the pasture was dominated by native grass like serdo, qaabo and while it was also dominated by low palatable grass weeds like shona. The dominant Native legume before over-sowing was Tura and which highly native/indigenous/ palatable legume.

Table 2: Botanical composition before and after legume over-sowing

Before over-sowing		After over-sowing	
Species category	Mean composition (%)	Species category	Mean composition (%)
Native grass	64.5	Native grass	52
Legume natural	3.25	Legume natural+improved	28.5
Weed (low palatable)	32.25	Weed (low palatable)	19.5

Table 3: Farmers' views on over-sowing legume forages

Perception indicators	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Increased biomass yield	4	2	2	0	0
Easy to manage and establish	2	3	2	1	0
suitable to integrate locally	2	2	4	0	0
Willingness to continue	3	3	0	2	0
Recommend to other farmers	2	4	2	0	0

Over sowing forage legumes come up with the considerable shift in species composition, legume establishment was successful across the trial pilots that contributed to the good land cover, dry mater yield and overall productivity of the pasture by suppressing weeds or unpalatable species.

Farmers' Perception

The table presents the feedback of 8 participating farmers regarding key aspects of legume forage over-sowing on fallow land. The perception indicators evaluated include productivity, management, adaptability, future use, and the likelihood of recommending the practice to others.

Half of the farmers (4) strongly agreed and 2 agreed that legume over-sowing improved biomass yield, with no disagreement. This indicates strong consensus and reflects farmers' recognition of the enhanced forage availability due to over-sowing (Table 3). While 2 farmers strongly agreed and 3 agreed that the practice is easy to manage, 2 were neutral and 1 disagreed. This shows that although a majority found it manageable, some farmers may have encountered challenges, possibly related to labor or establishment techniques.

A positive trend is observed, with 3 strongly agreeing and 3 agreeing to continue using legume over-sowing. However, 2 farmers disagreed, indicating that while most see value, a minority may have reservations possibly due to results, inputs, or knowledge gaps (Table 3). Six farmers expressed a willingness

to recommend the practice (2 strongly agree, 4 agree), and 2 were neutral. The absence of any disagreement suggests general approval and interest in broader adoption, provided concerns are addressed.

CONCLUSION AND RECOMMENDATION

Conclusion

The findings of this study clearly demonstrate that over-sowing legume forages on fallow land significantly enhances pasture productivity, botanical composition, and ground cover, addressing key feed-related challenges in the Gerese district. Among the tested species, common vetch (*V. sativa*) showed the most promising results, producing the highest biomass and dry matter yields, and offering superior basal cover. Both Greenleaf and Silverleaf desmodium also performed better than the control, confirming their potential contribution to pasture improvement. Botanical composition analysis revealed a marked increase in legume content from 3.25% to 28.5% and a decline in low-palatable weed species, indicating successful legume establishment, improved forage quality, and enhanced species diversity. This shift suggests that legume over-sowing contributes to weed suppression, soil fertility enhancement, and better ecological balance. Furthermore, farmers' perceptions were generally positive, with most participants acknowledging improvements in forage yield and expressing willingness to continue and recommend the practice. However, a few neutral or negative responses suggest the need for further capacity-building and support to optimize management and encourage wider adoption.

Recommendation

Given its superior performance in biomass yield, dry matter content, and basal cover, common vetch should be prioritized for over-sowing in similar agro-ecological zones. Extension services and development partners should ensure the availability of quality vetch seed and promote its adoption among smallholder farmers. Collaboration between research institutions and local agricultural offices is essential to facilitate the timely delivery of seeds, basic planting equipment, and technical support. This will help reduce barriers to adoption and encourage sustainable uptake of the technology

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