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Farmers perception and utilization status of improved forages grown in the natural resource areas of northwestern Ethiopia

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Abstract. *Shiferaw M, Asmare B, Tegegne F, Molla D. 2018. Farmers perception and utilization status of improved forages grown in the natural resource areas of northwestern Ethiopia. Biodiversitas 19: 1568-1578.* A study on the perception and utilization of improved forages grown in natural resource conservation areas was conducted in selected districts of northwestern Ethiopia**.** This study aims to investigate the perception of improved forage production and utilization system on natural resource conservation areas in selected areas of northwestern Ethiopia. Primary data was collected from selected households by interviewing using semi-structured questionnaire. Field observation and focus group discussion were also employed to enhance the survey data. A total of 180 households (90 from each district) were selected and interviewed. The collected data were analyzed with descriptive statistics using SPSS software version 20. The result indicated that the average land and livestock holding of respondents were 2.24 ha and 5.56 TLU per household, respectively. The most common forage production methods used by the smallholder farmers were broadcasting (41%), cutting (28%) and row seedling (18%) for both districts. For the majority of respondents (44%), the purpose of forage production of respondents was for animal fodder. Farmers in the study areas had a good perception about improved forage production as forages due have multifunction to the household in the form of soil conservation, fodder production, and income generation. Though improved forages have many roles in the livelihood and environmental management of the study districts, respondents had problems of skill in production and utilization of forages. This study elucidates that, relevant development and research interventions such as management and utilization of improved forage production should be the future direction of research and development. Sustainable forage development and use for nature conservation and is becoming very important to be a livestock feed source if cut and carry system is regularly applied.

Keywords: Conservation, farmers' perceptions, improved forages, natural resource, utilization

INTRODUCTION

Livestock production in Ethiopia has considerable economic and social importance at household and national levels and provides significant export earnings. The overall livestock sector, such as cattle, sheep, goats, equine and poultry contributes 15 to 17% of gross domestic product (GDP) and 37 to 87% of the household incomes (ILRI 2010; Behnke and Menagerie 2011). Generally, the contribution of livestock to the national economy is estimated to be 47.7% of the agricultural GDP (IGAD 2011). Although livestock has many roles in the household and national economy of the country, current contribution of this subsector is below its potential due to various technical and non-technical problems. Among technicalissues, shortage of cultivated and wild feedboth in quantity and quality is the one (CSA 2016).

In Ethiopia, due to the inconsistency of feed quality and quantity, livestock perform poor especially in dry seasons of the year (Ayantunde et al. 2005). This condition calls for integration of improved forage that could have several advantages over conventional feed resources available. Though improved forages were being introduced as biological soil conservation and animal fodder in government intervention areas of Ethiopia, little is known about how farmers perceive the production and utilization of such forages. Farmers' perceptions about technology were one of the factors, which can facilitate or undermine adoption of improved forage technology; proceed to the types of improved forages grown on natural resource conservation areas of an agro-ecological zone and institutional factors individual farmers from using the feed resource management technology (Garedew 2005).

The study aims to analyze farmers' perceptions, assess the utilization practice and identify production and utilization of improved forages grown on soil conservation areas of selected districts in northwesten Ethiopia.

MATERIALS AND METHODS

Description of the study area

The study was carried out from December 2015 to March 2016 in Mecha and North Achefer Districts, purposely selected based on the practice of improved forage production and utilization. North Achefer receives an average annual rainfall of 1409mm and the temperature ranges 16-22.5°C (CSA 2013) and located between 11°05'-11°38' N and 37°0'-37°23' E, at an altitude of ranging from 1800 to 2800 m above sea level, Mecha receives an average annual rainfall of 1750 mm and the mean annual temperature of 19.5 °C. (CSA 2013). A total of 180 households, ninety from each district were selected randomly from populations of farmers practice improved forage production and utilization in the areas.

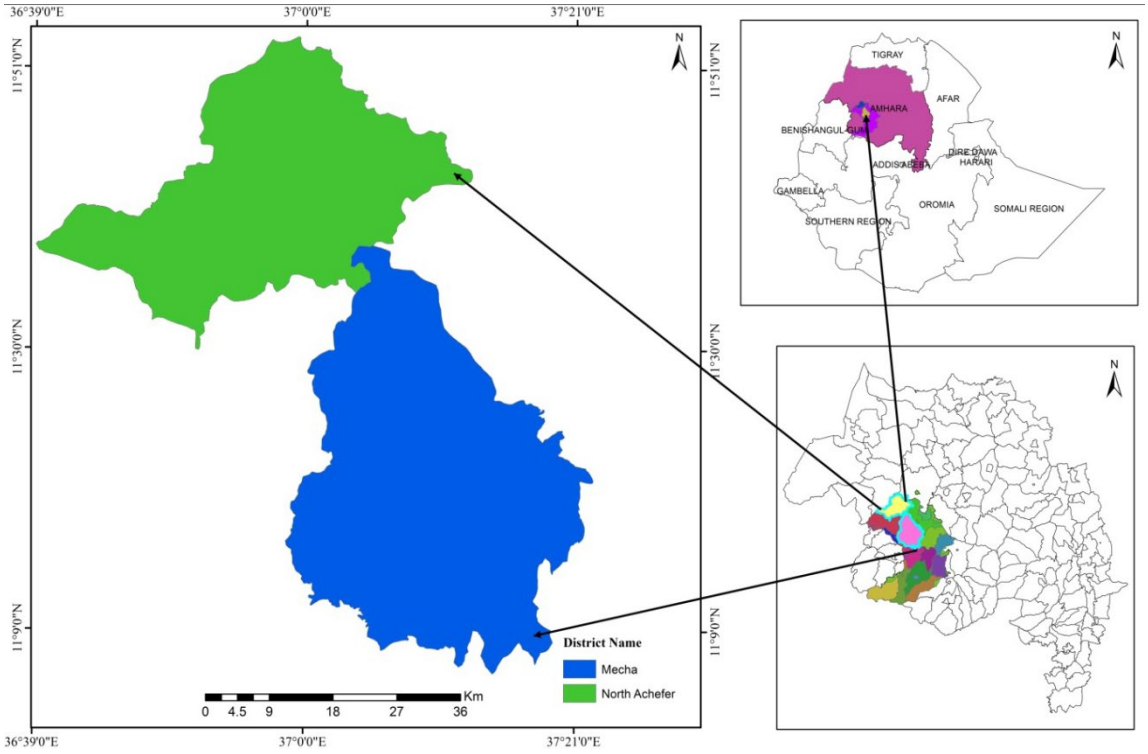

Figure 1. Map of the study areas in Mecha and North Achefer Districts of West Gojjam Zone, Amhara National Regional State, Ethiopia

Data management and statistical analysis

The collected data collected were analyzed using employing Statistical Package for Social Sciences (SPSS 2013). The purpose of livestock keeping and major livestock constraints were analyzed and summarized by index method. The index was computed with the principle of weighted average according to the following formula as employed by Musa et al. (2006):

$$\text{Index} = R_n{*}C_1 + R_n\text{-}1{*}C_2 \ldots R_1{*}C_n / \sum R_n{*}C_1 + R_{n\text{-}1}{*}C_2 \ldots R_1$$

Where;

R_n: Value given for the least ranked level (example if the least rank is 5th rank, then $R_{n\text{-}5}$, $R_{n\text{-}1}$=4 and … R_1= 1)

C_n: Counts of the least ranked level (in the above example, the count of the 5th rank = C_n, and the counts of the 1st rank = C_1).

RESULTS AND DISCUSSION

Socio-economic characteristics of respondents

The socioeconomic characteristics of respondents in the two districts are presented in Table 1. From the total respondents, 80% were male and the remaining (20%) were females of different age and educational status. The average age of the respondents' household member's was 45.41 ranging from 25 to 80 years. The age of respondents in the current result was comparable with the value of Worku (2015) who reported that the average age of the respondents of peri-urban and rural areas in Sekota district of Waghimra zone (Amhara National Regional State) was 41.9 years.

The mean family size observed in the current study was 3.16 persons per household. This result was lower than the study of Kebede (2009) who reported that the average family size in Bure district of Amhara National Regional State was 6.22. The analysis of variance indicated that the areas were not significantly different (P>0.05) concerning of family size and HH sex. However, there was significant variation (P<0.001) concerning of household sex and age intervals.

Educational characteristics of respondents

The education characteristics of respondents are indicated in Table 2. Of the total respondents, 20% were illiterate, whereas the remaining were literate with 26% read and write and 30% had attended primary school. The trend was similar at both locations. Education characteristics of respondents in the current study were better than Asmare et al. (2016) and Bitew et al. (2014) in northwestern Ethiopia. In both districts, the educational level had positive implications for forage development such as improved forage production and utilization practices.

Table 1. Socio-economic characteristic of interviewed respondents within the districts

Variables		North Achefer		Mecha		Overall		Prob
		N	%	N	%	N	%	
HH family size distribution	1-4	26	29	14	16	40	22	
	5-8	51	57	64	71	115	64	
	9-10	12	13	8	9	20	11	
	>10	1	1	4	4	5	3	
	Total	90	100.0	90	100.0	180	100.0	
HH head sex	Male	72	80	72	80	144	80	
	Female	18	20	18	20	36	20	0.315^{NS}
	Total	90	100.0	90	100.0	180	100.0	
HHs age	20-45	65	72.2	62	68.9	127	70.6	0.000^{S}
Interval	46-65	23	25.6	26	28.9	49	27.2	0.000^{S}
	>65	2	2.2	2	2.2	4	2.2	0.000^{S}
	Total	90	100	90	100	180	100	
HHs age interval	20-45	97	67.4	30	83.3	127	70.6	0.000^{S}
	46-65	43	29.9	6	16.7	49	27.2	0.000^{S}
	>65	4	2.7	0	0	4	2.2	0.32 ^{NS}
	Total	144	100	36	100	180	100	

Note: S: Significant difference at (P<0.05), NS: Not significant difference at (P>0.05), N: Number of observation

Table 2. Educational level of the household among the two districts

Educational the level of HHs	North Achefer		Mecha		Overall		Prob.
	N	%	N	%	N	%	
Illiterate	17	20	19	21	36	20	
Read only	21	23	26	29	47	26	-
Primary	30	33	24	27	54	30	0.057^{S}
Junior	10	11	6	6	16	9	
Secondary	8	9	7	8	15	8	
>Secondary	4	4	8	9	12	7	0.019^{S}
Total	90	100.0	90	100.0	180	100.0	

Note: HH: Household, N: Number of observations, S: Significance difference at (P < 0.05)

There were significant variations concerning of educational level of respondents, particularly the primary education and secondary education showed higher (P<0.001) than other respondents.

Landholding and land use patterns of farming activities

In the study areas, major farming activities were mixed crop and livestock farming. The overall land holding of the study areas was 2.24 ha per household(Table 3). The average total landholding of respondents in the current study was slightly lower than the national average land holding size of 2.5 ha (CSA 2013). In both districts, only a few farmers allocate land for forage cultivation (8%) which might be because of land scarcity, lack of awareness, shortage of input.

The finding is in agreement with reports of Mengistu (2006) for low adoption of forage plants. The average private grazing land in the study areas was 0.024 ha per household. The mean grazing land owned per household in this study was lower 0.51 ha in Bahir Dar Zuria which was reported by (Tassew 2007). The landholding status of respondents in all districts indicated that there was no significant difference among households. This condition might be due to the fact that farmers had the same place of land for multiple purposes in the study area.

Livestock holding of respondents

The overall mean of livestock holding in the study areas is shown in Table 4. The result showed that the mean livestock holding per household of 5.66 TLU. The finding of this study was comparable with 5.31 TLU, reported by Mulu (2009) in Bure district and lower than 7.3 TLU, Anteneh (2006) in Fogera district of the same area previously.

Purpose of livestock keeping

The purpose of livestock keeping by respondents in the study districts is shown in Table 5. The functions of cattle in the area like other locations were milk production, draught use, beef production and household consumption.

In the study area, livestock is an integral part of the agricultural systems serving as the source of draught power for land preparation, of meat and milk, of income and savings. The purpose of livestock in the current study area is in line with earlier reports for other areas of the country (Yeheyis et al. 2010; Assefa et al. 2015).

Livestock feed resources

The major livestock feed resources of livestock both in dry and wet seasons were presented in Tables 6 and 7. The most essential feed resources for livestock in the study areas were crop residues, natural pasture, hay and browsed trees, industrial by-products, improved forages and *Attela* (local breweries byproduct).

Dry season feeds

In the study area, during the dry season the major feed resources used by respondents were mixed sward grass hay, *Attela* (local breweries byproducts), improved forages, and household wastes and crop residues, respectively were among commonly used according to the order of availability. This result was in contrary with the result reported by Endalew et al. (2016) in Enebsie Sarmidr District, East Gojjam Zone. The contribution of crop residues was increasing from time to time as reported by Tolera (2007) which reaches up to 80% during the dry seasons of the year in the rural livestock feeding systems of the country.

Wet season feeds

During the wet seasons of the year, the major livestock feed resources in the study areas were ranked as natural pasture, weeds and green grasses like *Andropogon* species, improved forages and browse plants, *Attela,* industrial byproducts and HH wastes, crop residues (1st, 2nd,3rd ,4th,5th and 6th), respectively. This result agreed with Endalew et al. (2016), in Enebsie Sarmidr District, East Gojjam Zone.

Table 3. Landholding of the respondents across the different districts

Total landholding in interval (ha)	North Achefer		Mecha		Overall		Prob.
	N	%	N	%	N	%	
1.5-1.75	2	2.2	4	4.4	6	3.3	
2-3.0	60	66.7	66	73.3	126	70	
>3.0	28	31.1	20	22.2	48	26.7	0.067^{NS}
Total	90	100.0	90	100.0	180	100.0	
Mean ± SE		2.29±0.053		2.18±0.051		2.24±0.052	

Note: N: Number of observation (frequency), ha: hectare (1 ha: 4 *Kada* the local name), NS: Not significant difference at (P>0.05)

Table 4. Overall species composition of herds (TLU) distribution among districts per HHs

Livestock species	LHI (TLU)	North Achefer		Mecha		Overall		CF
		N	%	N	%	N	%	
Cattle	0-2	0	0	2	2.2	2	1	
	3-4	4	4.4	5	5.6	9	5	
	5-6	35	38.9	43	47.8	78	43	0.7
	7-8	20	22.2	33	36.7	53	29	
	>8	31	34.4	7	7.8	38	21	
	Total	90	100.00	90	100.00	180	100.00	
Sheep	0-1	8	8.9	18	20.0	26	14	
	2-3	14	15.6	16	17.8	30	17	0.1
	>3	68	75.6	56	62.2	124	69	
	Total	90	100.00	90	100.0	180	100.00	
Goats	0-1	29	32.2	56	62.2	85	47	
	2-3	14	15.6	22	24.4	36	20	
	>3	47	52.2	12	13.3	59	33	0.1
	Total	90	100.00	90	100.00	180	100.00	
Equines	0-1	62	68.9	70	77.8	132	73	
	2-3	28	31.1	20	22.2	48	27	
	>3	0	0	0	0	0	0	0.8
	Total	90	100.00	90	100.00	180	100	
Poultry	0-1	15	16.7	14	15.6	29	16	
	2-3	6	6.7	3	3.3	9	5	
	4-6	14	15.6	24	26.7	38	21	0.01
	>6	55	61.1	49	54.4	104	58	
	Total	90	100.00	90	100.00	180	100.00	
Bee colony*	0	47	52.2	43	47.8	90	50	
	1-3	30	33.3	41	45.6	71	39	No CF
	4-7	12	13.3	5	5.6	17	9	
	8-10	0	0	0	0	0	0	
	>10	1	1.1	1	1.1	2	1	
Total		90	100.00	90	100.00	180	100.00	

Note: LHI: Livestock holding interval, N: number of observation, TLU: Tropical Livestock Unit (Source (ILCA 1991), CF: Conversion factor, *: No conversion factor

Improved green fodders such as green grasses and weeds were relatively better available during the wet season (July to October). During this period, animals gain better body weight and body condition, but later as extended dry period precedes the body weight of the animals reduce weight from 10 to 15 kg gradually. The same type of work was reported by Tegegne and Assefa (2010) in the same area. The study of Endalew et al. (2016) also compliments the current finding.

Grazing land utilization

Grazing on either private grazing land or communal grazing land was a common practiced following the onset of rain in most parts of the study areas in the study areas. There was the higher utilization of grazing land as the source of animal feed in the average usage of grazing in the study sites were (73.5%). Statistically, there was significant difference between the two districts ($P<0.05$). There were two types of grazing lands, i.e., private and communal. Over 50% of the feed to animals came from natural pasture which conforms to the general indication that natural pasture is one of the major sources of animal feed (Endalew et al. 2016).

Table 5. Ranking index of livestock production purposes in the study areas

Livestock production purpose	North Achefer			Mecha			Overall		
	%	Index	Rank	%	Index	Rank	%	Index	Rank
Meat	72	0.14	3	59	0.12	4	131	0.13	2
Milk	83	0.16	2	87	0.17	1	170	0.17	1
Milk products	38	0.07	6	51	0.1	5	89	0.09	4
Sale/Income	47	0.09	5	64	0.13	3	111	0.1	3
Work/draft	90	0.17	1	79	0.16	2	169	0.17	1
Manure/compost	48	0.09	5	48	0.1	5	96	0.09	4
Breeding/Mating	34	0.07	6	29	0.06	8	63	0.06	5
Saving	46	0.09	5	46	0.09	6	92	0.09	4
Hide and skin	58	0.12	4	39	0.07	7	97	0.1	3
Total	516	1		502	1		1018	1	

Table 6. Ranking index of livestock feed resource in dry seasons in the study areas

Feed resources	North Achefer			Mecha			Overall		
	%	Index	Rank	%	Index	Rank	%	Index	Rank
Natural pasture	34	0.07	7	32	0.06	7	66	0.06	7
Crop residues	65	0.12	4	65	0.13	3	130	0.13	3
Hay	86	0.17	1	85	0.17	1	171	0.17	1
Browse plants	20	0.04	8	20	0.04	9	40	0.04	8
WGG	22	0.04	8	24	0.05	8	46	0.04	8
HH wastes **	68	0.13	3	60	0.12	4	128	0.12	4
Attela	74	0.14	2	72	0.14	2	146	0.14	2
Improved forages	66	0.13	3	68	0.13	3	134	0.13	3
IBP	46	0.09	5	46	0.09	5	92	0.09	5
Other feeds*	40	0.08	6	43	0.08	6	83	0.08	6
Total	521	1		515	1		1036	1	

Note: IBP: industrial by-products, others*: such as, Multiple responses were possible, WGG: Weeds and green grasses

Table 7. Ranking index of livestock feed resources in wet seasons in the study areas

Feed resources	North Achefer			Mecha			Overall		
	%	Index	Rank	%	Index	Rank	%	Index	Rank
Natural pasture	91	0.16	1	94	0.14	2	185	0.15	1
Crop residues	36	0.06	6	48	0.07	4	84	0.07	6
Hay	23	0.04	7	40	0.06	5	63	0.05	7
Browse plants	77	0.14	2	96	0.14	2	173	0.14	2
WGG	81	0.14	2	76	0.11	3	157	0.13	3
HH wastes **	48	0.08	4	47	0.07	4	95	0.08	5
Attela	64	0.11	3	76	0.11	3	140	0.11	4
Improved forages	64	0.11	3	104	0.16	1	168	0.14	2
IBP	46	0.08	4	47	0.07	4	93	0.08	5
Other feeds*	40	0.07	5	41	0.06	5	81	0.07	6
Total	570	1		669	1		1239	1	

Note: IBP: Industrial by-products; others*- such as Urea molasses block, Urea treatment; WGG: Weeds and green grasses

The status of grazing land improvement option of districts is shown in Table 7. The available grazing lands in the study districts include communal grazing areas and roadside grazing areas. In the study district, in addition to free grazing practices, cut and carry feeding was practiced by dividing the field into individual who own livestock and regularly kept to escape from free grazing which was in agreement with previous reports (Tesfaye 2010; 2014).

Status of improved forage production

The status of improved forage production of study areas is shown in Table 8 and 9. Finding elucidated that there was a relatively good status of improved forage production by farmers in the two districts. The reason might be due to the fact that integration of improved forages with the farming system has been promoted in the study areas for a long time. Among the species of forages used by smallholder farmers in the soil conservation areas were napier grass (*Pennisetum purpureum*), desho grass (*Pennestum pedicellatum*), rhodes grass (*Rhodes gayana*) which was similar in both districts.

These improved forage species and varieties were primarily introduced to the study districts by the government via the forage extension packages.Their productivity and feed value were also medium due to medium proportion of improved forages. Improved forages mainly legumes can improve the productivity of these pastures by improving the fertility status of the soil. It was observed that 78% of the sampled households practice forage cultivation in their private holding and the remaining (22%) of the households did not cultivate improved forage production.

The primary feed resources for livestock in the study areas were found to be natural grazing lands, crop residues and cultivated forages species sesbania (*Sesbania sesban),* pigeon pea *(Cajanus cajan),* and napier grass *(Pennisetum purpureum*). Forage legume trees like sesbania and pigeon pea are established using seedlings (Tesfaye 2014). Similarly, forage grasses like Napier grasses are established using cuttings and root split(Table 10). Browse forage legumes like pigeon pea are usually created using direct seeding. Likewise, perennial forage grasses like rhodes (*Cloris gayana*) grass, buffle grass, and aquatic grass are established by broadcasting.

Table 8. Intervention mechanisms for improved forage grown and the shortage of grazing land in the study areas

Intervention mechanisms	North Achefer		Mecha		Overall	
	N	%	N	%	N	%
Area Enclosures	5	3	6	3	11	6
Control of free grazing	5	3	8	4	13	7
Good commitment rule	5	3	6	3	11	6
Good management practice	4	2	5	3	9	5
Livestock take off	7	4	8	4	15	8
Mixing cropping sowing	5	3	3	2	8	4
Preservation when abundance	6	3	5	3	11	6
Combined intervention strategies	53	29	49	28	102	57
Total	90	50	90	50	180	100

Table 9. Improved forage production in the percentage of household in the study areas

Improved forage production	North Achefer		Mecha		Overall		Prob.
	N	%	N	%	N	%	
Yes	68	75.6	73	81.1	141	78	0.000^{S}
No	22	24.4	17	18.9	39	22	0.000^{S}
Total	90	100	90	100	180	100	

Note: S: significant difference at (P< 0.05)

Table 10. Improved forage establishment methods used by farmers in the study areas

Forage Establishment methods	North Achefer		Mecha		Overall		X^2	Prob.
	N	%	N	%	N	%		
Broadcasting (Rhodes grass)	82	54	66	32	148	41	74.76^{a}	0.000^{S}
Cutting (Napier grasses)	32	21	67	32	99	28	1.81^{a}	0.18^{NS}
Row Seeding/seed bed	24	16	41	20	65	18	13.89^{a}	0.000^{S}
Seedling (sesbania)	13	9	34	16	47	13	41.09^{a}	0.000^{S}
Total	151	100	208	100	359	100		

Note: [a:] X^2-Chi-Squares with columns having the same superscript letters are significantly different at ($p<0.01$) and not significantly different at ($p>0.01$), multiple responses were possible

Purpose of improved forage production

Based on the current results in both districts improved forage plants were primarily grown for animal feed (44%) (Table 10). The animals were supplemented with green forages during the long dry seasons. Improved forages had good feeding value concerning nutrient contents and digestibility. Especially protein and energy were essential for better animal performance because milk and other products increase their nutrients flourish for the neonate and human nutrition (Mengistu 2012; Endalew et al. 2016).

The current result was beside animal feeds grown forage provide multiple benefits forage seed production purpose of used in the study areas(Table 17). Different forage species were grown by the smallholder farmers in the study areas. The type of improved forage species produced includes Napier grass, *Desmodium interterm*, pigeon pea (*Cajanus cajan*), rhodes grass (*Chloris gayana*), sesbania (*Sesbania sesban*), vetiver grass, *Ficus thinning* and others. Biological conservation was used for gully treatment and degraded area rehabilitation. Here, forages like napier grass, vetiver grass and sesbania are largely utilized in combination with physical structures.

Ranking of improved forage species according to their importance

Based on the current results, among the grown improved forages species sesbania, pigeon pea, and napier grass were primarily produced by the smallholder farmers as first, second and third ranks based on their importance in the study areas(Table 11).

On average, in both districts, 0.019 hectares of land was covered by improved forages (perennial crops). Concerning species, the overall result showed that sesbania (33%), rhodes grass (19%), pigeon pea (18%) and napier grass (16%) were produced by farmers. Similar results were recorded by (Mekoya et al. 2008; Tesfaye 2010).

Forage development strategies

Improved forage development strategies practiced in the districts were more related with the aim of developing improved forage crops,soil conservation and forage (Table 13). The percentage of overall results in forage development strategies in the study areas as given by respondents were in the backyard/homestead16%, private pasture land 15%, both area exclosures and forage strips 14%, undersowing and oversowing 12% and others. The practice of backyard forage production by most farmers might be due to the fact that backyard methods require the small plot of land around the homestead areas. This result was disagreed with the previous and others of respondents in used alley cropping 47%, area exclosures 28%, under sowing 19%, backyard/homestead 4% finding and others reported by Tesfaye (2014) in Eastern zone of Tigray. The respondents have used strips/area exclosures 36.16%, backyard/homestead 35.27%, under sowing11%, oversowing 8.29% and others (Endalew et al. 2016).

Table 11. Purpose of improved forages under the smallholder farmers in the study areas

Forage growing purpose	North Achefer		Mecha		Overall		X^2	Prob.
	N	%	N	%	N	%		
Forage seed production	9	10	16	18	25	14	24.20^a	0.000^S
Hedge fence	8	9	3	3	11	6	45.00^a	0.000^S
Honeybee flora	8	9	10	11	18	10	18.69^a	0.000^S
Livestock feed	42	47	35	39	80	44	25.69^a	0.000^S
Soil and water conservation	14	16	13	14	24	13	3.20^a	0.074^{NS}
Windbreak	6	7	5	6	11	6	30.42^a	0.000^S
Others	3	3	8	9	11	6	62.42^a	0.000^S
Total	90	100	90	100	180	100		

Note: $^{a:}$ X^2-Chi-Squares with columns having same superscript letters are significantly different; at ($P< 0.01$) and not significantly different; at ($P>0.01$), others- includes fuel woods, biofuels, providing shelters), multiple responses were possible.

Table 12. Ranking index of improved forage according to their importance to the smallholders

Forage name	North Achefer			Mecha			Overall		
	%	Index	Rank	%	Index	Rank	%	Index	Rank
Napier grass	15	0.15	3	17	0.17	3	32	0.16	4
Ficus	3	0.03	5	5	0.05	6	8	0.04	6
Desmodium	0	0	6	4	0.04	7	4	0.02	7
Pigeon pea	28	0.28	2	7	0.07	4	35	0.18	3
Rhodes grass	10	0.1	4	28	0.28	2	38	0.19	2
Sesbania	34	0.34	1	32	0.32	1	66	0.33	1
Vetivar grass	10	0.1	4	6	0.06	5	16	0.08	5
Total	100	1.0		100	1.0		199	1.0	

Table 13. Ranking index of forage development strategies among districts

Improved forages	North Achefer			Mecha			Overall		
	N	Index	Rank	N	Index	Rank	N	Index	Rank
Backyard/homestead	76	0.16	2	79	0.17	1	155	0.16	1
Alley cropping	39	0.08	6	34	0.07	6	73	0.08	6
Private pasture land	81	0.17	1	62	0.13	3	143	0.15	2
Undersowing	57	0.12	5	57	0.12	4	114	0.12	4
Area exclosures	72	0.15	3	64	0.14	2	136	0.14	3
Forage strips	72	0.15	3	62	0.13	3	134	0.14	3
Oversowing	44	0.09	4	67	0.14	2	111	0.12	4
Others	39	0.08	6	48	0.10	5	87	0.09	5
Total	480	1		473	1		953	1	

Note: N: Number of observations, multiple responses was possible. HH interview in Enamrt *kebele (A:* napier grass*;* liben *kebele* (B: pigeon pea (plantation) as well as in dembola *kebele (C*: Sesbania).

Irrigation based improved forage production

The survey result was indicated that households having irrigation facility to produce improved forage in Mecha area (56%) was greater than in North Achefer area (47%) and statistically there was significance difference ($P<0.05$) of irrigation based forage production between districts (Table 13). Access to irrigation supplements moisture, which enables farmers to maximize agricultural production. The smallholder farmers grew different forage both in North Achefer and Mecha areas. Water is an essential resource for forage production; the amount and distribution of rainfall significantly determine the growth and production of improved forage. Irrigation access offers the chance for forage production to the farmers. Farmers having good access to irrigation, they can practice forage growth three times a year.

Forage productions were promoted in the study areas for a long time (Table 15 and 16). These were irrigated and none irrigated of improved forage grow in natural resource conservation at different months among in the study areas. Generally, even where farms were small, farmers may allocate a small portion of their plot to irrigated fodder where market linkages wereproper. Demonstrate irrigated fodder (integrate fodder in small-scale irrigation) (Haileslassie et al. 2012).

Empirical adoption studies of improved forage grown on natural resource conservation areas

Households had different perception about improved forage grown on natural resource biological soil conservation area enclosures. As already noted, the majority of smallholder farmers in Ethiopia are producing both crops and livestock. Based on farmers perceptions' on soil and water conservation among the bund stabilizers, farmers preferred sesbania (*Sesbania sesban*), napier grass (*Pennisetum purpureum*), pigeon pea (*Cajanus cajan*) and vetiver grass for its adaptability and performance on the soil bunds in the study areas. Napier grass showed very outstanding establishment and performance including dry months in a year even as compared to local grasses (Dejene et al. 2012). Farmer perceptions' about improved forage production and use technology was one of the factors which can facilitate or undermine adoption of improved forage technology and there were different socio-economic and institutional factors hindering individual farmers from using the technology (Garedew 2005).

Different improved forage species such as *Pennisetum purpureum, Sesbania sesban* and *Cajanus cajan* were tested and were found to be well adapted, productive and accepted by the farmers. Improved forage species various forage technologies such as hedgerow, backyard and soil bund mainly associated with the natural resource conservation areas were demonstrated. However, the adoption rate of forage production was found to be very low due to weak extension support, which mainly emphasized food crops in the study areas. Forage development strategies such as hedges around field edges and on soil bunds, particularly on the sloping land, intercropped with the cereals and alley cropping had a chance of better acceptance by the community. This study attempts to identify factors affecting the adoption and intensity of use of improved forage technologies, similarly, reported by (Beshir 2013). The current result showed that different organization supports different materials to the local community to integrate improved forage development on natural resource biological soil conservation areas enclosures. The farmers were the primarily responsible actors for improved forage development practice on natural resource conservation in the study areas. According to Dejene et al. (2012), the enclosures areas could be protected by not only community but also government should be involved in the protection and management of the enclosures areas. Farmers' perceptions and awareness of improved forage development on natural resource biological soil conservation practices in the study areas improved from time to time, similarly, reported by Geleti (2014).

According to Teklu et al. (2011), on the previous study in Benishangul-Gumuz; expansion of improved forage among households was limited due to weak extension services and limited involvement and devotion of research institutions. The difference in farmers' perceptions about the contribution of soil and water conservation to livestock productivity could be related to livestock management system. Livestock number before and after soil and water conservation, different in adoption of the technologies and geographical positions among the households of soil conservation.

Table 14. Forage production in irrigation scheme under the smallholder farmers' between districts

Irrigation access	Growing forage	North Achefer		Mecha		Overall		Prob.
		N	%	N	%	N	%	
Yes	Yes	42	47	50	56	92	51	0.009[S]
	No	25	28	13	14	38	21	0.000[S]
No	Yes	16	18	18	20	34	19	0.000[S]
	No	7	8	9	10	16	9	0.000[S]
Total		90	100.00	90	100.00	180	100.0	

Note: N: Number of observation, S: significant difference at (P<0.05)

Table 15. Ranking index primarily responsible for improved forage development on conservation areas closure protection in the study areas

Primarily responsible improved forage grown	North Achefer			Mecha			Overall		
	%	Index	Rank	%	Index	Rank	%	Index	Rank
Community	94	0.37	1	100	0.42	1	194	0.39	1
NGO	36	0.14	3	47	0.20	3	83	0.17	3
Government	87	0.35	2	58	0.24	2	145	0.30	2
Community leadership	36	0.14	3	32	0.14	4	68	0.14	4
Total	253	1		237	1		490	1	

Note: NGO: Non-government organization

Table 16. Ranking index of improved forage grown on natural resource biological conservation area closure ownership

Improved forage is grown on NBSCA	North Achefer			Mecha			Overall		
	%	Index	Rank	%	Index	Rank	%	Index	Rank
Individual	82	0.28	1	93	0.28	1	175	0.28	1
Kebele administrator	78	0.26	2	72	0.22	3	150	0.24	3
Community	74	0.25	3	88	0.27	2	162	0.26	2
NGO	30	0.10	5	47	0.14	4	77	0.12	4
Others	32	0.11	4	28	0.09	5	60	0.1	5
Total	296	1		328	1		624	1	

Note: NBSCA: natural resource biological soil conservation areas

Table 17. Improved forage is grown on natural resource conservation after area closure establishment across in the study areas

Improved forage is grown after area closure	North Achefer		Mecha		Overall		X^2	Prob.
	N	%	N	%	N	%		
Green area	88	17	86	17	174	17	156.80[a]	0.000[S]
Seed production	75	15	85	17	160	16	108.89[a]	0.000[S]
Soil fertility increase	88	17	84	16	172	17	149.42[a]	0.000[S]
Control of free grazing land	89	18	88	17	177	17	168.20[a]	0.000[S]
Decrease soil erosion	88	17	86	17	174	17	156.80[a]	0.000[S]
Others	77	15	82	16	159	16	105.80[a]	0.000[S]
Total	505	100	511	100	1016	100		

Note: [a]: X^2-Chi-Squares with columns having same superscript letters are significantly different; at (P< 0.01), others- includes fuel woods, biofuels, providing shelters), multiple responses were possible

As it was pointed out in the group discussion, poor farmers were able to buy livestock after soil and water conservation and started to share grasses from the communal areas. Therefore, those who keep the high number of livestock and those who used to take the share of the poor were the ones resisting the expansion of zero grazing and said that their milk yield was decreased after soil and water conservation. A similar observation was reported by Gebreyohannes and Hailemariam (2011). Integrating physical structure (soil bund) and biological measures (sesbania, napier grass, vetiver grass and etc.) were done with the full participation of farmers and the distance between the two soil bunds was determined by the farmers themselves. Finally, with the help of researchers were constructed soil bunds, planted stabilizers (napier grass and shrubs) and did continuous maintenance. We made continuous participatory, monitoring and evaluation and observed the improvement of the soil from time to time. Desho grass was also used for land conservation purposes (Asmare et al. 2016).

Table 18. Major constraints of improved forage grown on natural resource conservation areas closure across in the study areas

Major constraints of improved forage	North Achefer			Mecha			Overall		
	N	%	Rank	N	%	Rank	N	%	Rank
Expanded free grazing and shortage land	63	21	2	43	17	5	106	19	3
Lack of protection areas	68	22	1	51	20	3	119	21	2
Increased cost price improved forage seed	49	16	4	58	23	1	107	19	3
Seasons of factor improved forage plantation	61	20	3	47	18	4	108	19	3
Lack of awareness	65	21	2	57	22	2	122	22	1
Total	306	100		256	100		562	100	

Based on the current study improved forages grown on natural resource biological soil conservation after area closures establishment across the study areas both districts were getting the ability to protect the environmental condition. The survey result was indicated that smallholder farmers were accepted improved forage grown in the study areas. The difference in the improved forage compositions in the study areas. The study had generated ample information on farmers' perceptions, yield and chemical composition of improved forages grown on natural resource conservation Midland areas in two Districts of West Gojjam Zone, Amhara Region. According to Demeke et al. (2017), the chemical composition from the natural resource conservation areas were above 9% CP which was optimum for improved livestock production in the study areas. There were various forage species and varieties introduced to the areas by Government, NGO's and others across different periods and these improved forage plants were included sesbania, rhodes grass, pigeon pea, napier grass, vetiver grass and others. These species were well adapted to natural resource soil conservation areas which were served mainly as animal feeds. The chemical composition of improved forage was similar to what has been reported by Geleti (2014), Haftay and Kebede (2014), and Abebe and Tamir (2016).

Constraints to improved forages cultivation in soil and conservation areas

Major constraints of improved forage cultivation in the study areas showed in Table 18 were increased cost price improved forage seed in the community and lack of commitment to protection areas were in Mecha area (23%) and North Achefer area (22%), respectively, as a first major constraint in both districts. The overall percentages of lack of awareness in the community was the first ranked (22%) as the main constraint in the study areas, whereas lack of moisture, etc. improved forage plantation time and lack of commitment to protection area closures were (1st) (22%) ranked in North Achefer and Mecha areas (20%) districts.

The most constraints of improved forage utilization were un-cutting at the proper stage of growth (esp. tree legumes like *Sesbania sesban*); un-chopping, un-mixing with other dry feeds, imbalance of offering of harvested improved forage (priority of offering to productive livestock especially lactating dairy cows), land and water scarcity, low access to improved technologies and training. In agree with on the previous study, shortage of land (1st), the high expense of forage planting materials (2nd), lack of awareness (3rd) and weak extension services (4th) in rank were the main constraints hindering adoption of improved forages (Assefa et al. 2015).

In conclusion, the finding summarized that improved forages were already introduced, their utilization status wasinferior, hence more extension work should be implemented in the study areas to conserve natural resources and improve the productivity of livestock. Almost all of the farmers (97%) in the study areas had the good perception of improved forage production and utilization due to their function as soil conservation and feeding value as well as income generation. The most constraints of improved forage utilization were un-cutting at the proper stage of growth (esp. tree legumes); un-chopping, unmixing with other dry feeds, imbalance of offering of harvested improved forage (priority of offering to productive livestock especially lactating dairy Cows), land and low access to improve forage technologies and training. Generally, the farmers' perceptions yield and improved forages are grown on natural resource conservation areas were faced with various farmers' perceptions awareness of improved forage strategic development practices.

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