Assessment of Farmers Perception towards Production and Utilization of Improved Forages for Dairy Cattle Feeding in the central highlands of Ethiopia

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Abstract: This study was conducted to assess farmers' perception, production and utilization of improved forage (IF) under rural and peri-urban production systems of Adea-berga and Ejere districts of West Shewa and Welmera district of Oromia special Zone, central highlands of Ethiopia. A questionnaire based survey was conducted on 105 households (47 rural, 58 peri-urban) identified by purposive random sampling method. Fifteen non-users were also included to assess factors hindering IF utilization. The known commonly grown IF includes; oats, elephant grass, and vetch as reported by 95, 85 and 67% of the respondents, respectively. About 92% of the respondents produce their own IF while others either purchase or purchase and produce. About 91 % of respondents have medium and high level of perception score. Illiterateness and land holding significantly (p<0.05) predicted farmer's IF perception. On average, the respondent reported to allocate 0.316 ha of land to cultivate forages. Respondents perceived that utilization of Desho grass is increasing while that of tree lucerne and sesbania is declining due to variation in palatability of the forages. Improved forages were fed to dairy animals as green feed, hay, residue or their combination. Farmers perceived improvement of feed intake, milk yield, utilization of roughage feeds, and reduced expense for supplementary feeds as main benefit of IF utilization. Non-IF user farmers reported that land shortage (53%), skill gap (23%), and lack of appropriate information (15%) as major limiting factors from growing IF. About 13% peri-urban and 19% rural respondents, respectively were unhappy by the IF extension service. It is concluded that farmers in the study areas have good perception on the importance of IF as dairy feed resource. However, effective extension service in terms of seed supply, training, awareness building, regular technical back-ups, and monitoring should be emphasized to ensure sustainable production and utilization of improved forage crops in the study areas.

Keywords: *Feeding, Forage crops perception, Growing, Peri-urban, Rural, Survey*

Introduction

Livestock production as an integral component of the agricultural activities contributes for about 25% of national and 40% of agricultural GDP in Ethiopia (Stapleton, 2016). The total cattle population of the country is estimated at 59.49 million with 7.16 million used for milking (CSA, 2017). However, the productivity of milking cow is far below the demand of the nation (Land O'lakes, 2010) due to a number of problems including inadequate supply of quality feed, lack of improved forage and pasture, and high cost of concentrates (Ulfina *et al*., 2013; Malede *et al*., 2015). Natural pasture and crop residues are the major feed resources in mixed farming system (Adugna, 2007). Due to the diminishing grazing lands in mixed farming areas, crop residues covers 10 to 50% of livestock feed (Fekede, 2007) while the contribution of natural pasture declined from 80-90 % in the early 1960s to 30-40% during the last decade of 2000s (Getnet *et al*., 2016).

Planted forages and pastures offer the best possibilities for increasing milk production, but availability is constrained by limited extension and farmer training programs, inadequate access to forage seeds and planting materials (GRM, 2007). Under Ethiopian condition, different institutes participate in improved forage research and development activities. Among these, the Ethiopian Institute of Agricultural Research started forage research as a national program in the mid-1960s (Alemayehu *et al*., 2016a). In the 1970's Arsi Rural Development Unit introduced improved forages such as Alfalfa, Oats, Vetch and Fodder kept to be used by the dairy development cooperatives and associations (Alemayehu and Getnet, 2012). The fourth Livestock Development Project of the Ministry of Agriculture had demonstrated a series of alternative strategies in improved forage production across large parts of Ethiopian highlands (Alemayehu *et al*., 2017a). Research centers like Holeta Agricultural Research Center also disseminate improved forage along with on-farm dairy research and technology demonstration activities. In the past five decades, extensive research and development has been carried out in Ethiopia to test and evaluate the adaptability and performance of different forage species under different agro-ecological zones (AEZ) (Alemayehu *et al*., 2016a). As a result, various adaptable and high yielding fodder species of grasses, herbaceous legumes and browse trees have been identified and recommended for

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different AEZs of the country (Alemayehu *et al.*, 2017b).

Among the introduced improved forages, legumes have high feeding value providing a sustainable source of cheaper protein compared to concentrates (Seyoum, 1995), increase digestibility and intake of the conserved forage (Alemayehu *et al.*, 2017a). Pandey and Voskuil (2011) also reported that legumes have high palatability, rich in digestible crude protein, vitamins and minerals. About 33 improved forage varieties have been registered and released with their full production and utilization packages for different agro-ecologies of the country during the last fifty years (Getnet *et al.,* 2016).

Associated with the intensification and modernization of dairy farming, there is a need to maximize adoption and utilization of improved forages. Furthermore, population growth and urbanization resulted in reduction of grazing lands which may necessitate farmers to consider improved forage as a means of fulfilling the requirements for livestock feed. Farmers in the highlands of Ethiopia are expected to utilize the improved forages as they are located in areas where most researches on improved forages were undertaken and promoted (Alemayehu *et al.*, 2017a). Accordingly, understanding the current status of farmers' perception towards improved forage production and utilization in these areas is imperative for further research and development options to improve dairy animal productivity. Hence, this study was conducted to assess the existing farmers' perception towards production and utilization of improved forage in rural and peri-urban areas of West Showa and Oromia Special Zones of Oromia Regional State. The result will help to identify the major limitations and formulate appropriate interventions to improve the production and utilization of improved forage at smallholder dairy farmer level.

Methodology

Description of the Study Areas

The study was conducted in Adea-berga and Ejere districts of West Showa Zone and Welmera district of Oromia Special Zone in the central highland of Ethiopia. The districts are characterized with a crop-livestock mixed farming system. In West Shewa Zone, most rural farming, transport and source of income directly or indirectly link with livestock husbandry (Yazachew and Kasahun, 2011). Among the 108 rural *kebeles* (RKs) of west Shewa Zone, 36 RKs are suitable for market-oriented dairy value chain development, of which two third are located in Adea-Berga (12 RKs) and Ejere (12 RKs) (Fanos, 2012). Welmera and Ejere are located at about 29 and 44 km west of Addis Ababa along the main road to Ambo while Adea-Berga at about 64 km North West of Addis Ababa. The geographical location and climatic condition of the study districts is shown in Table 1.

Table 1. Geographical location and climatic condition of the study districts

District	Geographical location		Altitude (m.a.s.l.)	Temperature (°C)	Rain fall (mm)
	Latitude	Longitude			
Adea-berga	9°12'- 9°37'N	38°17 - 38°36'E	1500-3180	10-29	800-1400
Ejere	8°51'-9°15'N	38°25'- 38°28'E	1872-3238	9- 28	900-1200
Welmera	8°50'- 9°15'N	38°25 - 38°45'S	2060-3380	1- 27	634-1300

m.a.s.l= Meter above sea level.

Source: (Yazachew and Kasahun, 2011; EFEDO, 2012; Fekede, 2013; AFEDO, 2015; WFEDO, 2015)

Sampling Procedures

The districts were classified into rural and peri-urban production system based on their administration type. From each district one rural *kebele* (RK) and one peri-urban *kebele* (PUK) were selected purposively based on experience of improved forage production and utilization. Maruchebot, Rob-Gebeya, and Chiri from the RKs and Muger, Welmera and Ejere from PUKs were selected from Adea-berga, Welmera and Ejere districts, respectively. Twenty respondents having cultivated improved forage from each *kebeles* were randomly selected. However, in *kebeles* where improved forage users were below 20, farmers who owned crossbreed dairy cows and previously participated in IF training at least once were included. Accordingly, 120 households (105 improved forage users and 15 non users) were selected for the survey.

Data Collection

Discussion with districts Livestock Development Agency were carried out to have an overview of improved forages utilization experience and the information was used in preparing the survey semi-structured questionnaire. The questionnaire was pre-tested before used for data collection. The farmers were interviewed with the help of trained enumerators from Holeta Agricultural Research Center (HARC) under close supervision of the researcher. Secondary information was collected from development agents and livestock experts, finance and economy office, and administrative offices of the respective districts. Data collected includes respondent socio-economic profile, main feed resources, perception towards knowledge, production and utilization of improved forages for dairy cattle, major challenges, and improvement options.

Statistical Analysis

The data was analyzed based on production system (as rural and peri-urban) using descriptive statistics. Pearson's Chi-square ($\chi 2$) test was used for categorical variables to assess a statistical significance of a particular comparison. One-way analysis of variance was applied for quantitative variables using SPSS 20 (IBM Corp., 2011). Farmers' perception towards improved forage was tested by ordinal logistic regression, considering knowledge of growing improved forage, utilization of improved forage and describing benefits of utilization to develop three levels of perception score (low, medium and high). Based on Long (1997), the ologit model (in terms of probability) is written as:

$$\Pr(y_i > j \mid X) = g(X_i\beta') = \frac{\exp(X_i\beta' - \phi_j)}{1 + \exp(X_i\beta' - \phi_j)}$$

, $j = 1,....,m-1$, where x_i is a (k×1) vector of observed non-random explanatory variables; β is a vector of unknown parameters to be estimated; m is the number of categories of the ordinal dependent variable. The parameters of the model (β) and the cut-points (ϕ_1 and ϕ_2) are estimated by the method of maximum likelihood. Based on economic theories and empirical findings, common explanatory variable such as age of the household head, land holding, access to extension and educational status of household head, household income are considered as affecting factors and hence included in the model. Data analysis was conducted using Stata 13 (StataCorp, 2013). Before the estimation process, important tests and transformations have been conducted. Normality test for continuous variables was performed and income was transformed using ln function. In addition, multi-collinearity test between continuous and discrete explanatory variables was done using variance inflation factor (VIF) and contingency coefficient (CC), respectively. The highest VIF (1.06) and CC (0.096) values were below the maximum tolerance level of 10 (Gujarati, 2004) for VIF and 0.75 (Healy, 1984) for CC shows no severe multicollinearity problem among the explanatory variables. Since the coefficients of the ologit model tells only the direction but not the magnitude of the influence of the explanatory variables on the dependent variable, the results of the estimation was interpreted using marginal effect after ologit of the independent variables.

An index was calculated to provide overall ranking for major feed resources using the formula: Index = sum of (9 for rank 1 + 8 for rank 2 + 7 for rank 3 + 6 for rank 4 + 5 for rank 5 + 4 for rank 6 + 3 for rank 7 + 2 for rank 8 + 1 for rank 9) given for individual feed divided by the sum of (9 for rank 1 + 8 for rank 2 + 7 for rank 3 + 6 for rank 4 + 5 for rank 5 + 4 for rank 6 + 3 for rank 7 + 2 for rank 8 + 1 for rank 9) summed overall feeds.

Results and Discussion

Household Characteristics of the Study Area

About 78.3% of the responding households (HHs) were male headed while the remaining female headed, and their average age was 44.2 years (Table 2). Their mean dairying experience was 20.89 years on indigenous cows and 6.43 years on rearing crossbred dairy cows. The average family size of the sample households was 6.4. Family size can be seen as an asset to satisfy the labor demand for both crop and livestock farming activities. The mean family size was lower than 6.8 to 10 reported by other authors (Solomon, 2004; Tekleab, 2009; Fekede, 2013) in different parts of the country, but higher than that of 5.6 reported by Belay *et al.* (2012) and Yasar *et al.* (2016) in other parts of Ethiopian highlands.

Table 2. Household characteristics of respondents in the study area

Parameter	Peri-Urban (N=60)	Rural (N=60)	Total (N=120)
Age	43.4 (23-70)	44.97 (27-70)	44.2 (23-70)
Family size	6.3 (1-15)	6.5 (2-14)	6.4 (1-15)
Gender (%)			
Male	80	76.7	78.3
Female	20	23.3	21.7
Educational status (%)			
Illiterate	8.3	21.7	15
Read and write only	16.7	23.3	20
Primary (grade 1-6)	30	20	25
Secondary (grade 7-10)	30	26.7	28.3
Preparatory (grade 11-12)	3.3	6.7	5
Higher education	11.7	1.7	6.7

N= Number of respondents; values in brackets are ranges.

About 85% of the respondents have some level of education, while 15% were illiterate (Table 2). Generally, peri-urban respondents had relatively higher educational level as compared to rural respondents. This is due to better access to education facilities in the peri-urban than rural areas. Education may affect perception to new farming inputs and technology packages at the community level (Tekleab, 2009).

Farmers Perception about Improved Forage

The perception score result indicated that more than 91% of the respondents have medium and high level of perception while the rest 9% has low level of perception about improved forage production and utilization. Except for being illiterate (p=0.003) and total land holding (p=0.023), perception of respondents towards improved forage was not significantly predicted by other explanatory variables in the model.

The result indicated that illiterate farmers have low level of perception presumably due to level of skill and ability to understand trainings provided in forage production and utilization. The marginal effect shows that the probability of illiterate farmers to have high perception decreased by 12.11% and to have low level of perception increased by 34.3% as compared to literate farmers (p=0.002) keeping the effect of other explanatory variables constant. Landholding was positively associated with high level of perception (p=0.034). The marginal effect showed that as land holding increased by one unit, the probability of the farmers to have high level of perception increased by 1.7% and probability of having low level of perception decreased by 0.07% (Table 3). The present finding is in line with Tekalign (2011) who reported illiteracy and small land size hindered expansion of vetiver grass.

Table 3. Ordered logistic regression and marginal effect of improved forage perception

	Ologit		Marginal effects after ologit					
Perception score			Low		Medium		High	
Y			0.02956		0.89207		0.07837	
Variable	Coef.	P>|z|	dy/dx	P>|z|	dy/dx	P>|z|	dy/dx	P>|z|
Gender*	0.779	0.261	-0.0285	0.385	-0.0179	0.308	0.0465	0.184
Iliterate*	-3.443	0.003	0.3428	0.097	-0.2218	0.256	-0.1211	0.002
Basic*	-0.2018	0.849	0.0061	0.858	0.0077	0.826	-0.0139	0.841
Prime*	-0.4226	0.662	0.0134	0.695	0.0148	0.585	-0.0282	0.635
Sec*	0.2666	0.777	-0.0073	0.768	-0.013	0.799	0.0202	0.788
IFExt*	0.5712	0.366	-0.0187	0.451	-0.0186	0.31	0.0373	0.323
Prod System*	-1.0291	0.061	0.0322	0.177	0.0406	0.157	-0.0728	0.068
Age	-0.0225	0.384	0.0006	0.412	0.001	0.424	-0.0016	0.389
TotLand	0.2369	0.023	-0.0068	0.111	-0.0103	0.122	0.0171	0.034
LnIncome	0.6062	0.06	-0.0174	0.13	-0.0264	0.154	0.0438	0.06
/cut1	2.77716	9.7559						
/cut2	8.73302	16.115						

Log likelihood= -54.571; N= 105; LR chi2(10)=35.5; Prob> chi2= 0.0001; Pseudo R2= 0.2454; ologit= Ordered logistic regression; y= Pr(Perception Score i) (predict, outcome(i)), where i= low, medium, high; (*) dy/dx is for discrete change of dummy variable from 0 to 1.

Major Feed Resources in the Study Area

Natural pasture hay, crop residue (wheat and barley straw and maize stover), agro industrial by-products (AIBP), grazing and improved forages were the five top commonly available feed resources used by respondents in both rural and peri-urban production systems (Table 4). Furthermore, by-product of local brew (such as tella and areke), fallow land grazing, molasses and commercial ration feeds serves as sources of feed in the study area. Roasted barley and maize grains were also reported as common supplementary feeds used for dairy cattle. The current result appears to be in line with the report of CSA (2017) that noted the main livestock feed resources in the country as being hay, grazing on natural pasture, crop residues and agro-industrial by-products. Yazachew and Kasahun (2011) also reported natural pasture, crop residue and improved grasses as major livestock feeds in the study area.

Farmers Experience on Improved Forages Production and Utilization

Respondents have a six years mean experience in improved forages utilization as dairy animals feed. The majority of the respondents (92.4%) produce forages on own field, which is higher than 63% reported by Fekede (2013) for the central highland of Ethiopia. This might be associated with increase awareness about the importance of improved forage through time. The remaining few farmers either purchase (4.76%) or do a combination of purchase and self-production (2.86%).

Respondents who own improved dairy cows and took training on cultivation of improved forage, but didn't use improved forage as feed reported that land shortage, skill gap and lack of appropriate information as major challenges hindering the use of improved forage. Some farmers also noted the use of less adaptable forage species like alfalfa with limited extension support. This has resulted to dissatisfaction in terms of yield, hence farmers retreat from cultivating and using improved forages. Thus, it is crucial to consider the adaptability issue when disseminating improved forage seeds and planting material to farmers. The present study was in agreement with GRM (2007), Getahun (2012) and Fekede (2013) who reported land shortage, limited extension and farmer training programs, inadequate access to forage seeds and planting materials, and lack of knowledge on fodder establishment and management as limiting factors of improved forage production and utilization. Lapar and Ehui (2003) also reported poor adaptability as important limiting factor of wide adoption of forage species by smallholder farmers in the Philippine.

Oats *(Avena sativa)*, elephant grass (*Pennisetum purpureum*), vetch (*Vicia spps.),* Sesbania *(Sesbania sesban)* and tree lucerne (*Chamaecytisus palmensis*) were the most adopted and recognized forage species in the study area (Table 5). Similar to this study, Alemayehu (2006) noted that oats and vetch mixtures, elephant grass, hedgerows of sesbania and tree-lucerne as commonly grown forage crops for feeding dairy cattle. In recent years, desho grass (*Pennisetum glaucifolium*) is becoming preferred forage crop in the study area and has been widely distributed especially around Adea-berga district.

Table 4. Ranked locally available feed resources in the study areas

Feed type	Rural										Peri-Urban									
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	Index	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	Index
Hay	30	16	8	2						0.22	21	16	15	7						0.21
CR	5	26	20	2	1					0.19	7	29	15	5	2					0.19
AIBD	7	4	14	15	10	3	1			0.16	9	4	11	12	9	6	3			0.15
Grazing	14	8	5	6	2	1				0.13	20	8	3	6	6					0.14
IF	1	3	8	9	10	6		1		0.10	1	4	8	13	12	4	1	1		0.11
BLB			3	7	9	6	4			0.07			1	2	4	10	2		2	0.04
FL		1		8	3	2	2			0.04			3	9	6	7				0.06
Molasses		1		5	4	5	1	1		0.04				1	6	5	3	4		0.03
CF	2	1	3		2				1	0.03	1		1	3	4	2	1			0.03
Others	1		1	2		1				0.01		3	3	1		1				0.02
Weeds					2	1		1		0.01			1	2	1	4	2			0.02

Rank 1= Highest; 9= Least ranked; BLB= By-product of local brew; AIBP= Agro industrial by-products; CR= Crop residues; IF= Improved forage; CF= Commercial Feed; FL= Fallow land.

Table 5. Commonly adopted forage species in the study areas and known by respondents (% of respondent)

Forage species	Peri-Urban (N=47)	Rural (N=58)	Overall (N=105)
Oats	91.5	98.3	95.2
Elephant grass	83.0	86.2	84.8
Vetch	68.1	69.0	68.6
Sesbania	29.8	37.9	34.3
Tree lucerne	25.5	24.1	24.8
Desho grass	10.6	15.5	13.3
Alfalfa	6.4	0.0	2.9
Fodder beat	2.1	1.7	1.9
Lablab	2.1	0.0	1.0
Rhodes grass	0.0	1.7	1.0
Vetiver grass	2.1	0.0	1.0

N= Number of respondents.

Most rural and peri-urban respondents are familiar to two to four types of improved forage species (Figure 1). Knowledge and more focus on limited number of forage species might be associated with shortage of land for growing forages, and due to weak extension service in the provision of forage seeds/planting material and trainings. In line with this, Feleke *et al.* (2015) suggested the need for establishing an effective extension service to encourage farmers to grow diverse improved forage species.

Oats and vetch were the dominant annual forage crops grown in pure stand or in mixture. About 43% of the respondents reported that they grow oats as sole improved forage (Figure 2). About 23% grow oats and vetch on separate plots, and about 18% grow oats either as pure stand or as oats-vetch mixture (OVM). Furthermore, about 34% of the respondents use OVM while 31% of the respondents cultivate vetch as standalone forage. Oats and vetch have performed well across a wide range of Ethiopian agro-ecological zones, with oats showing good tolerance to relatively low fertility and poor drainage soils (Alemayehu *et al.*, 2016b).

Regarding perennial forages, about 85% of the respondents cultivate elephant grass followed by sesbania (34%), tree lucerne (25%) and desho grass (13%). Tree lucerne and sesbania were planted along the fence lines. However, the level of utilization was declining from time to time due to farmers' claim of low palatability, which calls for implementing available means of improving the palatability of these important forages and training. On the other hand, desho grass became preferable forage in both rural and peri-urban location of Ada-Berga district. Desho grass is a perennial plant utilized as a means of soil conservation practices and a year round animal feed in the Ethiopia highlands (Welle *et al.*, 2006). Desho grass is suitable for intensive management and performs well at an altitude ranging from 1500 to 2800 m.a.s.l to provide more forage per unit area and ensures regular multi-cut forage supply (Gerba *et al.*, 2013). At production system level, comparable proportion of respondents cultivates elephant grass while tree lucerne and sesbania were cultivated by relatively higher peri-urban and rural respondents, respectively. Majority of rural respondents use only oats as single forage and oats and OVM on separate plot, while more peri-urban respondents cultivate both oats and vetch separately (Figure 2).

Inputs and Production Practice of Improved Forage

During the study period, the sampled respondent allocated about 0.316 ha (ranging 0.001 to 2ha) of land for improved forage cultivation. About 71% of the respondents cultivate improved forages on farmland and backyards (Table 6). This result was higher than Abebe (2008) who reported 19.7% of farmers cultivated forage crops on farmlands in the Ethiopian highlands. The difference could be associated with study time that may indicate increasing trend in the level of awareness about improved forages by farmers through time. Alemayehu *et al.* (2016b) stated backyard forage production as the most important strategy, since it is convenient for intensive feeding of dairy animals. Majority (73.3%) of the respondents reported that they use rain water to grow forage crops. On the other hand, 10.5% of the target populations use irrigation while 6.7% of the respondents use both rain and irrigation as water source for forage cultivation.

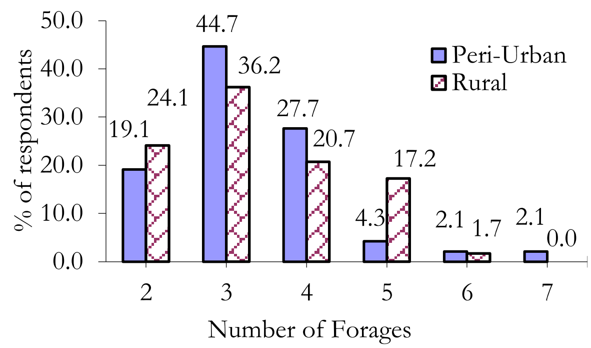

Figure 1. Number of known improved forages grown by respondent (%) in the study areas.

Table 6. Inputs and cultivation practice of improved forages (% of respondents)

Parameter		Peri-Urban (N=47)	Rural (N=58)	Total (N=105)	P value
Allocated land type	Backyard	29.8	19.0	23.8	
	Backyard, Farmland	2.1	3.4	2.9	0.466
	Backyard, Fence	4.3	1.7	2.9	
	Farmland	63.8	75.9	70.5	
Water source	Rain water	74.5	72.4	73.3	
	Irrigation	10.6	10.3	10.5	
	Tap water	6.4	3.4	4.8	0.465
	Water well	6.4	3.4	4.8	
	Rain water and Irrigation	2.1	10.3	6.7	
Seed and seedling source	HARC	25.5	19.0	21.9	
	DLA	27.7	43.1	36.2	
	Market	29.8	22.4	25.7	0.308
	NGO	6.4	3.4	4.8	
	HARC and DLA	4.3	10.3	7.6	
	HARC and Market	6.4	1.7	3.8	
Sowing time	May	17.0	22.4	20.0	
	June	66.0	72.4	69.5	0.134
	July	17.0	5.2	10.5	
Seeding rate (Kg/ha)	40	2.8	5.9	4.6	
	60	11.1	5.9	8.0	
	80	11.1	11.8	11.5	0.766
	100	58.3	56.9	57.5	
	120	11.1	17.6	14.9	
	Assumption	5.6	2.0	3.4	

HARC= Holeta agricultural research center; DLA= District livestock agency; NGO= Non-government organizations; N= Number of respondents.

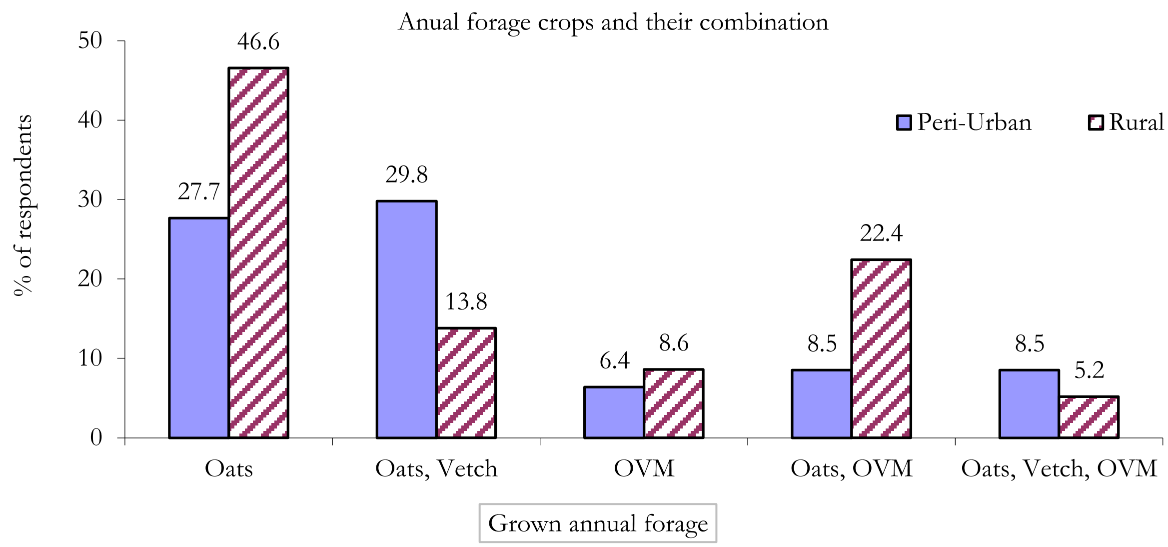

Figure 2. Commonly grown annual forage crops by the interviewed respondents (% of respondents) (*OVM= oats-vetch mixture; forages separated by "," grown in on separate plots).*

Respondents used District Livestock Agency (DLA), Holeta Agricultural Research Center (HARC) and market as main source of forage seeds (Table 6). Different non-governmental organizations (NGOs) such as Lives, Berga Bird Conservation, Biftu-Berga union and World-Vision also serve as source of forage seed and seedlings for about 5% of the respondents. About 8% of the respondents also reported to obtain forage seeds both from HARC and DLA.

Planting or seeding of improved forage was practiced mainly in June, followed by May and July. All respondents preferred broadcast seeding method for the annual forages (oats and vetch) while perennials forages were planted by raw planting. Oats-vetch mixture was cultivated at proportion of 3:1 as advised by HARC and DLA experts. Mohammed (2016) also reported better performance of 3:1 proportion of oats:vetch mixture in Endamehoni of Northern Ethiopia. Vetch is grown in arable lands either in pure stand or in mixture with oats (Firew and Getnet, 2010). Seeding rate used by most respondents ranges from 40 to 120 kg/ha which is wider variation than the seed rates ranges of 60 kg/ha to over 100 kg/ha reported by Suttie (2000). About 3.4% of the respondents practiced assumptions based seeding rate. Suttie (2000) revealed that high seed rate probably reflects the poor quality and low germination of seeds.

Use of Fertilizer to Enhance Forage Productivity

About 22 and 33% of the households used inorganic fertilizer and manure for growing forage crops, respectively; while 2.5% of the respondents apply compost. Difference was noted between production system ($p<0.01$) regarding fertilizer utilization practices, with more rural farmers applying fertilizer as compared with the peri-urban farmers. This might be associated with better accessibility of fertilizer in the rural areas for use in food crop production. Combined with the recent increases in the costs of inorganic fertilizers, manure has become a viable option for improving soil fertility in perennial forage plots. Solid cattle manure application increased forage yield and quality by increasing protein content although the nutrient composition of manure is highly variable and requires testing for acceptable nitrate levels before use (Malhi and McCartney, 2004).

In the present study there was a wide range of fertilizer, manure and compost application rates. Fertilizer was applied at average rate of about 88 (ranging 40 to 150) kg/ha. Among the sampled respondents who used fertilizer, 89% reported to apply fertilizer by broadcasting while only 11% use row based application. Among the manure and compost users, majority (57%) of the respondents reported that manure and compost were applied with the assumption of sufficiency for the area covered with improved forage. While 43% of the farmers applied manure and compost at a rate of 250 to 2800 kg/ha by broadcasting and mixing it with soil. Madison *et al.* (1995) revealed ammonia-N may be lost to the air if manure is surface-applied without incorporation. The wide range of fertilizer, manure and compost application rate without knowing the acceptable nitrate levels may affect forage productivity since nitrate deficiency causes lack of tillering, rhizome or stolon development and slow growth (Ernest *et al.*, 2016). While higher application rate cause high accumulation of nitrate in the forage (usually caused by stressful growing condition) that cause nitrate toxicity which results difficult breathing, collapse and death in animals (Hancock, 2013). Hence, farmers may require awareness building and trainings on managing productivity enhancement inputs.

Table 7. Farmers' decision on time and criteria of harvesting forages (% of respondents)

Parameter		Peri-Urban (N=47)	Rural (N=58)	Total (N=105)	P value
Harvesting criteria					
	Color change, flowering	14.90	13.80	14.30	
	Dryness, height	25.50	37.90	32.40	
	Flowering	10.60	17.20	14.30	0.339
	Flowering, seed bearing	10.60	10.30	10.50	
	Height	25.50	10.30	17.10	
	Height, biomass	12.80	10.30	11.40	
Annual forage harvesting time					
	October to November	34.20	41.80	38.70	
	December	42.10	38.20	39.80	0.718
	August to October* and December	23.70	20.00	21.50	
Perennial forage harvesting time					
	Every 2 Month	23.30	16.20	19.40	
	Every 3 Month	43.30	43.20	43.30	0.754
	Height dependent	33.30	40.50	37.30	

**= As green feed; N= Number of respondents.*

Farmers' Decision on Time and Criteria for Harvesting Forages

Farmers use different harvesting time depending on the type of cultivated forge. Annual forage crops were harvested from October to November for making hay by 38.7% of the respondents (Table 7). About 40% of the respondents extended harvesting time until December, especially when oats was grown as standalone for seed, and the forage obtained contain low level of nutrient and serve as straw. About 22% of the respondents harvested some portion of the annual forage in August to October to be offered as green feed. Perennial forage crops were harvested every two to three months or depending on height of the plant. Though not statistically significant, more peri-urban farmers harvest perennial forages every two months than the rural counterparts. This might be associated with better understanding and practicing of the knowledge gained from trainings as compared with their rural counterparts. The harvesting criteria of improved forage include; flowering, color change, seed bearing, dryness, height and biomass of the crop field. Among these, a combination of height and dryness were the main criteria used by 32.4% of the interviewed farmers.

Storage, Quality Assessment and Feeding of Improved Forages

About 25% of the respondent offer improved forage immediately as green feed. While the rest store forages by drying in forms like hay hip (24%) by lifting above ground, simply compacted in house prepared for forage store (33.3%), and finely threshed and sacked (12.4%) in store to avoid forage loss. More than two fold of the Peri-Urban respondents use green forage than that of the rural respondents. Similarly, 19% rural respondents store forage by finely trashing and filled in sacks while only 4.3% of peri-urban respondents use this method (Table 8). Respondents reported that they consider appearance, animal feeding preferences, stem length, color change, mold-free, leaves quality and level of weed infestation as quality indicators of stored improved forages. Alemayehu *et al.* (2017a) revealed that forage conservation ensures a supply of balanced nutrients throughout lactation for dairy animals.

Improved forages were offered to dairy animals as green feed, as hay or as crop residue and/ or mixing with other hay and crop residue (Table 8) for about 7.3 months per year. According to respondents, utilization of IF benefited the dairy holder by increasing animal feed intake when given alone or mixed with hay and crop residue; improve body condition that in turn improves milk yield. It also reduces the cash expenditure for purchasing supplementary feeds during wet season when most fields are covered by food crops and grazing lands enclosed for hay production. About 6% of the respondents also replied that they generate additional income from forage sell. Nangole *et al.* (2013) reported oats to be more marketable and profitable forage crop for Kenyan forage producers. Straw intake improvement and better milk production are also reported as benefit of using improved forage by Abebe (2008).

Improved Forage Extension Service in the Study Area

Extension service is the major technology transfer pathway between the technology owners and end user of the improved technology. About 72% of sample respondents said they have access to extension service while 28% were not addressed. In the study area, improved forage has been disseminated to farmers either by HARC as part of on farm dairy research and technology demonstration activities or by the district livestock agency (DLA). To some extent NGOs like ILRI, World Vision and Berga Bird Conservation Association also support these activities in collaboration with DLA. Some respondents also reported to get improved forages from their neighbors and friends.

Among the improved forage extension service beneficiaries, the support was satisfactory for 84% of the respondents. The unsatisfied respondents noted local adaptability of some introduced forage, provision of proper training, inputs and follow up, and lack of fair distribution of new technology as drawback of the extension services. Feleke *et al.* (2015) also reported the need for effective extension service to encourage farmers to grow improved forage species.

Table 8. Forage storage, quality assessment, feeding and benefits (% of respondents)

	Variable	Peri-Urban (N=47)	Rural (N=58)	Total (N=105)	P value
Forage storage method	Baled in house	6.4	3.4	4.8	
	Finely trashed and sacked	4.3	19.0	12.4	
	Hip as hay	21.3	25.9	23.8	0.064
	Compacted in house	31.9	34.5	33.3	
	Immediate use as green feed	36.2	17.2	25.7	
Forage quality indicators	Appearance	17.0	19.0	18.1	
	Appearance, feeding preferences	2.1	13.8	8.6	
	Appearance, aroma	0.0	5.2	2.9	
	Appearance, stem length	8.5	6.9	7.6	
	Color change, mold-free	10.6	10.3	10.5	0.033
	Feeding preference	31.9	19.0	24.8	
	Feeding preference, yield	25.5	8.6	16.2	
	Leaves quality	4.3	6.9	5.7	
	Stem length, feeding preference	0.0	3.4	1.9	
	Weed infestation, feeding preference	0.0	6.9	3.8	
Forage feeding method	As green feed	29.8	24.1	26.7	
	Mix with hay	2.1	6.9	4.8	
	Mix with crop residue	27.7	25.9	26.7	
	mix with concentrate	2.1	6.9	4.8	0.711
	As green and hay	14.9	12.1	13.3	
	As green feed and crop residue	12.8	17.2	15.2	
	Mix with hay and crop residue	10.6	6.9	8.6	
Forage feeding benefit	Increase intake	87.2	82.8	84.8	
	Increase intake and milk yield	0.0	6.9	3.8	0.329
	Increase intake, IBC, RFC	6.4	5.2	5.7	
	Increase intake, income by forage sell	6.4	5.2	5.7	

IBC= Improve body condition; RFC= Reduce feed cost; N= Number of respondents.

Conclusion

From the present study it can be concluded that farmers in the study area have a good perception on the importance of improved forage and utilize as one type of dairy animal feed resource by cultivating on land allocated for forage production. Being located around Addis Ababa milk-shed, most of the surveyed farmers have information access to different improved technologies of improved forage production. Hence, production and utilization of improved forage was not affected by the production system. However, different factors such as shortage of land, inadequate extension service, shortage of training and skill gap, and forage seed/seedling shortage were the major limiting factors for wider utilization of improved forage crops in the study areas. Therefore, it is recommended that effective extension service in terms of seed supply, awareness building and regular technical back-ups is important and should be emphasized to ensure sustainable production and utilization of improved forage crops in the study areas. Furthermore, animal performance trial would help to confirm the benefits of improved forages mentioned by respondents.

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Conflict of Interests

The authors declare that they have no competing interests.

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