

## Evaluation of Barley Green Forage as Animal Feed Intercropping with Vetch in North Gondar Zone, Ethiopia.

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**Abstract:** The objective of the study was to evaluate the optimum stages of forage harvest for chemical composition of barley/vetch mixture for better yield of forage. The methodology of the experiment was designed and employed randomized complete block design (RCBD) with three replication in the mixture. The plot size was 2 x 5 m. Data was subjected to analysis of variance using SPSS Statistical Package for chemical analysis and forage quality. Highly significant variation ( $P < 0.01$ ) on Crude Protein contents (CP) (24.15%) at harvesting stages one and CP yields of 1.55t/ha was also obtained at harvesting stage two (HS2). In all observation increasing stages of harvest the forage quality becomes deteriorated while increasing of the fiber contents (NDF). Acid detergent fiber (ADF) was high after two successive cutting of forage but all the fiber content is high at HS3. Acid detergent lignin (ADL) was higher at HS3 and the lowest value was obtained at HS1. In general, the fiber contents were increased with increasing the stages of harvesting as a whole. In vitro dry matter digestibility (IVDMD) was higher with the value of 78.5 at HS1 and followed by HS2 with the value of 72%. The highest metabolizable energy value was recorded at HS1; digestible crude protein (CP) was also higher at HS1, with the value of 3.57%. With all these findings the experiment result of this study, harvesting of forage at milk stage could be considered as the best stages of cutting for barley: vetch forage mixture.

**Key words:** Evaluation • Cutting • Quality • Barley • Vetch • Ethiopia

### INTRODUCTION

Natural grazing land of the area consists of largely wide range of grasses, legumes and other herbaceous species. According to Daneil [1], the existing feed stuffs in Ethiopia, native pasture and crop residues are poor in quality and provide insufficient protein, energy, vitamins and minerals. Animals' thrive predominantly on high-fiber feeds, which are incomplete in nutrients (nitrogen, sulfur, phosphorus, etc) necessary for microbial fermentation [2]. A major factor in increasing livestock productivity will be the improvement of animal nutrition and feed supplies, especially in case of ruminants. Improved animal disease and parasite control, breeding and management will also be important, but initially a major emphasis must be placed on providing better nutrition [3].

Tropical forages play a vital role in the development of sustainable cropping system and a best methods of

forage improvement has arisen by using intercropping of annual crops and perennial legumes in sole cropping patterns makes it possible to manipulate the outcome of competition [4].

The performance of the mixture depends on their compatibility and initial seed rate proportions of grass and legume species [5]. Low seed rate results in a poor stand and prolonged time required for development of satisfactory grass-legume mixed pasture and high seed rates are in conspicuous because it incurs higher cost [6]. Barley species and the legume vetch have been identified to have a promising potential for pasture improvement. Therefore, this study was designed with the following specific objectives;

- To study the optimum seeding rates and cutting stages for chemical analysis of forage quality in the mixture.

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- To assess the *in vitro* dry matter digestibility of forage barley and vetch mixture.

## MATERIALS AND METHODS

**Description of the Study Area:** The experiment was conducted at, North Western parts of the district, Ethiopia, 736 km North of Addis Ababa and 36 km from Gondar to Gorgora Tana road. The area experiences one main rainy with long rainy season extending from half of March to the mid October. But the effective rainfall is from May to half October.

**Soil Characterization of the Experiment Site:** The surface soil characterization was done by taking samples from different places of the experimental site diagonally at the depth of 15-20 cm, thus the samples were compiled and duplicate for all types of soil chemical analysis based on the soil laboratory procedure. Soil pH at the soil: water ratio of 1: 2.5, Organic carbon content (%), total nitrogen (N) and Available phosphors (P) was determined by Bremner and Mulvancy [7].

**Experimental Design and Treatments:** The experiment was conducted with three stages of cutting for better quality and chemical analysis grown in red soil. The experimental treatment were, boot stage of Barley, milk stage of barley and dough stage as a whole.

**Sample Preparation and Methods of Chemical Analysis:** The dried forage was ground in a cyclone mill to pass a 1 mm screen for chemical analysis at Holleta Animal Nutrition Laboratory. The sample were analyzed for dry matter (DM) contents of the feed by putting the sample in the oven dried at a temperature of 65°C for 72 hours, then calculate the dry matter composition of the forages. Crude protein (CP) can be determined according to A.O.A.C [8]. Maynard and Loosli [9], was indicated that the usual methods of obtaining an estimate of the protein contents of the feed are indirect. That is by analyzing the nitrogen contents of feed and converted it by multiplying the values by the factor of 6.25 units (Kjeldhal methods). Neutral detergent fiber (NDF) it is only plant fraction that can account for rumen fill and voluntary intake of forage and that is highly correlated with both rumination and chewing time among a wide range of forages [10].

## RESULTS AND DISCUSSION

**Crude Protein Yield (CPY):** Crude protein yield increased slightly with harvesting stages and higher value of crud protein yield was obtained at harvesting stage three with the value of 1.6t/ha (Table 2) above. The direct effect of increasing dry matter yield that consequently increased the CPY from HS1 to HS3 and the average value was 1.34t/ha. The lowest crude protein yield was found at the first stages of harvesting of forage (0.96).

**Crude Protein (CP) Content:** Analysis of variance data revealed significantly affected ( $P<0.01$ ) by harvesting stages showed in (Table 2). The average crude protein contents in all cutting phases was 16.32% and the lowest value was registered in HS3 which has 12.62%, where as the highest crude protein percentages if found in HS1 with the value of 19.81% in the above (Table 2).

The CP content of all the treatments in this study was above the minimum level of 7.5 percent required for optimum rumen function [11]. In addition, the crude protein content of the forage species under most of the treatments in this study could also satisfy the requirement for lactation and growth [12], that the minimum of 15 percent CP required for lactation and growth. Barley/vetch associated forage crops could be categorized under medium to high quality forage groups and it could be potentially useful as a supplement or substitute to crop residue and natural pasture in mixed farming system of Ethiopia [13].

**Dry Matter (DM) Content:** The mean dry mater percentage of the forage at the harvesting stages two was 27.44% (Table 2). The DM content of forage also affected increasing in HS. The maximum value was obtained at HS3 with the value of 30.91%. The increasing tendency of DM content was observed from HS1 to HS3 this is due to increasing the ages of the plant. Highly significant difference ( $P<0.01$ ) of DM percentage was obtained at HS2.

**Total Ash Content (%):** Their interaction was also significantly influenced ( $P<0.01$ ) in the total ash content of the forage. Higher ash content was found harvesting phase one (12.65) while the lowest value was found in stages three where as the average total ash contents was 11.21 showed in the above (Table 2). This result has an agreement, Olsen et al. [14], who found that higher mineral value for the two vetch verities and lower ash content for the three oat verities used in his oat/vetch trail.

Table 1: Soil Characterization of the Experiment Site

Types soil element	Results
Nitrogen	4.5%
Organic carbon	3.1
pH	6.6
Extractable phosphorus	1.6%
Organic matter	9.1 ppm

**Neutral Detergent Fiber (NDF):** Analysis of variance indicated that, neutral detergent fiber percentage was significantly affected at ( $P<0.01$ ) in the various phases of cutting at (Table 2). As the stages of plant growth become advanced the contents of NDF also high and vise versa, in addition the highest value was obtained at

Table 2: Chemical ingredients of the various stages of forage in the mixture

Feed ingredients	Stages of cutting			
	HS1	HS2	HS3	Mean
Crude protein yield	0.96 <sup>a</sup>	1.45 <sup>a</sup>	1.6 <sup>b</sup>	1.34 <sup>a</sup>
Crude protein (%)	19.81	16.51	12.62	16.32
Dry matter	22.14	27.44	30.91	26.83
Total ash	12.65 <sup>a</sup>	12.16 <sup>a</sup>	8.83 <sup>b</sup>	11.21 <sup>a</sup>
Neutral detergent fiber	51.19 <sup>b</sup>	52.6 <sup>b</sup>	61.25 <sup>a</sup>	54.98 <sup>b</sup>
Acid detergent fiber	35.6	37.6	46.5	39.9 <sup>a</sup>
Acid detergent lignin	8.99 <sup>b</sup>	9.57 <sup>b</sup>	14.16 <sup>a</sup>	10.91
Hemicelluloses	15.81	17.33	19.45	17.53
Cellulose	26.31 <sup>b</sup>	27.75 <sup>b</sup>	31.98 <sup>a</sup>	28.68
Metabolizable energy (Mca/kg)	5.35 <sup>a</sup>	4.71 <sup>a</sup>	3.43 <sup>b</sup>	4.50
Invitro dry matter digestibility (%)	69.33 <sup>a</sup>	63.84 <sup>b</sup>	50.83 <sup>c</sup>	61.33
SE (±)	0.7	0.18	0.32	-
CV (%)	3.73	3.73	3.73	-

Key: SE = Standard error, LSD = Least significant different, CV = coefficient of variation, HS= Harvesting stages (1-3), =, different letter within the columns are indicated significant different, whereas the same letter showed no significant, TA =total ash.

harvesting stage three (HS3) and the lowest average value at harvesting stage one (HS1) measuring the value 61.25 and 51.19 percent with the difference of 10.06 percent correspondingly. According to Singh and Ousting [15], roughage diets with NDF percent of 45-65% and below 45% are generally considered to be medium to high quality feeds respectively.

**Acid Detergent Fiber (ADF):** Acid detergent fiber was again significantly affected ( $P<0.01$ ) by both main plot and sub plot treatments and with their interactions (Table 2). According to Tessema [12], the average value of acid detergent fiber in the different harvesting stages was 39.9 with a range of 35.6 to 46.5%. The study agreed with the results reported by. The interaction between in the different harvesting stages was also showed significant effect at ( $P<0.01$ ) [16].

**Acid Detergent Lignin (ADL):** The various harvesting stages of the forage development interaction showed significant difference ( $P<0.01$ ) in acid detergent lignin content of the mixed forages. The lowest and highest value being at HS1 and HS3 which measured 8.99 and 14.16 percents with the variation 5.17 unit respectively at (Table 2) [12]. According to Maynard and Loosli [9], some other scientists be lived that the content of lignin increases steadily as the growing plant matures and its chemical linkage especially with hemicelluloses and

cellulose markedly reduces the digestibility of the forage, due to its strong hydrogen bondages between the different fiber proportions of the plant species.

**Hemicelluloses (HEM):** Statistical significant different ( $P<0.01$ ) was observed in the experiment on the hemicelluloses contents of main plot treatments of the forage mixture. The highest and the lowest value were found at harvesting stage three and harvesting stage one with the value of 19.45 and 15.81 percent respectively. Since hemicelluloses is the derivatives of neutral detergent fiber, hence, acid detergent fiber content at first stage of cutting was relatively low that could contributed the highest result of hemicelluloses in the forage mixture [14].

**Cellulose (CEL):** Cellulose content was significantly influenced ( $P<0.01$ ) by the various stages of harvesting in the forage mixture. The result obtained in the different harvesting stages showed an increasing tendency with respect to maturity stages of plant growth this is because of the high cell wall contents of matured plant which contributed to high proportion of the different fiber constituent of the plant. The highest and the lowest cellulose value was found at harvesting stage three and one (31.98 and 26.31%) respectively, with the average value of 28.68 percent in the forage mixture [16].

#### **Metabolizable Energy (ME) Contents of the Mixture:**

The results clearly indicated that harvesting stages showed significantly affected at ( $P < 0.01$ ) of ME contents of the forage. Metabolizable energy (Mcal) per kg of dry matter was higher at harvesting stage one with value of 5.35 Mcal/kg in the mixture. In addition, the interaction effect showed significant difference ( $P < 0.01$ ) in ME contents of both forages species. The highest and the lowest values of metabolizable energy contents were found at harvesting stage one and harvesting stage three which measured 5.35 and 3.43 Mcal respectively. The trends of the different harvesting stage indicated decreasing tendency in ME as stages of maturity of forage become advanced similar results were also reported elsewhere [17]

**In Vitro Dry Matter Digestibility (IVDMD):** *In vitro* dry matter (IVDMD) was significantly affected ( $P < 0.01$ ) by the different plot treatment in the forage mixture. IVDMD was high at harvesting stage one and declined at harvesting stage three with the values from 69.33 and 50.83 correspondingly. The reduction in IVDMD among the different harvestings was very high. Therefore when the stages of harvesting increases then the *in vitro* dry matter digestibility is decline [18].

#### **CONCLUSION**

In general with all these important forage or feed quality parameters and other useful morphological characteristics, it can be conclude that, harvesting stage to 50% flowering of forage would be recommended for improved forage production with respect to higher nutritional value which can defeat the livestock feed problems particularly in the highlands of Ethiopia due to their mixed farming agricultural system where implemented using barley and vetches as sources of forage intercropping grown successfully.

The performance of the intercropping is much more dependent on the assortment of compatible crop type and varieties. It is therefore indispensable to study the different varieties of barley and vetch so as to identify the compatible ones. Intercropping of forage is known to have a significant role in improving the nutritional status of the soils and hence increases the forage yield. It is therefore important to study the effect of barley / vetch intercropping on soil fertility and its impact on forage biomass yield. Assessment along with the effect of feed intake and animal productivity trial such as milk and meat production, body weight gain are required

to develop barley / vetch mixture based diets for small holder farmers in the highlands of Ethiopia is highly recommended. In conclusion, the current experiment should be conducted on different agro ecological areas and soil types where barley and vetches are grown and expected to be potential feed sources for livestock feeding.

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