Journal of Scientific Research & Reports
12(6): 1-10, 2016; Article no.JSRR.27223
ISSN: 2320-0227

SCIENCEDOMAIN *international*
www.sciencedomain.org

Temporal Change in Relative Availability/ Contribution of Different Livestock Feed Resources to the Total Feeds Available to Livestock Keepers in the Mixed Crop-livestock Highlands of Ethiopia: The Case of Household Perception in Tiyo District, Arsi Zone

Aklilu Mekasha[1*]

[1]Ethiopian Institute of Agricultural Research, Melkassa Research Center, P.O.Box 436, Adama, Ethiopia.

Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/JSRR/2016/27223
Editor(s):
(1) Lesław Juszczak, University of Agriculture in Krakow, Poland.
Reviewers:
(1) Gidi Smolders, Wageningen University, The Netherlands.
(2) Rafael Julio Macedo Barragán, Universidad de Colima, México.
Complete Peer review History: http://www.sciencedomain.org/review-history/17667

Original Research Article

Received 24th May 2016
Accepted 28th July 2016
Published 29th January 2017

ABSTRACT

In this study, temporal change, over the last 30-40 years, in relative availability/ contribution of different livestock feed resources to the total feeds available to livestock keepers were assessed based on household perception. The study was conducted in the Tiyo District of Ethiopia in Arsi Zone -as a typical representation of the mixed crop-livestock highland system of the country. The results revealed that over the last 30-40 years relative availability/ contribution of communal and private pasture lands have significantly declined. On the other hand; aftermath grazings as dry season feeds; crop residues particularly wheat and barley as year round feeds, and flour and oil mill/ agro-industrial by-products as year round supplementary feeds have significantly increased. Nevertheless, the relative contribution of cultivated forage grasses, herbaceous legumes and browses were low and remained unchanged over the study period. Thus the results suggest that

**Corresponding author: E-mail: mekashaaklilu@gmail.com;*

efforts on livestock feed resources development, better focus on local level strategies aimed at maximizing productivity and quality of the increasing feed resources. The unchanged very low contribution of cultivated forage crops also require new innovative systems of technology generation, demonstration and dissemination over the approaches being followed for the last 30-40 years.

Keywords: Feed resources; availability; relative contribution.

1. INTRODUCTION

Among most tropical countries, Ethiopia has extensive areas of land classified as highland. The highland plateaus and mountains above 1500 m constitute about 40% of the total land mass; over 60% of the human and 70% of the livestock population of the country [1]. In this part, the major land use is extensive smallholder mixed crop-livestock where the crop and the livestock husbandry are highly interlinked [1]. The highland livestock production system is based on feeding grazing resources which mainly is composed of annual foraging on natural pasture and forest lands. Substantial amount of feeds are also derived increasingly from crop residues, agro industrial by-products and other non-farm and farm products [2,3,4]. The proportional contribution of these feeds; however, varies with location and season [5,6].

Over the last decades the mixed crop-livestock highlands of Ethiopia experienced rapid change in land use/land cover mainly due to increase in human population pressure and partly due to climate change. In some parts, over the last three decades, the area under crop cultivation has expanded considerably by about 21%, while that of grassland has contracted greatly by about 15% [6]. This has resulted in a considerable change both in the type and the amount of feeds available to the livestock keepers. A study conducted in northern Ethiopia revealed that availability and use of communal grazing lands, private pastures, woodlots and forest areas as feed sources has significantly declined over the past decades and that this was accompanied by an increase in availability and use of crop residues [7]. At the same time, in some parts of the eastern highlands, 33% of the land has undergone transition since 1970's, and this has resulted in a significant decrease in the relative contribution of feeds from grazing resources by about 37%, and increase in crop residues and agro industrial by-products by 30% and 5%, respectively [6], and the total volume of available feeds could meet only 64% of the livestock's requirement [8]. As a result, feed shortage is the major factor responsible for low productivity of animals.

Nevertheless, previous studies have focused on understanding the general trends and lacked detailed account of temporal changes in relative availability/ contribution of individual categories of feeds under each of the major grazing, crop residues, cultivated forages, agro industrial by-products and other feeds from crop lands. On the other hand, having detailed information on this is vital to have firsthand information on the type(s) of feed(s) that is (are) increasing or decreasing in specific areas. Such information helps to identify and plan site specific areas of focus for future research and development undertakings under the changing climate and land use/land cover. Thus, taking the case of Tiyo District in Ethiopia, this paper explored household perceptions on temporal changes in relative availability/ contribution of the different feed resources from grazing, crop residues, agro industrial by products, cultivated forage crops and others in the mixed crop-livestock system of the tropical highland, and there by point out areas of future intervention to bridge the gap in feed supply and demand.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

This study was conducted in Tiyo District of the Arsi Zone, Ethiopia, located 175 km south east of Addis Ababa. The District is situated between 7°45'13''and 8°2'26''N latitude, and 38°56'6''and 39°19'33''E longitude. The area receives an annual rainfall of 1149 mm with the largest amount of water during June, July, August and September months (Heavy rain season) and the small rain during February, March, April and May months (Light rain season). October, November, December and January months (Dry season) are dry months and serve as period of harvest for the Heavy rain season sown crops. The District is known for production of range of crops

including wheat, barley, faba bean, field pea, sorghum, maize, tef, and others to varying degrees [5,6].

2.2 Household Survey

Data on relative availability/ contribution of different feed resources from grazing, crop residue, agro industrial by product, cultivated forage crop and others was collected through household survey. Following discussions with experts and elders on availability of various feed resources, check lists were first prepared, and used in group discussions with farmers. Information was elicited on kinds of feeds available under each of the grazing, crop residue, agro industrial by product, cultivated forage crop and others in the past (30-40 years ago), at present (2011) and the perceived trends. Based on feedback, semi-structured questionnaires were prepared on what was the relative availability/contribution of the various categories of feeds and tested with 10 randomly selected farmers. The questionnaires were then further refined and fully structured for the final interview.

The 'kebeles' (the smallest administrative unit) in the District were classified into three strata based on local agro-ecological classification with the help of District level experts. From each stratum one kebele was randomly selected with the help of development workers. Household heads older than 50 years old (assumed to have rich local knowledge) were identified as the study population from whom 92 households were randomly selected using Bartlett et al. [9] equation and interviewed.

During the interview, each respondent was given 100 maize seeds to divide among the different response options to show relative contribution of each feed type under grazing, crop residue, agro-industrial by-product, cultivated forage crop and others to the total amount of feeds of each category available to him/her both at present (2011) and in the past (30-40 years ago). This was done for the Major rainy, Small rainy and Dry seasons, separately for each category of feed.

2.3 Data Analysis

The different feed resource categories from grazing, crop residue, agro industrial by product, cultivated forage crop and others were described, and households' response on the relative availability/ contribution of each were subjected to the general linear model (GLM) procedure of SAS Institute (2002) to identify significant differences among the different categories of grazing, crop residue, agro industrial by-product, cultivated forage crop and others from croplands within a season or among seasons, whereas paired T test was used to identify mean differences between past (30–40 years ago) and present (2011). All significant differences were separated at 5% probability level.

3. RESULTS

As is evident from Table 1, in the study area, the relative availability/contribution of the different feed resources to the total volume of available feeds varied among seasons, and between past and present times. In the past, grazing was the major feed available to livestock keeping households. It used to account significantly more of the total volume of feeds available both at seasonal and annual levels. However, overtime, the relative availability/contribution of grazing resource has been significantly reduced, and at present, crop residue has become significantly more available and is the dominant feed during the rain seasons and at annual level. Similarly, at present, the relative availability/ contribution of agro-industrial by product has significantly increased across all seasons and at annual level. On the other hand, the seasonal and annual availability/ contribution of cultivated forage crop were minimal both at present and in the past.

3.1 Grazing Resource

Farmers in the District identified communal pasturelands, private pasturelands, fallowlands and aftermath grazing as the major grazing resources available to them both at present and 30-40 years ago. However, as shown in Table 2, the relative availability/ contribution of these grazing resources have shown considerable variation among seasons and over years. Inline of this, in the past, communal and private pasture lands used to contribute significantly more to the total feeds available during Heavy rain and Light rain seasons, and aftermath grazing shared the largest proportion of feeds available during the *Dry* season. Though presently too these grazing resources did not show noticeable differences in relative seasonal order of contribution to grazing resources, their contribution to the total feeds

available to farmers have significantly changed (Table 2). Over the last three to four decades, the contributions of communal pasturelands, private pasture lands, and fallow lands have significantly declined. More significant reduction in contribution of communal and private pasture lands was observed during Heavy rain and Light rain seasons, and during Dry season in case of fallow land grazing. On the other hand, the contribution of aftermath grazing has significantly increased as a major grazing resource available during Dry season.

3.2 Crop Residue

Farmers identified wheat, barley, tef, maize, sorghum and pulses (faba bean and field pea) as the major crops, residues of which is available for livestock feeding (Table 3). The relative availability/ contribution of these resources to the total feeds available to livestock keeping households; however, varied over years and seasons. In the past, crop resides used to contribute only 19% to the total annual feeds available to livestock keeping households. At that time, significantly more crop residues were consumed during the Dry and the Light rain seasons, and among crop residues, barley and wheat used to contribute significantly more residues to the total available feeds. Over the years; however, the relative availability/ contribution of crop residues to the total available feeds have significantly increased across all seasons. Wheat residue alone has significantly increased by about 12.4%, for Heavy rain season, 7.6% for Dry season and 21.8% for Light rain season and has become the leading crop residue available to livestock keepers.

3.3 Cultivated Forage Crop

Farmers in the District reported that they rarely cultivate grasses, herbaceous legumes and browses as livestock feeds. These crops contribute very less to the total feeds available to the farmers at any season, and remained almost unchanged over the last three to four decades (Table 4). Among cultivated forage crops, grasses contribute relatively more to the total feeds available to famers both at present and in the past. Significantly more cultivated forage crops were used during the Heavy rain season, but without any practical effect on the available feeds for animals.

3.4 Agro-industrial by-Product

Farmers indicated that agro-industrial by products from local flour mill and oil mill plants like linseed cake, wheat bran middling, and home brewery by products such as '*Tela and Areke Atela'* are the major by-products available to the livestock keeping households. As shown in Table 5, farmers hardly use agro-industrial by products as a supplementary feeds in all seasons, and no significant differences were observed in relative availability/ contribution among seasons. However, among others, home brewery by-products accounted significantly more in relative availability/ contribution in all seasons. Over the last decades, significant change in relative availability/ contribution of home brewery by product was observed only during Light rain season while, flour and oil mill by products have shown significant increase in all seasons.

3.5 Other Feeds from Cropland

Farmers in the study District also use other sources grown on from lands-mainly crop lands. These feed resources include thinnings and leaf striping/tops from garden sown maize, and weeds from land boundaries, as well as garden and field grown crops (Table 6). On seasonal basis, thinnings and weeds contribute significantly more to the total feeds available during Heavy rain season (both at the present and in the past), and the relative availability/ contribution of these feeds showed significant increment by over 4% in the Heavy rain season.

4. DISCUSSION

4.1 Grazing Resource

As perceived by farmers, over the study period (30-40 years), the mixed crop-livestock tropical highland system of the country-represented by Tiyo District in this study-experienced significant changes over years in the intra seasonal relative availability/ contribution of the different grazing resources. However, there was little or no change in the seasonal relative availability/ contribution among the grazing resources (communal or private pastures, fallow and aftermath) to the total volume of feeds available to the livestock keepers. This implies that farmers, in the study area, are experiencing marked changes in the

inter annual availability of grazing resources relative to that of the intra seasonal changes. Similar declining changes in availability of gazing resources from communal grazing lands, private pastures, woodlots and forest areas have also been reported in other parts of the country [7,10]. The significant reduction in contribution of communal pasture and private pasture lands as major grazing resources of the Heavy rain and the Light rain seasons might be linked to the increased land cultivation (Light rain season) and subsequent ground cover by field crops (Heavy rain season). On the other hand, the decline in contribution of fallow lands as important grazing grounds of Heavy rain and Dry seasons could be because of the abandoning of the traditional fallow practices in response to shortage of cultivable land. At the same time, private pasture lands have become significantly important over communal grazing lands which might be due to land alienation and fencing of small plots of land to conserve feeds [11].

4.2 Crop Residue

As in the case of grazing resources, the availability and use of crop residues have also shown substantial inter annual, but relatively less inter seasonal changes. The observed increase in availability of residues of all crops might be related to the general increase in areas of crop production [6,12]. In the study area, the relative availability/ contribution of wheat residue has shown marked upsurge in all seasons, and this might be related to the impacts of the nearby kulumssa research center which has developed and released many high yielding and disease resistant bread wheat varieties over the study period [13]. In conjunction with this, the ongoing global warming might have also opened up new climatic areas of ideal wheat production in the cooler highlands that once was dominated by barley production [14,15]. Crop residues are highly valued as livestock feeds during the Light and Heavy rain seasons as these are the times of a year when lands are brought under cultivation, and livestock free movements are restricted. These are also times when crop residues are highly demanded for competing interests between livestock feed and mud house construction that contributes to raising prices [5]. At the same time substantial quantities of crop residues are also wasted being exposed to rain induced decomposition at storage, trampling over in fields and feeding grounds/ troughs.

4.3 Cultivated Forage Crop

The present study has demonstrated that the relative contribution of cultivated forage crops to the total feeds available to the farming households is very low and has not changed over the last decades. This signifies that forage crops technology adoption and diffusion is very meager in spite of research and development efforts since the Chilalo Agricultural Development Unit (CADU) time- late in 1960's [16,17], and it is in line with the reported very small contribution at a national level [5,18,19]. Such very low level of contribution is often attributable to the low level of resource allocation to forage crops cultivation. Farmers often give priority for food and cash crops to be grown on the limited non expandable land that is getting sliced and fragmented over time. In many cases, forage crops cultivation is exercised at plot level [20] either as part of demonstration by research or extension personals, and are not competitive enough to demonstrate advantages over other competing interests for which resources (land, labour and cash) are allocated. According to Tefera et al. [18] forage crops are cultivated by less than 0.01% of the Ethiopian farmers, and Negassa [11] also in his studies of market access of dairy farmers in the Arsi Zone found no improved forage or pasture crop cultivated on farmers' private grazing lands.

4.4 Agro-industrial by-Product

The availability and use of agro-industrial by-products in all seasons have increased over the last decades. The observed increase could be related to the increase in flour mill and edible oil mill processing plants in nearby areas [21,4], and the corresponding increased awareness among farmers on benefits of feeding agro-industrial by-products [22]. Among others, cakes from edible oil mill by-products have increased more by over three percent, and that could be because of relatively more production of linseed, and the use of the less efficient mechanical pressing method of oil extraction against the organic solvent extraction by modern and big oil mills [5]. This is followed by wheat bran from bread wheat flour milling plants and barley bran from households own milling at small flour mills. However, the supply of agro-industrial by-products is lagging much behind farmers' demand and unexpected price raises are common problems as in other parts of the country [4,5].

Table 1. Relative contribution of different feed resources (%) to the total seasonal and annual feeds available to livestock keepers in the past (30-40 years ago) and at present (2011) in Tiyo District, Arsi Zone, Ethiopia

Feed resource	Heavy rain season			Dry season			Light rain season			Annual		
	Past	Present	Change	Past	Present	Change	Past	Present	Change	Past	Present	Change
Grazing	72.5^{A}	27.7^{BC}	-44.8*	67.8^{A}	52.2^{A}	-15.6*	67.1^{A}	16.7^{B}	-50.4*	69.1^{A}	32.2^{B}	-36.9*
Crop residues	13.6^{B}	43.3^{A}	29.7*	23.5^{B}	36.7^{B}	13.2*	20.0^{B}	64.9^{A}	44.9*	19.0^{B}	48.3^{A}	29.3*
Cultivated Forage Crop	0.8^{C}	2.0^{D}	1.2	0.4^{D}	0.2^{D}	-0.2	0.5^{D}	0.5^{D}	0.0	0.6^{D}	0.9^{D}	0.3
Agro-Industrial by-product	4.6^{B}	9.3^{CD}	4.7*	7.7^{C}	10.4^{C}	2.7*	6.1^{C}	12.3^{B}	6.2*	6.1^{C}	10.7^{C}	4.5*
Other	8.5^{B}	17.6^{C}	9.2*	0.6^{D}	0.5^{D}	-0.1	6.3^{C}	5.6^{BC}	-0.7	5.1^{C}	7.9^{C}	2.8*

Different alphabetical letters in a column indicate values that are significantly different from each other, and the star (*) indicates significantly changed value between past and at present

Table 2. Relative contribution of different grazing resources (%) to the total seasonal and annual feeds available to livestock keepers in the past (30-40 years ago) and at present (2011) in Tiyo District, Arsi Zone, Ethiopia

Grazing Resource	Heavy rain season			Dry season			Light rain season			Annual		
	Past	Present	Change	Past	Present	Change	Past	Present	Change	Past	Present	Change
Communal pasture	27.8^{A}	$4.\ 5^{B}$	-23.3*	15.5^{B}	2.1^{C}	-13.4*	33.5^{A}	3.3^{B}	-25.9*	25.6^{A}	3.3^{C}	-22.3*
Private pasture	35.5^{A}	18.0^{A}	-15.5*	13.6^{B}	6.1^{B}	-7.5*	28.3^{A}	9.8^{A}	-18.5*	25.1^{A}	11.3^{B}	-13.8*
Fallow land	9.9^{B}	3.5^{B}	-6.4*	9.0^{C}	2.0^{C}	-7*	1.1^{B}	0.3^{C}	-0.8	6.7^{C}	1.9D	-4.7*
Aftermath	1.3^{C}	1.7^{B}	+0.4	29.7^{A}	42.0^{A}	+12.3*	4.2^{B}	3.3^{B}	-0.9	11.7^{B}	15.7^{A}	3.9*

Different alphabetical letters in a column indicate values that are significantly different from each other , and the star (*) indicates significantly changed value between past and at present

Table 3. Relative contribution of different crop residues (%) to the total seasonal and annual feeds available to livestock keepers in the past (30-40 years ago) and at present (2011) in Tiyo District, Arsi Zone, Ethiopia

Crop Residue	Heavy rain season			Dry season			Light rain season			Annual		
	Past	Present	Change	Past	Present	Change	Past	Present	Change	Past	Present	Change
Sorghum	0.3^{C}	1.6^{EF}	+1.3*	1.5^{BC}	1.8^{D}	+0.3	0.4^{D}	1.7^{E}	+1.3*	0.7^{D}	1.7^{E}	1.0
Maize	0.3^{C}	3.2^{DE}	+2.9*	1.8^{C}	2.8^{CD}	+1.0*	0.8^{D}	4.0^{D}	+3.2*	1.0^{CD}	3.3^{D}	2.4*
Tef	2.9^{B}	7.2^{C}	+4.3*	2.7^{B}	3.0^{C}	+0.3	3.9^{C}	9.8^{C}	+6.0*	3.2^{B}	6.7^{C}	3.5*
Wheat	4.9^{A}	17.3^{A}	+12.4*	6.5^{A}	14.1^{A}	+7.6*	5.9^{B}	27.7^{A}	+21.8*	5.8^{A}	19.7^{A}	13.9*
Barley	4.8^{A}	10.2^{B}	+5.4*	7.9^{A}	10.1^{B}	+2.2*	7.9^{A}	15.3^{B}	+7.9*	6.9^{A}	12.0^{B}	5.2*
Pulse	0.4^{C}	3.8^{D}	+3.4*	3.1^{BC}	4.9^{C}	+1.8*	1.1^{D}	5.8^{D}	+4.7*	1.5^{C}	4.8^{CD}	3.3*

Different alphabetical letters in a column indicate values that are significantly different from each other, and the star (*) indicates significantly changed value between past and at present

Table 4. Relative contribution of different cultivated forage crops (%) to the total seasonal and annual feeds available to livestock keepers in the past (30-40 years ago) and at present (2011) in Tiyo District, Arsi Zone, Ethiopia

Cultivated forage crop	Heavy rain season			Dry season			Light rain season			Annual		
	Past	Present	Change	Past	Present	Change	Past	Present	Change	Past	Present	Change
Grass	0.4^{A}	1.4^{A}	+1.0	0.0	0.0	0.0	0.5^{A}	0.2	- 0.3	0.3^{A}	0.5^{A}	0.2
Herbaceous legume	0.0^{B}	0.3^{B}	+0.3	0..0	0.0	0.0	0.0^{B}	0.1	+0.1	0.0	0.1^{B}	0.1
Browses /fodder tree	0.1^{B}	0.3^{B}	+0.2	0.4	0.1	-0.3	0.0^{B}	0.2	+0.2	0.3^{A}	0.2^{B}	-0.1

Different alphabetical letters in a column indicate values that are significantly different from each other, and the star (*) indicates significantly changed value between past and at present

Table 5. Relative contribution of different agro industrial by-products (%) to the total seasonal and annual feeds available to livestock keepers in the past (30-40 years ago) and at present (2011) in Tiyo District, Arsi Zone, Ethiopia

Agro-industrial by-product	Heavy rain season			Dry season			Light rain season			Annual		
	Past	Present	Change	Past	Present	Change	Past	Present	Change	Past	Present	Change
Flour mill by-products	0.0^{B}	0.4^{C}	+0.4*	0.3^{B}	1.2^{C}	+0.8*	0.1^{B}	0.8^{C}	+0.7*	0.1^{B}	0.8^{C}	0.7*
Oil mill by -products	0.1^{B}	3.2^{B}	+3.1*	1.4^{C}	3.8^{B}	+2.5*	0.6^{B}	4.7^{B}	+4.2*	0.7^{B}	3.9^{B}	3.3*
Home brewery by-products	5.1^{A}	5.7^{A}	+0.6	6.0^{A}	5.4^{A}	-0.6	5.5^{A}	6.8^{A}	+1.3*	5.9^{A}	6.0^{A}	0.1

Different alphabetical letters in a column indicate values that are significantly different from each other, and the star (*) indicates significantly changed value between past and at present

Table 6. Relative contribution of other feeds from croplands (%) to the total seasonal and annual feeds available to livestock keepers in the past (30-40 years ago) and at present (2011) in Tiyo District, Arsi Zone, Ethiopia

Other feeds from crop lands	Heavy rain season			Dry season			Light rain season			Annual		
	Past	Present	Change	Past	Present	Change	Past	Present	Change	Past	Present	Change
Thinnings	5.3^{A}	9.4^{A}	+4.1*	0.0	0.1	+0.1	3.7^{A}	2.7^{A}	-1.1	3.0^{A}	4.0^{A}	1.0
Leaf strippings	0.1^{C}	0.2^{B}	+0.1	0.3	0.1	-0.2	0.1^{B}	0.2^{B}	+0.1	0.2B	0.1^{B}	0.0
Weeds	3.1^{B}	8.1^{A}	+5.0*	0.3	0.4	+0. 1	2.5^{A}	2.8^{A}	+0.3	2.0^{A}	3.8^{A}	1.8

Different alphabetical letters in a column indicate values that are significantly different from each other, and the star (*) indicates significantly changed value between past and at present

4.5 Other Feeds from Cropland

Thinnings and leaf stripings from back yard or field grown maize mainly as green corn and sorghum crops as well as weeds from mostly hand weeded faba bean fields, and others are also available to households as feeds. However, during the survey work, farmers expressed that increased availability of these group of feeds is constrained by farmers' better crop management practices. Repeated land cultivation without resting to restore soil seed banks and the increased application of herbicides are decreasing availability of weeds and weed species of economic importance as livestock feeds. On the other hand, the ongoing global warming and associated increase in temperature of the District [6] could increase suitability and area of production of maize and sorghum, thereby increasing potential availability of thinnings and leaf strippings from these crops.

5. CONCLUSION AND RECOMMENDA-TION

From the results of the present study it is apparent that over the study period, livestock feed resources are in a dynamic state of change in relative availability/ contribution to the total amounts of feeds available to livestock keeping households. Among grazing resources, relative contributions of the communal and private grazing lands have significantly declined in all seasons with increase in relative availability/ contribution of the aftermath grazings in the *Dry* season. Relative contribution/use of crop residues have also significantly increased with major surge in the Heavy rain season, and the bulk of residues come from wheat followed by barley. Cultivated forage grasses, herbaceous legumes and browses contribute very meager and has not changed over the study period. The relative availability/ contribution of agro industrial by-products from flour and oil mills have increased in all seasons. The relative availability/ contribution of the other feeds from crop lands, including weeds and thinnings have also increased and become important feeds available to livestock keepers in the Heavy rain season. Thus to bridge the gap in feed supply and demand, the results of the present study suggest that future research and development efforts on livestock feed resources, better focus on devising local level strategies aimed at maximizing productivity and quality of the increasing crop residues, agro industrial by-products and other feeds from crop lands. The unchanged very low contributions of cultivated forage crops also require new innovative integrated approaches of forage technology generation, demonstration and dissemination that challenge the systems in place over the last 30-40 years. Future research and development efforts should also better focus on improving the quantity and quality of the categories of feeds which are on increasing scale on farmers' level.

ACKNOWLEDGEMENT

The author is grateful to the handling editor and the two anonymous reviewers for their valuable input in revising the manuscript to the current level.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Gebru H. Role of livestock in food security and food self-sufficiency in the highland production system. In: Livestock in Food Security– Roles and Contributions. Proceedings of the 9th Annual Conference of the Ethiopian Society of Animal Production (ESAP), August. Ethiopian Society of Animal Production, Addis Ababa, Ethiopia. 2001; 30–31.
2. Habte T. Livestock feed security and associated impacts on sustainable agricultural development. Paper presented at the 7th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia May 26-27, 1999 ESAP, Addis Ababa; 2000.
3. Mengistu A. Feed resources base of Ethiopia: Status, limitations and opportunities for integrated development. Paper presented at the 12th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia August 12-14, 2004 ESAP, Addis Ababa; 2005.

4. Tolera A, Assefa G, Geleti D, Gizachew L, Mengistu A. Feed resources availability and quality. In: Tolera, A., Yami, A., Alemu, D. (Eds.), Livestock feed resources in Ethiopia: challenges, opportunities and the need for transformation. Ethiopian animal feeds industry association, Addis Ababa, Ethiopia; 2012.
5. Gebremedhin B, Hirpa A, Berhe K. Feed marketing in Ethiopia: Results of rapid market appraisal. Improving productivity and Market success (IPMS) of Ethiopian farmers project working paper 15. International Livestock Research Institute (ILRI), Nairobi, Kenya. 2009;64.
6. Mekasha A, Gerard B, Tesfaye K, Nigatu L, Duncan JA. Inter-connection between land use/land cover change and herders'/farmers' livestock feed resource management strategies: a case study from three Ethiopian eco-environments. Agriculture, Ecosystems and Environment. 2014;188:150–162.
7. Benin S, Ehui S, Pender J. Policies for livestock development in the Ethiopian highlands. Socio-economic and policy working Paper 41. ILRI (Inter-national Livestock Research Institute), Addis Ababa, Ethiopia. 2002;29.
8. Berhe K, Woldu Z, Peden D, Hoekstra D, Mammo A. Impact of changes in land use and land cover on feed resources in the Ethiopian highlands; 2013.
   Available:http://www.ipms-thiopia.org/content/files/Documents/publications/ Proceedings/Impact of changes.pdf (Accessed 28.05.13)
9. Bartlett JE, Kottrlliikk JW, Hiiggiinss CC. Organizational research: Deter-mining appropriate sample size in survey research. Inform. Technology Learning Performanc. 2001;19(1):43–50.
10. Gebremedhin B, Fernandez-Rivera S, Hassen M, Mwangi W, Ahmed S. Maize and livestock: Their interlinked roles in meeting human needs in Ethiopia. Research report 6, International Livestock Research Institute (ILRI), Nairobi, Kenya. 2007;103.
11. Negassa A. Improving small holder farmers marketed supply and market access for dairy products in Arsi Zone, Ethiopia. Research Report 21, International Livestock Research Institute (ILRI), Nairobi, Kenya. 2009;107.
12. Taffesse AS, Dorosh P, Asrat S. Crop production in Ethiopia: Regional patterns and trends. Ethiopia Strategy Support Program II (ESSP II), ESSP II working paper No. 0016; 2011.
13. MoA (Ministry of Agriculture). Plant variety release, protection and seed quality control directorate. Crop Variety Register, Addis Ababa, Ethiopia; 2014; 14.
14. Evangelista P, Swartzinski P, Waltermire R. A profile of the mountain Nyala (Tragelaphus buxtoni). African Indaba; 2007;5.
   Available:www.africanindaba@co.za (Accessed 10.22.12)
15. Mekasha A, Nigatu L, Tesfaye K, Duncan AJ. Modeling the response of tropical highland herbaceous grassland species to climate change: The case of the Arsi Mountains of Ethiopia. Biological Conservation. 2013;168:169–175.
16. Kaske K. Achievements and directions of forage seed research and production in the highlands of Arsi. Ethiopian Institute of Agricultural Research (EIAR), Addis Ababa, Ethiopia; 2012.
17. Mengistu A, Assefa G. The evolution of forage seed production in Ethiopia. In: Forage seed research and development in Ethiopia. Ethiopian Institute of Agricultural Research (EIAR), Addis Ababa, Ethiopia; 2012.
18. Tefera TL, Puskur R, Hoekstra D, Tegegne A. Commercializing dairy and forage systems in Ethiopia: An innovation systems perspective. Working paper 17. ILRI (International Livestock Research Institute), Nairobi, Kenya. 2010;57.
19. Duncan AJ, Hanson J, Spielman DJ, Puskur R. Forage seed supply in Ethiopia: Some thoughts on status and how it might evolve. Ethiopian Institute of Agricultural Research (EIAR), Addis Ababa, Ethiopia; 2012.
20. Dejene M, Assefa G, Kebede G, Kaske K. Forage seed production and supply systems in the central highlands of Ethiopia. In: Forage seed research and development in Ethiopia; 2012;59–70.
21. Aregheore EM. Crop residues and agro-industrial by-products in four pacific island countries: Availability,

utilization and potential value in ruminant nutrition. Asian-Australas Journal of Animal Sciences. 2000;13:266–269.

22. Gizachew L. Drought-induced livestock feed crises and emergency responses. In: Tolera, A., Yami, A., Alemu, D. (Eds.), Livestock Feed Resources in Ethiopia: Challenges, Opportunities and the Need for Transformation. Ethiopian Animal Feeds Industry Association, Addis Ababa, Ethiopia. 2012;47–58.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/17667