

Research Article

Morphological Characters, Yield, and Chemical Composition Potentials of Desho Grass (*Pennisetum glaucifolium* H.) Intercropped with Vetch Species in the Highlands of Ethiopia

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This experiment was conducted with the objective of evaluating the effects of intercropping vetch species and harvesting age on the morphological characteristics, forage yield, and chemical composition of sole and intercropped forages. The experiment was laid out using a randomized complete block design (RCBD) in a factorial arrangement consisting of two factors ((five forage varieties (four vetches & one desho) * two harvesting ages)) for a total of ten treatments with three replications. The experimental treatments were sole desho (Var-Kulumsa), desho+*V. villosa* (Var-Lalisa), desho+*V. villosa* (Var-Gebisa), desho+*V. sativa*, and desho+*V. dasycarpa* (Var-Lana) at 90 and 120 harvesting days. All morphological characteristics forage yield and chemical composition data were collected from two middle rows by excluding the border rows. The result showed that the interaction ($P < 0.001$) effect of harvesting age and intercropping of vetch species and varieties with desho grass was observed on the morphological characteristics, dry matter yield, and chemical composition of intercropped forage. Intercropping of vetch species/varieties with desho grass had shown significantly ($P < 0.001$) higher dry matter yield than sole desho except desho with *V. sativa*. The highest crude protein (CP) content was obtained from desho grass intercropped with two *V. villosa* (Var-Lalisa and Var-Gebisa) at 90 days of harvesting age. This CP content of intercropped desho+vetch species/varieties was double in amount than the CP obtained from sole desho in these species at 90 days of harvesting age. Moreover, the highest CPY was recorded from two *V. villosa* varieties (Var-Lalisa and Var-Gebisa). Hence, for the intercropping of vetch with desho grasses, the two *V. villosa* varieties (Var-Lalisa and Var-Gebisa) are recommended for on-farm evaluation and demonstration in the study area and similar agro-ecologies during the establishment phase at 90 days of harvesting age. It is possible to conclude that the intercropping of desho with these selected vetch species could be better than sole desho grass in terms of forage yield and quality in the highlands of northwestern Ethiopia to maximize ruminant livestock production. Hence, for the intercropping of vetch with desho grasses, the two *V. villosa* varieties (Var-Lalisa and Var-Gebisa) are recommended for on-farm evaluation and demonstration in the study area and similar agro-ecologies during the establishment phase at 90 days of harvesting age.

1. Background

The use of indigenous forage as a feed source is among the options under the present conditions of tropical countries to increase production and productivity of livestock. Thus, one of the major interference areas to boost livestock production in Ethiopia is the use of indigenous forage like desho grass as the major source of feed [1, 2]. Desho grass is among the locally available, multipurpose, and potential feed sources in

Ethiopia [3]. The grass is palatable to cattle and serves as a business opportunity for farmers in Ethiopia through the sale of seedlings and fresh biomass [4, 5]. Like the other forage crops, harvesting date had an effect on the morphological characteristics, yield, and chemical composition of desho grass grown in northwestern Ethiopia [2], which is the same species available in the country. It has been documented that sole grass production is not feasible in terms of nutritive value and proper land utilization for high

biomass production. Hence, intercropping of grasses with forage and food legumes could be an option to improve the nutrient content of fodder produced and properly utilize the parcel of available land under smallholders' conditions.

Intercropping plays a vital role in subsistence food and feed production in both advanced and emerging countries [6]. It tends to give a higher yield than sole crops, greater yield stability, and efficient use of soil nutrients. Regarding forages, the use of grass-legume mixture has more advantages than the use of pure stand forages [7]. This could reduce the costs for the commercial concentrates that majority of the smallholder farmers could not afford in most tropical conditions. Apart from the above benefits, forage legumes play a significant role in nitrogen fixation and have high crude protein in the leaves and foliage, which can be used as a protein supplement for livestock [8]. They are rich in minerals (calcium, phosphorus) and vitamins A and D [9]. Information on the intercropping of forage legume with forage grass, especially the integration of vetch with desho grass, is scanty in Ethiopia. Intercropping of desho grass with vetch species at the establishment phase could help in achieving better forage yield and feed quality for livestock. Since the vetch species grow and mature earlier than desho grass do, the forage production for livestock was supposed to be complimentary grass and legume species. However, such information is limited especially regarding desho grass intercropping with legume species or accessions. Therefore, this study was conducted to determine the effects of harvesting age and the intercropping of different vetch species with desho grass on dry matter yield, morphological characteristics and chemical composition of the intercropped forages, land equivalent ration, and relative yield of the intercropped forage.

2. Materials and Methods

2.1. Description of the Study Area. The study was conducted in the North Mecha district at Ambomesk PA's northwestern Ethiopia, under rain-fed conditions. The district is located at 9° 23' to 9° 26'N latitude and 41° 59' to 42° 02'E longitude at an experimental area altitude of -2400 meter above sea level. The mean annual rainfall is 1537 mm with a unimodal pattern, the mean maximum and minimum temperatures range from 10 to 27°C, and humidity ranges from 95% throughout the rainy season to 35% during the dry season. The topography of the area varies from river valley plain to gentle slope grassland. The experimental land is characterized as Nitisol.

2.2. Field Experiment

2.2.1. Land Preparation and Planting. The experimental land was ploughed by oxen to fine tilth before laying out plots and planting.

2.2.2. Experimental Design and Treatments. A factorial arrangement of treatments was employed using a randomized complete block design (RCBD) with two factors (five forage varieties (4 vetches and one desho) and two harvesting ages) containing three replications. The treatment consisted of

four vetch varieties from three species and one local variety desho grass (Var-Kulumsa) at two harvesting ages (5 * 2) totally 10 treatments with a total of 30 experimental plots. The sources of desho grass as well as vetch accessions and varieties were from Andassa Livestock Research Center-Farm. The treatments (2 * 5) were as follows: sole desho, desho+*V. villosa* (Var-Lalisa), desho+*V. villosa* (Var-Gebisa), desho+*V. sativa*, and desho+*V. dasycarpa* (Var-Lana). The second factor was harvesting ages where the forage was harvested at 90 and 120 days after planting. The spacing between the rows and plants of desho grass was 50 and 30 cm, respectively, while the space between the row and plants of vetch species was 50 and 15 cm, respectively. The vetch species were intercropped between two consecutive rows of desho grass, which created 25-cm space between the vetch species and desho grass.

The space between plot and block was 1 and 1.5 m, respectively. The plot size current experiment was 3.5 * 4 m (14 m²). Each species of vetch with 10 kg/ha seed rate and desho grass (using vegetative root splits) were planted in rows on a well-prepared soil at the rain-fed condition. NPS fertilizer at the rate of 100 kg/ha was applied at the time of planting for both vetch and desho followed by the application of 25 kg/ha rate urea for sole desho grass 30 days after planting [2]. Desho grass was intercropped about three weeks (21 days) after vetch species were sown. This was due to the fact that early sowing of vetch in June is recommended, while the desho grass is usually established at peak rainy period in July like Napier grass as reported by [10].

2.2.3. Data Collection. Data for vetch species were collected at 50% flowering age and at 90 and 120 days of harvesting age for desho grass. Data on the morphological and yield parameters were recorded at each harvesting period and collected from the middle two rows of the experiment by excluding the outer rows. In each plot, ten plants were randomly selected by leaving border plants and rows to record plant height, number of tillers per plant (NTPP), number of leaves per plant (NLPP), leaf length per plant (LLPP), and leaf:stem ratio (LSR). The plant height was measured on the primary shoot from the soil surface to the base of the top-most leaf using a meter ruler. The number and length of leaves of desho grass per plant were counted and measured by graduated ruler after the shoot parameters were accomplished. At the end of each harvesting day, ten sets of plant samples were collected from all plots. The leaf-to-stem ratio was determined by harvesting all plants in two consecutive rows, randomly selected in the middle of each plot and separating these plants into stem and leaf. Each sample of leaf and stem was air-dried for 3 days up to constant weight, and then, the leaf:stem ratio was estimated by dividing leaf dry weight by stem dry weight [11]. The numbers of tillers per plant of desho grass were counted from the randomly selected sample of ten plants of each plot. Sample tillers from each of the randomly taken ten plants were used to determine the number of leaves per plant (NLPP) [12]. Harvesting was performed by hand using a sickle, leaving a stubble height of 5 to 10 cm. The data of

TABLE 1: Effect of harvesting age and intercropping of vetch species on morphology and dry matter yield forages.

Factors		Variables								
HD	Forage species	PH (m)		NTPP (count)	NLPP (count)	LL (cm)	LSR	DMYTHA		
		Desho	Vetch	Desho	Desho	Desho	Desho	Vetch	Desho	Vetch
90	Sole desho (Var-Kulumsa)	0.59 ^h	—	41.1 ^f	254.8 ⁱ	20.33 ^d	1.304 ^b	—	12.2 ^d	—
	Desho+ <i>V. sativa</i>	0.64 ^g	0.6 ^e	37.37 ^g	298.5 ^h	18.67 ^e	1.35 ^b	2.05 ^d	8.08 ^g	6.61 ^e
	Desho+ <i>V. dayscarpa</i> (Var-Lana)	0.81 ^e	1.35 ^d	42 ^{ef}	318.3 ^g	23.33 ^c	1.66 ^a	3.08 ^b	8.78 ^f	13.6 ^d
	Desho+ <i>V. villosa</i> (Var-Gebisa)	0.83 ^e	1.4 ^c	42.3 ^{ef}	339.7 ^f	23.67 ^c	1.65 ^a	2.86 ^c	10.24 ^e	14.6 ^c
	Desho+ <i>V. villosa</i> (Var-Lalisa)	0.97 ^d	1.413 ^{ab}	43.93 ^e	345.5 ^e	23.33 ^c	1.69 ^a	3.16 ^{ab}	12.25 ^d	15.534 ^b
120	Sole desho (Var-Kulumsa)	0.75 ^f	—	51.33 ^d	503.9 ^d	21 ^d	1.12 ^c	—	15.5 ^c	—
	Desho+ <i>V. sativa</i>	0.83 ^e	0.61 ^e	54.97 ^c	538.8 ^c	23.33 ^c	1.11 ^c	2.05 ^d	10.65 ^e	6.6 ^e
	Desho+ <i>V. dayscarpa</i> (Var-Lana)	1.12 ^b	1.36 ^d	64.13 ^b	618.8 ^b	26.67 ^a	1.28 ^b	3.08 ^b	15.3 ^c	14.01 ^{cd}
	Desho + <i>V. villosa</i> (Var-Lalisa)	1.08 ^c	1.406 ^{bc}	64.33 ^b	639 ^a	25.33 ^b	1.26 ^b	3.16 ^{ab}	16.2 ^b	15.25 ^b
	Desho+ <i>V. villosa</i> (Var-Gebisa)	1.23 ^a	1.42 ^a	72.5 ^a	637 ^a	25.33 ^b	1.26 ^b	3.34 ^a	18.06 ^a	17.013 ^a
	Overall mean	0.89	1.195	51.4	449.5	23.1	1.37	2.84	12.72	12.91
	SEM	0.037	0.07	2.13	27.02	0.481	0.04	0.1	0.598	0.79
	SL	***	***	***	***	***	***	***	***	***
	CV	2.17	0.64	2.27	0.36	3.35	5.53	4.38	2.16	2.41
	P-value	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0005	<0.0001	0.00042
R ²	0.994	0.999	0.993	0.999	0.932	0.92	0.956	0.995	0.995	

TRT = Treatment, PH = plant height, NTPP = number of tillers per plant, NLPP = number of leaves per plant, LLPP = leaf length, SEM = standard error of mean, CV = coefficient of variation, SL = significant level, *** = significant at 0.001; means within column followed by the same letters are not significantly different R² = coefficient of determination.

intercropped vetch species were collected at 50% of flowering age. The dry matter yield was determined at the end of every harvesting day for desho and at 50% flowering age for vetch species. A fresh herbage yield of the desho and vetch species was measured immediately after each harvest and weighed on the field, soon after mowing using a field spring balance. Leaf and stem dry weight was divided by leaf and stem fresh weight and multiplied by 100 to determine DM% for each sample. DM% and fresh biomass yield from the sample area of each plot were used to calculate total dry matter yields for each plot, which were then converted to tons per hectare.

2.3. Chemical Composition Analysis. After air drying, samples were ground to pass a 1-mm Wiley mill screen and stored in airtight bag containers for chemical analysis. Following that, all samples were subjected to chemical analysis for the determination of organic matter following the methods described in [13]. Forage quality measurements such as determination of crude protein (Kjeldahl procedure), acid detergent fiber (ADF), neutral detergent fiber (NDF), and acid detergent lignin (ADL) were analyzed using the detergent fiber analysis system [14] using the wet chemistry method. Ash was determined by igniting at 550°C overnight and total DM by drying at 105°C for two hours. Dry matter yield (DMY) was multiplied with the CP content of the feed samples to determine crude protein yield (CPY).

2.4. Data Analysis. The data collected were subjected to ANOVA based on the model designed for a randomized complete block design (RCBD) according to Gomez and Gomez (1984) [15]. To compare the significant differences in

response variables, GLM ANOVA analysis was carried out using SAS package [16]. Duncan's multiple range test (DMRT) was carried out for the subsequent comparison of means as described by [16] at $P < 0.05$. The model used for the data analysis of the experiment was

$$Y_{ijk} = \mu + T_i + H_j + (T_i * H_j) + E_{ijk}, \quad (1)$$

where Y_{ijk} is all dependent variables (data on grass morphology, forage yield, and chemical composition), μ is the overall mean, T_i is the treatment effect (intercropping effect), H_j is the effect of harvesting age (90 and 120 days), $T_i * H_j$ is the interaction effect (harvesting age and intercropping), and E_{ijk} residual error.

3. Results

3.1. Effects of Harvesting Age and Intercropping of Vetch Species on Morphological Characteristics and Dry Matter Yield Desho Grass

3.1.1. Plant Height of Desho Grass. The interaction between harvesting age and intercropping of vetch species with desho grass had a significant ($P < 0.001$) effect on the plant height (PH) sole and intercropped forages (Table 1). The longest PH was recorded from desho+*V. villosa* (Var-Gebisa) in which the combination of desho and vetch has shown an increment of 208.5% at 120 days of harvesting age over sole desho grass at 90 days of the harvesting period.

3.1.2. Number of Tillers per Plant of Desho. The interaction between harvesting age and intercropping of vetch species with desho grass had a significant ($P < 0.001$) effect on the number of tillers per plant (NTPP). The maximum NTPP

TABLE 2: Total dry matter yield of sole desho and intercropped vetch species.

HD	Variables	Parameters (dry matter yield ton/hectare)		
	Forage species	DMY of desho	DMY vetch	TDMY
90	Sole desho (Var-Kulumsa)	12.2 ^d	—	12.2 ⁱ
	Desho+ <i>V. sativa</i>	8.78 ^f	6.61 ^e	15.38 ^h
	Desho+ <i>V. dayscarpa</i> (Var-Lana)	8.034 ^g	13.6 ^d	21.64 ^f
	Desho+ <i>V. villosa</i> (Var-Gebisa)	10.24 ^e	14.6 ^c	24.84 ^e
	Desho+ <i>V. villosa</i> (Var-Lalisa)	12.25 ^d	15.53 ^b	27.8 ^d
120	Sole desho (Var-Kulumsa)	15.5 ^c	—	15.5 ^h
	Desho+ <i>V. sativa</i>	10.65 ^e	6.6 ^e	17.28 ^g
	Desho+ <i>V. dayscarpa</i> (Var-Lana)	15.3 ^c	14.01 ^d	29.28 ^c
	Desho+ <i>V. villosa</i> (Var-Lalisa)	16.2 ^b	15.25 ^b	31.45 ^b
	Desho+ <i>V. villosa</i> (Var-Gebisa)	18.06 ^a	17.01 ^a	35.73 ^a
	Overall mean	12.72	12.91	22.89
	SEM	0.598	0.785	1.334
	SL	***	***	***
	CV	2.156	2.41	1.86
	R ²	0.995	0.995	0.997

TRT = Treatment, DMY = dry matter yield, TDMY = total dry matter yield ton per hectare, SEM = standard error of mean, CV = coefficient of variation, SL = significant level, *** = significant at 0.001; means within column followed by the same letters are not significantly different R² = coefficient of determination.

was recorded from desho+*V. villosa* (Var. Gebisa), which showed an increment by 176.4% at 120 days of harvesting age compared to NTPP from sole desho at 90 days of harvesting age. In this study, the total NTPP was increased linearly with intercropping of vetch species with desho grass and harvesting age from 90 to 120 days. Harvesting age and intercropping of vetch species significantly affected the NTPP, which increases as the harvesting age increases from 90 to 120 days in this study.

3.1.3. Number and Length of Leaves per Plant of Desho.

The interaction between harvesting age and intercropping of vetch species with desho grass had a significant ($P < 0.001$) effect on the number of leaves per plant (NLPP). The maximum NLPP was recorded from desho+*V. villosa* (Var-Lalisa) and desho+*V. villosa* (Var-Gebisa), which showed an increment by 250.8% at 120 days of harvesting age compared to that from sole desho at 90 days of harvesting age. On the other hand, the interaction between harvesting age and intercropping of vetch species with desho grass had a significant ($P < 0.001$) effect on the leaf length (LL). The highest LL was recorded from desho+*V. dayscarpa* (var. Lana) followed by desho+*V. villosa* (Var-Gebisa) (25.33 cm) and desho+*V. villosa* (Var-Lalisa) at 120 days of harvesting age, while the shortest LL was observed from sole desho and desho+*V. sativa* at 90 days of the harvesting period. The length of leaf increased progressively with the intercropping of vetch species with desho grass and by rising the age of harvesting from 90 to 120 days of harvesting age in this study.

3.1.4. Leaf-to-Stem Ratio of Desho. The interaction between harvesting age and intercropping of vetch species with desho grass had a significant ($P < 0.001$) effect on the leaf-to-stem ratio (LSR) of desho grass (Table 1). The highest LSR was recorded from desho+*V. villosa* (Var-Gebisa), desho+*V. villosa* (Var-Lalisa), and desho+*V. dayscarpa* (Var-Lana) at 90

days of harvesting age, while the lowest LSR was counted from sole desho and desho+*V. sativa* at 120 days of the harvesting period. Reduced LSR is a major cause of the decline in forage quality with maturity, and also the loss in quality that occurs under adverse hay curing conditions [17] indicated that LSR reflected the variation of leaf stem mass with harvest and is a trait that can affect preference during grazing.

3.1.5. Dry Matter Yield. The interaction between harvesting age and intercropping of vetch species with desho grass had a significant ($P < 0.001$) effect on dry matter yield (DMY) (Table 2). The DMY of 148% higher than sole desho grass was obtained from desho+*V. villosa* (Var-Gebisa) followed by desho+*V. villosa* (Var-Lalisa) at 120 days of the harvesting period, while the lowest DMY ton per hectare of desho grass was obtained from desho+*V. sativa* and desho+*V. dayscarpa* (Var-Lana) at 90 days of the harvesting period. On the other hand, the current finding showed that the intercropping of vetch species/varieties with desho grass can produce a higher dry matter yield than sole desho grass from all treatment groups. In this study, there was an interaction between harvesting ages and intercropping of vetch species with desho grass, which had a highly significant ($P < 0.001$) effect on the total dry matter yield of sole desho grass and intercropped vetch species/varieties. A significantly highest total dry matter yield was recorded from desho+*V. villosa* (Var-Gebisa) at 120 days of harvesting age, while the lowest total dry matter yield was recorded from sole desho at days of harvesting age. Intercropping of vetch species with desho grass provided a significantly ($P < 0.001$) very higher total dry matter yield than sole desho grass in this study.

3.2. Effects of Harvesting Age and Intercropping on Chemical Composition of Sole and Intercropped Forages. The interaction effects among intercropped vetch species with desho grass and harvesting age of desho grass on the chemical

TABLE 3: Effect of harvesting age and intercropping of vetch species on chemical composition of forages.

Factors	HD	Forage species	Variables in percentage (dry matter basis)													
			DM		ASH		NDF		ADF		ADL		CP		CPY (ton/ha)	
			Desho	Vetch	Desho	Vetch	Desho	Vetch	Desho	Vetch	Desho	Vetch	Desho	Vetch	Desho	Vetch
		Sole desho (Var-Kulumsa)	94.41 ^a	—	11.94 ^a	—	75.46 ^c	—	52.69 ^c	—	9.65 ^c	—	6.9 ^f	—	0.84 ^e	—
		Desho+V. sativa	94.15 ^{ab}	93.5 ^a	9.5 ^d	10.46 ^a	81.46 ^{ab}	63.38 ^a	58.32 ^{ab}	60.47 ^a	11.66 ^{ab}	12.6 ^{ab}	8.38 ^{de}	21.47 ^d	0.74 ^e	1.42 ^e
		Desho+V. dayscarpa (Var-Lana)	93.59 ^{bc}	92.4 ^c	11.76 ^a	8.5 ^c	77.2 ^{bc}	55.13 ^c	55.11 ^{abc}	54.48 ^c	11.94 ^a	11.68 ^c	11.94 ^{ab}	24.9 ^c	1.6 ^b	3.39 ^d
		Desho+V. villosa (Var-Gebisa)	93.96 ^{ab}	93.52 ^a	10.54 ^{bc}	10.2 ^{ab}	78.13 ^{bc}	53.62 ^{bc}	54.33 ^{abc}	52.55 ^d	10.37 ^{abc}	9.81 ^d	11.45 ^b	26.52 ^{bc}	1.40 ^c	3.87 ^c
		Desho+V. villosa (Var-Lalisa)	93.67 ^b	93.57 ^a	11.39 ^a	9.7 ^b	80.66 ^{ab}	57.06 ^d	56.7 ^{abc}	55.99 ^b	11.6 ^{abc}	11.77 ^c	12.36 ^a	30.71 ^a	1.62 ^b	4.77 ^a
		Sole desho (Var-Kulumsa)	93.61 ^{bc}	—	9.93 ^{cd}	—	83.84 ^a	—	58.62 ^a	—	11.31 ^{bc}	—	5.41 ^g	—	0.56 ^f	—
		Desho+V. sativa	93.92 ^{ab}	93.61 ^a	11.32 ^{ab}	10.42 ^a	78.57 ^{bc}	61.21 ^b	54.17 ^{abc}	60.09 ^a	9.89 ^{bc}	12.53 ^b	7.88 ^e	20.73 ^d	1.22 ^d	1.37 ^e
		Desho+V. dayscarpa (Var-Lana)	93.09 ^c	92.75 ^{bc}	10.41 ^c	8.47 ^c	78.85 ^{bc}	54.67 ^f	53.66 ^{bc}	52.2 ^d	10.86 ^{abc}	12.91 ^a	9.29 ^c	25.23 ^c	1.42 ^c	3.53 ^d
		Desho+V. villosa (Var-Lalisa)	93.97 ^{ab}	93.48 ^a	10.19 ^{cd}	10.2 ^{ab}	78.59 ^{bc}	53.92 ^{bc}	57.16 ^{abc}	52.5 ^d	10.18 ^{abc}	9.76 ^d	8.84 ^{cd}	27.23 ^b	0.71 ^e	4.15 ^{bc}
120		Desho+V. villosa (Var-gebisa)	93.97 ^{ab}	93.41 ^{ab}	10.19 ^{cd}	9.89 ^b	78.59 ^{bc}	60.05 ^c	57.16 ^{abc}	55.35 ^{bc}	10.18 ^{abc}	12.29 ^b	8.89 ^{cd}	30.0 ^a	1.9a	5.1 ^a
		Overall mean	93.83	93.3	10.72	9.73	79.14	57.4	55.79	55.4	10.76	11.67	9.13	25.84	1.17	3.45
		SEM	0.09	0.12	0.19	0.19	0.61	0.9	0.57	0.8	0.23	0.29	0.49	0.87	0.01	0.08
		CV	0.27	0.31	3.33	2.42	2.58	0.32	3.87	1.07	8.22	1.32	3.17	2.78	5.07	6.82
		SL	*	*	***	***	*	***	*	***	*	***	***	***	***	***

SL* = P < 0.05, SL*** = P < 0.001, HD = harvesting date, DM = dry matter content, ASH = ASH content, NDF = neutral detergent fiber, ADF = acid detergent fiber, ADL = acid detergent lignin, CP = crude protein, CPY = crude protein yield, SEM = standard error of mean, CV = coefficient variation, SL = significant level.

composition of sole and intercropped desho grass are shown in Table 3. This finding indicated that the chemical composition of intercropped desho grass with vetch species is significantly different from that of sole desho grass at both harvesting ages. This difference might be due to the intercropping effect in which desho grass presumed to be benefited from vetch species through nitrogen fixation in the soil, which increased the uptake of important nutrients for growth and nutritive value of *desho* grass. The degree of response on chemical composition might be different within species.

3.2.1. Dry Matter Content. The DM content from sole desho at 90 days of harvesting was significantly ($P < 0.05$) higher than desho+*V. dayscarpa* (Var-Lana) at both harvesting ages, and desho+*V. villosa* (Var-Gebisa) at 90 days of harvesting and itself at 120 days of harvesting age. A significantly lower DM content was recorded from desho+*V. dayscarpa* (Var-Lana) at 120 days of harvesting age. Harvesting age and intercropping of vetch species had a significant effect on the DM content of intercropped desho grass in this study.

3.2.2. Ash and Organic Matter. The ash content from sole desho, desho+*V. dayscarpa* (Var-Lana), desho+*V. villosa* (Gebisa) at 90 days of harvesting, and desho+*V. sativa* at 120 days of harvesting significant each other and higher from all the remaining treatment groups at both harvesting ages ($P < 0.05$) and significantly lower ash content was obtained from desho+*V. sativa* at 90 days of harvesting age. The opposite of ash content significance difference was true for the OM content: the higher the ash content, the lower the OM is, and vice versa at the same harvesting age of intercropped desho grass.

3.2.3. Crude Protein Content and Crude Protein Yield of Desho. A significantly higher CP content (%) was recorded from desho+*V. villosa* (Var-Gebisa), while a significantly lower CP content was obtained from sole desho at 90 and 120 days of harvesting. On the other hand, the crude protein yield (CPY) ton per hectare recorded from desho+*V. Villosa* (Var-Gebisa) (1.9) was significantly ($P < 0.05$) higher than all experimental groups at 90 days of harvesting age, while a significantly lower CPY was recorded from sole *desho* grass (0.56) at 120 days of harvesting age. Harvesting age and intercropping vetch species/varieties in this study had a significant effect on the CPY of *desho* grass.

3.2.4. Fiber Contents of Desho Grass. A significantly higher NDF content (%) was obtained from sole *desho* at 120 harvesting age, while a significantly lower NDF content was recorded from sole desho (75.46) at 90 days of harvesting age. Neutral detergent fiber has been shown to be negatively correlated with dry matter intake. On the other hand, a significantly higher ADF content (%) was obtained from sole *desho* grass at 120 harvesting age and desho+*V. sativa* at 90 harvesting age, while a significantly lower NDF content was

recorded from sole *desho* (52.69) at 90 days of harvesting age. A higher ADL content (%) was obtained from *Desho+V. dayscarpa* (Var-Lana) followed by *Desho+Vicia sativa* at 90 harvesting age, which is significantly similar to all treatment groups except sole *desho* at 90 days of harvesting age and *Desho+Vicia sativa* at 120 days of harvesting age, while a significantly lower ADL content was recorded from sole *desho* at 90 days of harvesting age followed by *Desho+Vicia sativa* at 120 days of harvesting age.

4. Discussion

The PH of *desho* grass increases progressively with increasing plant maturity from 90 to 120 days of harvesting at all intercropped *vetch* species, indicating that an increment in the current experiment at 120 days of harvest age could be due to massive root development and efficient nutrient uptake, allowing the plant to continue to increase in height of the grass [18]. The effect of harvesting age on the plant height of desho grass in the present study is in agreement with the report of [2] on the sole *desho* grass PH, which reported an increased plant height with advancing harvesting age from 90 (71) to 120 (94) to 150 days (106 cm). In the present study, the PH of *desho* with two accessions of *V. villosa* (Var-Gebisa & Lalisa) and *V. dayscarpa* (Var-Lana) treatment groups was significantly higher than that of *desho* grass reported by [2] without intercropping at 90 and 120 days of harvesting, while the plant height of sole *desho* and *desho* with *V. sativa* treatment groups were smaller than that reported by the same author at 90 days of harvesting age. This difference might be from soil fertility condition, altitude difference, planting system (sole and intercropping), rainfall pattern and distribution, and management practices where experiments were conducted.

In the present study, the PH of *desho* grass with two accessions of *V. villosa* (Var-Gebisa & Lalisa) and *V. dayscarpa* (Var-Lana) treatment groups was significantly higher than that of *desho* grass as reported in [19] at all harvesting ages, while the PH of sole *desho* (0.59 m) and *desho* with *V. sativa* (0.64 m) treatment groups was shorter than that of *desho* grass as reported by the same author at 105 and 135 days of harvesting age. This difference might be due to variations in harvesting ages, planting systems of intercropping and sole *desho* grass, altitudes, and soil fertility of the study area.

On the other hand, the intercropping of vetch species/varieties with desho grass showed a significantly higher PH than sole *desho* in the current result, which disagrees with [10] who reported that intercropping two types of vetch species with Napier grass, namely, *V. dayscarpa* and *V. villosa* had no significant effect on the plant height of intercropped Napier as compared to sole Napier. The mean heights of 75.8, 75.4, and 88.8 cm were recorded from sole Napier, Napier with *V. dayscarpa*, and Napier with *V. villosa*, respectively, as reported by [10]. This difference might be due to variations in grass species, soil fertility, and altitudes differences, where the current experiment was conducted. This might be due to nitrogen fixations of vetch species in the soil, which helps to intercropped *desho* grass grow faster than sole *desho* and also could reduce unwanted weeds and

shattering of *vetch* leaves on the ground, which may create a favorable environment for plant growth.

In the current finding, the tiller number increased with grass maturity, showing the appearance of numerous fine branches, and growing out from the leaf axils of the main stems leads to a high number of tillers per plant. As the age of the plant advances to 90, 120 and 150 days, the number of tillers increased as reported by [2] in sole *desho* grass. The NTPP from all treatment's groups of the current study except *desho* grass with *Vicia sativa* was higher than that of *desho* grass as reported by [2] at the 90 and 120 days of harvesting age. This difference might be due to variations in planting systems of *desho* grass and environmental conditions of the study area. The current result of the NTPP of intercropped and sole *desho* was lower than sole *desho* as reported by [19] at 105 and 135 days of harvesting age. These differences might be due to variations in harvesting ages, planting systems of intercropping and sole *desho* grass, altitude differences, and soil fertility conditions of the study area.

The intercropping of two *V. villosa* varieties with *desho* grass results in a higher tiller number, and the intercropping of *V. dayscarpa* (*Var-Lana*) and *V. sativa* with *desho* grass results in a lower tiller number compared to the intercropping of Napier grass with two vetch species as reported by [20]. The higher NTPP in the intercropped *desho* might be due to nitrogen fixations of vetch species in the soil, which helps to have more tillers per plant of intercropped *desho* grass than sole *desho* grass in the current study.

The leaf length per plant observed in the current study is in line with [2] who reported that an increment in the leaf length was found as the age of the plant increased from 90 to 120 days of harvesting age. The NLPP in the present study from all treatment groups was higher than that of *desho* grass as noted by [2] at the same harvesting age of 120 days, while the NLPP from sole *desho* grass in the current study was lower than that of *desho* grass and that of *desho* with *V. sativa* is higher than that of *desho* grass as reported by the same author at the same harvesting age of 90 days. This difference might come from the genetic potential of intercropped vetch species, rainfall distribution, altitudes, and soil fertility of the area where both studies were conducted in the different seasons. This variation might come from harvesting ages, planting system of intercropping *desho* grass with vetch species, and environmental conditions, of the study area.

Leaf length is a key factor determining the vegetative yield of forage grasses. As the harvesting age increased from 90 to 120 days, LL was increased in the present study is in agreement with sole *desho* grass as reported by [2] increased from 90 (20 cm) to 120 (27 cm) to 150 (29 cm) days of harvesting age. The LLPP in the current study from all treatment groups was nearly similar ranging from 23.33 to 26.67 cm with *desho* grass as noted by the same author at the same harvesting age of 120 days, while LLPP from sole *desho* grass in the current study was similar to *desho* grass and LLPP from *desho* with *Vicia sativa* (18 cm) is shorter than that from *desho* grass as reported by the same author at the same harvesting age of 90 days. This difference might be due to variations in altitudes, planting systems, environmental conditions of the study area. The LLPP from *desho* grass in the

current study from all treatment groups was higher as reported by [19] at both harvesting ages. This difference might be due to variations in harvesting ages, planting systems, altitudes, environmental conditions of the area, where both experiments were conducted in the different seasons.

The leaf-to-stem ratio of the current study is in agreement with reports of [2] who stated that as the harvesting age increased from 90 to 120 days of harvesting age the LSR was decreased which is in line with *desho* grass, early harvesting 90 (1.24) and 120 (1.17) days was resulted in significantly higher LSR compared to the late harvesting date 150 (0.82) harvesting day. The mean LSR in the current study from *desho* with two varieties of *V. villosa* and *V. dayscarpa* was higher and that from *desho* with *V. sativa* and sole *desho* was lower than that from *desho* grass as reported by [2] at the same 90 and 120 days of the harvesting period. This higher LSR in the current study might be due to variations in genetics, management, plant spacing, soil type, fertility, and environment of the area where both of experiments were conducted.

The dry matter yield of *desho* grass is not different from the reports of [2] who stated that as the harvesting age increased from 90 to 120 days, the DMY also increased in all treatment groups, which is in line with the current study that *desho* grass dry matter ton/ha increased from 90 (12.71) to 120 (13.73) to 150 (20.75) days of harvesting age. The mean DMY from *desho* grass with all vetch species was higher than that from *desho* grass as reported by [2] at the same 120 days of harvesting age, while mean dry matter from *desho* with two *V. villosa* Varieties (*Var-Gebisa* & *Lalisa*) and *V. dayscarpa* (*Var-Lana*) was higher and that from *desho* with *V. sativa* and sole *desho* grass was lower than that from *desho* grass as reported by the same author at 90 days of harvesting age. This difference might be due to variations in environmental conditions, management practices, planting systems, and soil fertility conditions of the area where both studies were conducted in the different seasons.

The mean DMY of *desho* grass with all vetch species/ varieties and sole *desho* was higher than that of *desho* grass as reported by [19] at 75 days of harvesting age and lower at 135 days of the harvesting period, while dry matter yield of *desho* grass with *Vicia sativa* and sole *desho* was at 90 days of harvesting lower than that of *desho* grass as noted by the same author at 105 days of harvesting age and nearly similar to the remaining treatment groups at 120 days of harvesting. This difference might come from variations in environment, management, plant spacing, rainfall, and soil type and fertility. This current result is in line with Napier grass intercropped with two species of vetch as reported by [10]. The total dry matter yield ton per hectare of was 0.49, 5.95, and 5.21 ton per hectare from sole Napier, Napier with *V. dayscarpa*, and Napier with *V. villosa*, respectively, as reported by [10]. The current result from all treatment groups was higher than that of the Napier grass intercropped with two species of vetch as indicated by the same author. This difference might be due to variations in genetic species of grasses, environmental conditions like rainfall condition, temperature, humidity, altitude, soil property of the area where the current experiment was conducted. In this finding, it was

indicated that Napier grass intercropped with herbaceous perennial legume had a significant advantage than growing sole Napier grasses to increase the DM yield [20].

The dry matter yield of desho grass is not different from the reports of [2] who stated that as the harvesting age increased from 90 to 120 days so also the DMY increased from 12.71 to 120 13.73 t/ha. This difference might be due to management system, altitude, soil fertility and soil type, drying methods, and environmental conditions of the area where the current experiment was conducted. On the other way, the current study is in line with the study of desho grass as indicated by [19] of which harvesting age had a significant effect on the DM content (%) of desho grass, which linearly increased from 75 (88.2) to 105 (88.4) and 135 (89.0) days of harvesting. Ref. [21] reported that the fertilizer type had no significant effect on the DM content (%) of desho grass with results of NPS (84.23), manure (83.58), and without fertilizer (82.98) at 120 days of harvesting age.

The current study is in line with the study of sole desho grass as reported by [19], indicating that harvesting age had a significant effect on the ash and OM content (%) of desho grass without intercropping. The ash and OM content was 9.16 and 79.1, 7.89 and 80.6, and 7 and 82 at 75, 105, and 135 harvesting days, respectively. The current result was higher than the same desho grass as reported by the same author. This difference might come from planting system, management practices, harvesting age, and environmental conditions of the area where the current and previous studies were conducted. Ref. [21] reported that the fertilizer type had a significant effect on the ash and OM content (%) of desho grass. The current result on the ash content was lower and on the OM content was higher, except with NPS fertilizer at 120 days of harvesting age. This difference might be due to variations in altitude, planting system, fertilizer level and type, and environmental condition of the area where the current study was accomplished. On the other hand, Ref. [2] reported that harvesting age had no significant effect on the OM content (%) of desho grass at 90 (89.12), 120 (89.66), and 150 (90.57) days of harvesting age.

The crude protein contents obtained in the current study are in line with the reports of [19] at 75 (10.9), 105 (10.2), and 135 (9.3) days of harvesting age. The current result from sole desho was lower than [20] who reported that the intercropped desho grass was higher than both authors. Ref. [21] reported that fertilizer type had a significant effect on the CP content of desho grass with results of NPS (10.95), manure (10.04), and without fertilizer (9) at 120 days of harvesting age. This result was higher than that of sole desho and lower than that of intercropped desho grass at similar 120 days of harvesting age. These differences might be due to the variations in planting system, fertilizer, soil type and fertility, altitude, and environmental conditions of the area where the experiment was conducted. Crude protein is the highest in the early (90) harvesting ages compared to late age (120) harvesting ages in the current study. This could be attributed mainly to the dilution of the CP contents of the forage crops by the rapid accumulation of cell wall carbohydrates at the later ages of growth and also soluble cell

components are highest in actively growing forage tissue and decline as plants become mature and dormant.

Intercropping of desho grass with vetch species had a significant effect on the CP content (%) of desho grass in the current study, which disagrees with [22], which reported that the intercropping of herbaceous legumes such as *Stylosanthes scarab* and *Macroptilium atropurpureum* with Napier grass was not significantly different from sole Napier grass in CP content in the semi-arid region of Eastern Kenya. The mean CP content (%) was 6.2, 6.66, and 6.11 from sole Napier, *Stylosanthes scarab* with Napier, and *Macroptilium atropurpureum* with Napier grass, respectively. This result was lower than the current study result from all experimental groups, due to the genetic difference in grass and intercropped legumes species, management system, soil fertility and type, and environmental conditions of the area such as rainfall where the current experiment was conducted.

The current result for sole desho grass is in agreement with the report made by [20] who stated that harvesting age had significant effect on CPY at 75 (0.8), 105 (1.6), and 135 (2.4) days of harvesting age. This result was significantly higher than the current result. This might be due to planting system, harvesting age, altitude, soil type and fertility, and environmental conditions of the area where the experiment was conducted. Ref. [2] reported that harvesting age had no significant effect on the CPY of desho grass at 90 (1.21), 120 (1.21), and 150 (1.44) days of harvesting age. This result was higher than that of sole desho and lower than that of intercropped desho grass at the same 90 and 120 days of harvesting age. This might come from the planting system, altitude, soil type and fertility, and environmental conditions of the area where the experiment was conducted. Ref. [21] reported that fertilizer type had a significant effect on the CPY content of desho grass with the result of NPS (2.76), manure (1.39), and without fertilizer (0.7) at 120 days of harvesting age. The current result on CPY was lower than that of desho grass with NPS at 120 days of harvesting age. This difference might be from planting system, fertilizer type, and environmental conditions of the area where the current experiment was conducted.

A better prediction of forage intake can be made using NDF; therefore, better rations can be formulated [23]. Harvesting age and intercropping vetch species had a significant effect on the NDF content of desho grass in the current study. Harvesting age had a significant effect on the NDF content of desho grass as reported by [2] at 90 (72.78), 120 (73.9), and 150 (77.68) and [19] at 75 (45.26), 105 (46.26), and 135 (51.7) days of harvesting age. Ref. [21] reported that the fertilizer type had a significant effect on the NDF content of desho grass with results of NPS (51), manure (55), and without fertilizer (61) at 120 days of harvesting age. This difference might be from planting system, harvesting age, altitude, soil type and fertility, fertilizer, and environmental conditions of the area where the current experiment was conducted.

Intercropping of desho grass with vetch species had a significant effect on the NDF content (%) of desho grass, which is in line with [21], which reported that the

intercropping of herbaceous legumes such as *Stylosanthes scarab* and *Macroptilium atropurpureum* with Napier grass was significantly different from sole Napier grass in the NDF content in semi-arid region of Eastern Kenya. The mean NDF content was 64.78, 63.23, and 62.81 from sole Napier, *Stylosanthes scarab* with Napier, and *Macroptilium atropurpureum* with Napier grass, respectively. The lowest NDF content was recorded from those intercropped legumes. This result was lower than the current result, due to the genetic difference in grass and intercropped legumes species, management practices, and environmental condition of the study area.

Acid detergent fiber is a good indicator of digestibility and thus energy intake [24]. As the ADF increases, the forage becomes less digestible [23]. Harvesting age and intercropping vetch species had a significant effect on the ADF content (%) of *desho* grass in the current study. Harvesting age had a significant effect on the ADF content of *desho* grass; as reported by [2], harvesting age had significant effect on the ADF content of *desho* grass at 90 (40.27) and 120 (42.15). Moreover, the reports of [19] indicated significant variations at 150 (45.06) and at 75 (33.1), 105 (37.6), and 135 (42.6) days of harvesting age.

Intercropping of *desho* grass with vetch species had a significant effect on the ADF content (%) of *desho* grass, which is in line with [22] who reported that the intercropping of herbaceous legumes such as *Stylosanthes scarab* and *Macroptilium atropurpureum* with Napier grass was significantly different from sole Napier grass in the ADF content in the semi-arid region of Eastern Kenya. The mean ADF content was 45.91, 43.57, and 43.91 for sole Napier, *Stylosanthes scarab* with Napier, and *Macroptilium atropurpureum* with Napier grass, respectively. The lowest ADF content was recorded from those intercropped legumes. This result was lower than the current result due to the genetic difference in grass and intercropped legumes species, management system, and environmental condition of the area where the current experiment was conducted. There was a significant gain in CP and reduced ADF and lignin by mixing legumes with Napier grass, thus improving herbage nutritive value and digestibility [21]. Lignin limits cell wall (fiber) digestion by providing a physical barrier to microbial attack, and the concentration of both fiber and lignin increases as plants mature [23]. Ruminants can digest the cellulose and hemicellulose components of fiber, but the lignin inhibits the rate and extent of digestion especially when the proportion of lignin in fiber begins to increase.

Harvesting age and intercropping vetch species had a significant effect on the ADL content (%) of *desho* grass in the current study. Harvesting age had a significant effect on the ADL content of *desho* grass as reported by [2] at 90 (4.68), 120 (5.53), and 150 (5.95) days of harvesting age. Intercropping of *desho* grass with vetch species had a significant effect on the ADL content of *desho* grass, which disagrees with [22] who reported that intercropping of herbaceous legumes such as *Stylosanthes scarab* and *Macroptilium atropurpureum* with Napier grass was not significantly different as compare to sole Napier.

5. Conclusion

The current study confirmed that the intercropping of *desho* grass with vetch species/varieties can help to overcome the shortage of livestock feed in both quantity and quality by producing the additional quantity and quality feed especially by intercropping with the two *V. Villosa* varieties (Var-Gebisa & Lalisa). Therefore, two *V. Villosa* varieties (Var-Gebisa & Lalisa) were found best compatible with *desho* grass in terms of total dry matter yield and CPY content during the establishment phase of *desho* grass without affecting the main forage grass of *desho* in the current study. Further studies should be conducted to maximize the productivity of intercropping *desho* grass with those selected vetch varieties. Moreover, animal evaluation studies of mixed pasture using best vetch varieties could be the future research direction in the study area.

Data Availability

All data are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this article.

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