Research Article **AJBAS (2020) 3:15**

American Journal of Basic and Applied Sciences
(ISSN:2637-6857)

STATUS AND CHALLENGES OF AVAILABLE FEED RESOURCES AND IT'S QUALITY UNDER THE CHANGING CLIMATE IN ADAMI TULU DISTRICTS OF EAST SHOA ZONE, ETHIOPIA

LELISA DIRIBA[1*] AND MENGISTU URGE[2]

[1]Oromia Agricultural Research Institute, Adami Tulu Agricultural Research Center, Batu, Ethiopia.
[2]Department of Animal and Range Science, Haramaya University, Haramaya, Ethiopia.

ABSTRACT

The study was conducted in Adami Tulu Jido Kombolcha (ATJK) district of the East Shoa Zone Oromai Region, Eethiopia, with the objectives to assess the existing status of feed resource under climate change and examine chemical composition. Feed sample from grazing lands (protected communal (PC), protected private (PP) and unprotected communal (UnPC) and crop residues were used for chemical composition analysis (23 from the natural pasture (NP) and 48 from crop residues (CRs). Out of 23 herbaceous species identified in ATJK district, Cynodon dactilon in ATJK district was the dominant grass species. The average mean DMY (ton ha-1) of grass obtained from PPGL (2.43) and PCGL (2.36) was significantly ($P<0.01$) higher than that from UnPCGL(1.18) in ATJK . The mean value of CP contents of CRs in ATJK district were 3.5±0.17 for maize stover (MS) to 6.5±0.93 for Haricot bean (HCB) straw. The NDF contents of CRs were between 63.5±1.83 for HCB to 79.74±1.24 for maize stover (MS). The ADF contents of CRs varied from WS (49.12±2.82) to HC (52.63±1.16) in ATJK district. Generally, the nutritive values of the evaluated feed resources were lower than the minimum and should supplement with protein and energy source. The analysis of meteorological data of 30 years of ATJK district indicated that; as temperature increase, the annual rainfall decrease and increases the rate of crop water use. This situation of climate change affects directly or indirectly the nutritive values and yields of the crop, natural pasture, and production and productivity of livestock and it will be suggested that to study the effects of climate on soil and animal feed nutrients.

Keywords: Crop residues, Grazing land, herbaceous species, Natural pasture, Nutritive value.

***Correspondence to Author:**
ELISA DIRIBA
Oromia Agricultural Research Institute, Adami Tulu Agricultural Research Center, Batu, Ethiopia.

How to cite this article:
LELISA DIRIBA AND MENGISTU URGE.STATUS AND CHALLENGES OF AVAILABLE FEED RESOURCES AND IT'S QUALITY UNDER THE CHANGING CLIMATE IN ADAMI TULU DISTRICTS OF EAST SHOA ZONE, ETHIOPIA .American Journal of Basic and Applied Sciences, 2020, 3:15

eSciPub LLC, Houston, TX USA.
Website: https://escipub.com/

1. INTRODUCTION

Demand for animal products in Sub-Saharan Africa and generally in the developing countries is likely to rise significantly because of population growth, urbanization, and rising income [66]. Livestock production in Africa accounts for about 30% of the gross value of Agricultural production, with 92% of this is coming from the production of beef cattle, dairy cattle, goats, sheep, and chickens [96]. Ethiopia was gifted with a huge and wide range of natural resource and diverse agro-ecological zones. These potentials make the country to be well known as a reservoir area for animal genetic diversity [92]. The country livestock sector contributes about 15 to 17% of gross domestic product (GDP), 35 to 49% of agricultural GDP, and 37 to 87% of the household income [35]. The estimate of livestock population in the country stands at about 59.5 million cattle, 30.70 million sheep, 30.20 million goats, 2.16 million horses, 8.44 million donkey, 0.41 million mule, 1.21 million camels, 56.53 million poultry and 5.92 million beehives [53]. Despite high livestock population and the existing favorable environmental conditions, the current livestock contribution is below its potential due to various reasons associated with a number of complex and inter-related factors such as feed shortage, disease, and drought [40].

There were less effort made in introducing appropriate package of improved livestock technologies, improved feed management practices, and adequate health care services that could enhance the current livestock production and productivity [84]. According to Gelayenew *et al.* [79] seasonal feed shortage and inefficient utilization are the major problems affecting livestock productivity. The productivity of the natural pasture in most parts of Ethiopia is extremely low [165, 3] due to seasonal fluctuation of rainfall, poor grazing land management, conversion of grazing lands in to crop lands, and increased human population [68]. This problems leads to low dry matter yield (DMY), which results in to a critical shortage of animal feed, below the maintenance requirement of livestock throughout the year [71, 68]. Crop residues are fibrous and high in lignin, and low in essential nutrient (proteins, energy, minerals, and vitamins) contents that limit the feeding value, and they generally have low digestibility and intake [14].

Agriculture in Ethiopia is mostly affected by climate change whereby decreasing in precipitation and increases in temperature are both destructive factors [61]. Several studies showed that there is a declining trend of livestock numbers per household and species [103, 26]. According to Negassa and Jabbarr [126], the size of livestock holdings at the household level is very small and does not support stable and sufficient commercial off-take even though there is apparently large livestock population in Ethiopia. This is due to the changes associated with temperature itself, relative humidity, rainfall distribution in time and space, altered disease distribution, changes in the ecosystem, encroachment of grazing land by undesirable plant species [136]. Thus, to obtain good quality in animal production and productivity, an assessment on the types and sources of livestock feed, total DM production of the area and livestock feed requirement was needed [69].

In the present study area, factors contributing to the declining trends of livestock numbers per household as well as annual availability of feed production with animal requirements per TLU are not estimated. So far, different research activities regarding assessment of livestock production practices in relation to available feed resource and major factors affecting livestock production were conducted in part of East Shoa Zone [30, 54]. However, there is no recently research activity undertaken in the study district regarding the pattern of utilization, biomass production, and status of grazing land under the current climate change and chemical composition of major available feed resources. In this regard, identification of feed resources and assessment of opportunities and constraints associated with livestock feed resource are preconditions for designing suitable livestock development strategies. Such studies had not been recently carryout in ATJK district. Therefore, the current study were designed to generate base-line information with the objective to assess the status of major grazing ruminant feed resources under the current climate change and its nutritional quality during wet and dry seasons, and to assess the challenges and opportunities of livestock feed resource in relation to the current climate change.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

Geographically Adami Tulu-Jido Kombolcha (ATJK) district is located between 38°25'E and 38° 55'E latitude and 7°35'N and 8°05'N longitudes, bordering in the West by Southern Nations, Nationalities, and Peoples' National Regional State and Arsi Negele district, in North West by Dugda-Bora woreda, in East-South by Arsi Zone [109]. It is located at a distance of about 168 km from Addis Ababa. The district has semi-arid and arid agro-climatic Zones and lies between 1500-2000 m a.s.l., with exception of areas located around Mount Aluto. This district is characterized by mixed crop-livestock farming system, semi-arid, and sub-humid in which 90% of the area is lowland while the remaining 10% is intermediate. The average annual temperature ranges from 22ºC to 28ºC. The area receives average annual rainfall of 760 to 1000 mm, in which the distribution is uneven and erratic in nature [121, 100], and characterized by very short and unreliable rain during the months of April-May. While most of the rain in the district occurs during three months (June-August) and sometimes up to September [102, 4, 5]. About 72352 ha of the land in ATJK was allocated for cultivation while the rest 14601.75 ha were allocated for private grazing land, communal grazing, homestead land, and 4968 ha were allocated for enclosed plantation/wood land and forest, respectively [1].

2.2 Study Population and Sampling Procedures

To select the specific study sites from the two districts, discussions were held with district livestock experts and secondary information from district and Zonal Agricultural and Rural Development offices was utilized to assist in the selection of RKs. Then, 6 representative rural kebeles (RKs) were selected from ATJK district. Descriptive cross-sectional study was conducted in order to assess major available feed resource and quantity during wet and dry season, feeding system, and its constraints, effects of climate change on animal feeds and coping strategies.

2.3 Data Collection and Sampling Procedures

The grazing lands were classified by grazing types as protected communal grazing (PC) which is called also enclosure area, protected private (PP), and unprotected communal (UnPC) grazing land (GL) in selected study RKs of the district. Feed samples from natural pasture were collected by using 0.25 m^2 quadrates at a distance of 10 km between the grazing sites [95]. From each of the grazing site, 3 samples were taken from different areas that are 10 m far apart from each other using 0.25 m^2 quadrates, mixed, and a composite of one sample per site (kebele) was taken. Hence, the total samples from the grazing lands were 18 from the district (that is one sample per grazing type *3 grazing type per rural kebele * 6 rural kebele), and a total of 18 samples from 18 quadrates were taken from the district. Sampling was conducted from August 15 to September 20 when almost all the pasture plants were fully grown to over 50% of flowering stage.

2.4 Herbaceous Composition and Dry Matter Yield Estimation of Grazing Land

Immediately after harvesting, the total fresh weight of the samples were measured using a sensitive balance and the herbaceous species composition with regard to relative proportion of the grasses, legumes, and other weeds/forbs on weight basis was determined by relating the weights of each group to the weight of the whole samples [94]. The dry weight rank (DWR) procedure described by Tothill *et al*. [162] that involves cutting and sorting by hand were used to measure percentage proportion of each forage type according to the following formulas.

$$\text{TDW of species} = \frac{\text{TFW of a species}}{\text{SFW of a species}} \times \text{SDW of a species} \text{---------} (1)$$

$$\text{\% proportion of species} = \frac{\text{TDW of a species}}{\text{GTDW}} \times 100 \text{----------------} (2)$$

Where, TFW =Total fresh weight of individual species, SFW = sub-sample fresh weight, TDW= Total dry weight, SDW=sub-sample dry weight, and GTDW=Grand total dry weight.

The average dry weight of the pasture samples per quadrates were calculated, which then extrapolated into dry matter yield (DMY) per hectare. The DM output from grazing land was estimated by multiplying the area of grazing land by 2.0 tons ha^{-1}, which was determined by this study as describe earlier. For the other land, use types, such as tree/shrub/wood and other forest areas were estimated by multiplying the area of land by 0.7 tons ha^{-1} [73, 119]. The interviewed household heads identified the pasture species present in the selected site, the abundant feed type that preferable by livestock, and the droughts tolerant species. The botanical compositions of herbaceous species (local and scientific name) were identified in the field using key pastoralist and farmers, researchers, technical assistance of ATARC experts (range experts) being assisted by guidebooks [18].

2.5 Dry Matter Estimation from Crop Residues

The quantity of available crop residues on DM basis were estimated from the total crop yields of the households, which was obtained during the interview, using the conversion factors that were developed [73] for Ethiopia condition. The conversion factor used for wheat, barley, and *teff* straws, and faba bean and field pea were 1.5 and 1.2, respectively [73]. Whereas, a multiplier of 4.0 for linseed [73], 2.0 for maize [55], 2.5 for sorghum [104], and 0.5 for crop aftermath [73, 119] were used to obtain DM yield of the feed produced from these straws. The total quantity of potentially available crop residues for animal consumption were estimated by multiplying the crop residue yield by 90% assuming that 10% was used for other purposes such as for fuel and wastage that occur during feeding. The daily dry matter requirement for maintenance of one TLU was estimated to be 2.5% of the body weight [90] that is 250 x 2.5%=6.25kg/day/animal or 2.28 ton DM per year (2281kg $year^{-1}$ $animal^{-1}$). Data of livestock population in the sampled households was obtained from the interviewed household heads during the survey and from livestock and fisheries office. The number of livestock population was converted into tropical livestock units (TLU) using the conversion factors [97, 90, 36].

2.6 Retrospective Status of Climate Condition in the Study Site

Among the households selected for an interview, 12 individuals per district having knowledge on climate change and its effect on livestock were taken based on the suggestion of expertise and the community and in-depth information was collected using interviewing these key informants. Some of the current situation of feed resource as compared to previous years, challenges of climate change on livestock and feed resources, and existing coping mechanisms were gathered by interviewing participants' and through field observation as well as from relevant available data at the Offices of the District and Zone. The climatic (rain fall and temperature) data of (1987-2017) 30 year for the two districts were also collected from the meteorology stations of the Zone and

ATARC and recorded on Microsoft office excel to show trends and compare with the perception of the respondents.

2.7 Chemical Analysis of Major Feed Resources

Representative feed samples during wet season from different grazing type were harvested at height of 0.5 cm above the ground from ATJK district and major crop residues from crop cultivation were sampled purposively from crop fields. Accordingly, 44 representative feed samples, 18 from natural pastures, and 24 from major crop residues were taken from the two districts. About 1/3 of the samples of the herbaceous species and about 300 g samples of major crop residues were thoroughly mixed and ground for chemical analysis. The samples were dried in an oven at 65^{O}C for 72 hours and ground in Willey mill to pass through 1mm sieve and allowed to equilibrate at room temperature for 24 hrs. Dry matter and ash contents of feed samples were determined by oven drying at 105^{O}C overnight and by igniting in a muffle furnace at 600^{O}C for 2 hour, respectively [28] (%DM= DW/FW x 100). Nitrogen (N) content was determined by Kjeldahl method (major feed have 16% N which means 100/16=6.25N) and CP was calculated as N*6.25 [29] in Batu/Ziway Soil Research Center, and then taken to Hawassa University of Animal Nutrition Laboratory to determine ADF, ADL, NDF and IVDMD by the modified Tilley and Terry method [168].

2.8 Data Management and Statistical Analysis

The data was organized and analyzed by Statistical Package for Social Sciences [144]. Descriptive statistics such as frequency, means, percentages, and standard error of the means were used to present the results of households' response. All data obtained from chemical analysis of the feeds including dry matter yield of each species from the grazing site were analyzed by one way analysis of variance (ANOVA) employing the General Linear Model (GLM) Procedure of SAS [135]. When significant differences between means were detected at $P<0.05$, the Tukey's Studentized Range (TSD) test was used to separate the individual means. The model used was; $Y_{ij} = \mu + A_i + e_{ij}$; Where, Yij=quality and quantity of feeds, μ=over all mean, Ai = the grazing site of ith Grazing type, i.e., protected communal, protected private and unprotected communal and Eij= Random error.

The major livestock and grazing land constraints were summarized by index ranking methods and Index ranking method (weighted averages) was used to obtain the major livestock production and grazing land constraints in the study area [124].

3. RESULTS AND DISCUSSION

3.1 Major Feed Resources and Feeding Systems in Study Areas

Among the feed resources crop residues, natural pasture, and aftermath were the main livestock feed resources contributing the largest feed in the study area for cattle and sheep, which was in line with the reports from other highland areas of Ethiopia [152]. Accordingly, respondents from ATJK district indicated that the major feed resources during dry season for cattle were crop residues (68.33%), aftermath (14.17%), concentrate (11.67%), and hay (5.82%) and during wet season natural pasture (48.33%), crop residues (39.17%), and concentrate (5.83%), respectively. In terms of availability, crop residues in ATJK district, crop residues can hardly meet the requirement of the animals in dry season, as most of the feed resources are not available, which agree with the reports of Sisay [140] and Elias [67]. Generally, farmers in ATJK district zero grazing (5%), free grazing (70%), and cut-carry (25%). In terms of availability respondents indicated that livestock feeds in the wet season were adequate (20.8%), abundant (36.67%), and inadequate (42.5%), and during dry season were adequate (35%), abundant (25%) and inadequate (40%), respectively showing that the available feed resource is not adequate at any season in the study area. This result is in agreement with the other research findings (140, 67].

3.2 Seasonal Availability of Feed Resources in ATJK

The months of the year classified according to feed availability (Table 1). In the ATJK district, natural pastures were the main feed resources from July to September. In the dry period (September to August), crop residues like maize stover, wheat straw, *teff* straw, haricot bean straw, and barley straw were the major feed resources. In wet season (July to the beginning of September), few of the respondents (25%) around ATJK district move with their cattle to Habernosa and Langano area, which was called '*Godantu/Godansa*', where green grazing pasture was available as most farm land is used for crop production. Animals and some family members stay in the '*Godantu/Godansa'* area from June to September. In the dry season (January to May), about 16.67% of respondents in ATJK moves their cattle to relatives far away from their residence. This was because some family relatives in other areas have relatively larger grazing pastureland and allow them to use by their relatives free of charge. majority (75%) of the respondents do not move their cattle to other areas and they use their own grazing lands, borderlands in between adjacent crop fields, green maize stock and weeds for feeding.

Table 1. Feed resources availability across different months of the year in the study districts

Feed sources	Months											
ATJK	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Natural pastures	*										*	*
Crop residues		*	*	*	*	*	*	*	*	*	*	*
Crop aftermath				*	*	*	*					
Weeds and maize Thinning	*	*									*	*

*The feed resource mentioned is available in the specified month/months.

3.3 Estimation of Annual Feed Availability in Study District

3.3.1 Dry matter production from the different grazing area

In ATJK district about 29,203.5 tons per year of total DMY from natural pasture and 3477.6 tons of feed dry matter from the total 4968 ha area of land covered by forest/degraded/enclosed were produced (Table 2). Generally, from different grazing and enclosure area of land a total of 6399.1 tons DM yield per annual were produced in ATJK district.

Table 2. Estimation of dry matter yield from grazing land managed in different ways

Districts	Land use type	Area of land (ha)	Conversion Factors	Total DMY (ton ha^{-1})
ATJK	Grazing lands (protected private and communal) and unprotected communal grazing	14,601.75	2	29,203.5
	Enclosure area of Shrub/tree lands and other forest	4,968	0.7	3,477.6
	Subtotal			6,399.1

DMY=dry matter yield, ATJK= Adami Tulu Jido Kombolcha

3.3.2 Crop residues production

A total of 222122.3 tons of crop residues were produced from different crop types in ATJK district (Table 3).

3.3.3 Livestock feed balances in Adami Tulu Jido Kombolcha (ATJK) District

The total estimated annual feed supply in ATJK districts can only meet about 58.97% DM requirement for maintenance with low production and productivity (Table 4). Therefore, in ATJK livestock were a negative DM feed requirement. The observed lower in DM requirement of the current study agrees with earlier work reports [54] that noted quantities of available feed resources were very low and do not supply annual dry matter required by livestock. Therefore, under such a huge gap between availability of feed resources and livestock population, sustainable production and productivity of livestock in the future in the study area is difficult and requires strategic intervention in feed production and matching of livestock number with the available feed resources.

Table 3. Crop residues yield from total cultivated land in ATJK District

Crop type	Total land cultivated (ha)	Total grain yield (qt/ha)	Conversion factor (CF)	Crop residues yield in tones
Maize	35,005.44	700108.8	2.0	200043.42
Wheat	12299.84	14759.81	1.5	2213.97
Haricot bean	9405.76	30098.43	1.2	3611.8
Sorghum	7855.2	62841.6	2.5	15710.4
Barley	1447.04	1447.04	1.5	217.1
Teff	4341.12	21705	1.5	325.6
Total	72352			222122.3
Aftermath	72352		0.5	36176
Total crop residues and aftermath produced				**258298.3**

ATJK= Adami Tulu Jido Kombolcha

Table 4. Estimation of feed balance in study districts

District	Annual feed DM supply (tons)	Estimated annual DM requirement for maintenance (tons)	DM supply versus requirement (tone)
ATJK	264697.4	448891.7	-184194.4 (58.97%)

ATJK= Adami Tulu Jido Kombolcha

3.4 Major Livestock Constraints and their Consequences in the Study Districts

3.4.1 Major livestock production constraints

The most devastating phenomenon that restricts livestock productivity ranked was feed scarcity, land shortage, water shortage, and disease in study district (Table 5). The current result is in line with other earlier reports [153] who generally noted that scarcity of feed resource become a critical constraint to livestock production in almost all parts of the country.

3.5 Status of Available Grazing land in Study Districts

The majority of respondents indicated that, the size of the current grazing land size was decreasing from time to time and the composition of herbaceous species were dominated with less palatable plant species, which is an indicator of declining grazing land productivity in the study areas. The major reasons for shrinking were due to the expansion of crop cultivation, increased population density, expansion of investments, and land degradation (Table 6). This current finding agrees with the reports of Amaha and Belaynesh [27] that the grazing areas were converted into cropland due to rapid population growth. This result is similar with the reports of Yoseph [183].

Table 5. Ranks of major livestock production constraints in ATJK districts

No.	Problems	Livestock production constraints in ATJK (Ranks)											PI	Rank
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	F.sum		
1	Feed scarcity	28	7	8	5	5	4	1	3	0	0	505	0.152	1
2	Land shortage	17	10	13	16	1	1	0	0	1	1	490	0.147	2
3	Disease	0	8	10	4	17	7	11	2	1	0	369	0.111	5
4	Water shortage	13	9	13	16	6	0	1	2	0	0	473	0.142	3
5	Drought	12	14	6	7	5	3	6	1	4	2	425	0.128	4
6	Management	0	0	1	3	5	14	16	11	3	6	238	0.072	7
7	Inbreeding	0	0	3	4	2	6	8	32	5	0	232	0.070	8
8	Lack of market	1	1	6	3	13	23	5	5	1	2	320	0.097	6
9	Lack of AI	0	0	1	1	2	4	6	4	29	13	154	0.046	9
10	Other	0	1	0	4	0	0	3	1	17	34	120	0.036	10
	Total											3326	1.000	

F-sum=3326 in ATJK No=number; AI=Artificial insemination; PI=Priority Index, F-sum=the sum of all weight constraints mentioned by respondents

Table 6. Status of grazing land and reason for shrinking grazing land in the study district (60 respondents)

	Reasons for decreasing grazing land (rank)								
ATJK	Reasons	1	2	3	4	5	Total	Index	rank
1	Expansion of crop land	9	27	12	8	4	209	0.2240	2
2	Land degradation	10	10	9	22	9	170	0.1824	4
3	Increase population density	31	13	5	7	4	240	0.2575	1
4	Expansion of investment	11	16	19	12	2	202	0.2167	3
5	Reduction of livestock numbers	0	7	11	8	34	111	0.1190	5
Total							932	1.00	

ATJK=Adami Tulu Jido Kombolcha; NS= non-significant, F-sum=880 in ATJK

3.6 Quality Composition of Major Feed Resource in Study Districts

3.6.1 Chemical composition of major feed resource in the study area

The laboratory DM of all evaluated major feed resources in Adami tulu jido kombolcha (ATJK) district was more than 90% (Table 7), which was similar with the findings of earlier studies [62] that reported above 90% DM for different feed resource. The ash contents of wheat straw of the current study were higher than that reported by Mekuanint and Girma [114] (9.34%). The average mean ash content of maize stover recorded in the present study was far greater than the result reported by Yitaye [182], which was 7%. The ash content of all evaluated crop residues and natural pasture in the current study areas were not difference (p>0.05). However, the overall mean values of ash contents of natural pasture of the current results were lower than (10.99%) reported by Mekuanint and Girma [114]. The average mean value of CP of *teff* straw, maize stover, and wheat straw recorded in the current study agreed with that reported [182, 18]. The current result of CP value obtained from crop residues were lower than the minimum level of nitrogen (7%) which limit feed intake [117] (168). The average mean value of CP content of haricot bean straw obtained was significantly higher (P< 0.001) than that of the other crop residues in the study district (Table 7). This is due to the high nitrogen content of the pulse crops as they are legumes. The CP value of wheat straw was higher than the previous reports of 2.4% [138] and 2.7% [77]. The average mean value of CP contents of natural pasture harvested at blooming stage obtained from unprotected communal grazing land was significantly (P<0.05) lower than that from protected private and protected communal in ATJK district (Table 7).

The average mean value of neutral detergent fiber (NDF) contents of maize stover, *teff* and wheat straw of the current study were lower than the NDF contents of maize stover (82.13%), *teff* straw (81.5%) and wheat straw (78.6%) reported by Chalchissa *et al.* [87]. The current result of NDF value of cereal crop residues agree with the reports of Sisay [140] and Alemu *et al*. [25] who indicated that NDF contents of crop residues were greater than 70% and 72.98 to 79.4%, respectively. The NDF contents of natural pasture of the current study were lower than 74.1% in dega and 75.54% in weinadega reported in earlier studies [62]. The higher NDF content could be a limiting factor on feed intake, since voluntary feed intake and NDF content are negatively correlated [70]. The NDF contents of crop residues and natural pasture in this study were beyond the limit of 65% and this may be due to growth stage and temperature affecting the balance between photosynthesis and respiration and, hence could limit DM intake [167]. Roughage feeds with NDF content of less than 45% categorized as high quality, 45-65% as medium quality and those with more than 65% as low quality [139]. The NDF content of maize stover of the current study in the study district were less than the NDF content of maize stover (82.13%) reported by Chalchissa *et al.* [87].

The Acid detergent fiber (ADF) contents of crop straws and natural pasture were shown in Table (15). The ADF content for crop residues of the current result were within the range reported by Ahmed and Abule [18] and Solomon *et al.* [142]. The averages mean value of ADF contents of natural pasture of the current study were lower than that reported by Ahmed and Abule [18]. which were 78.9 and 77.8% in low altitude, and 73.9 and 75.6% in mid-altitude obtained from communal and private grazing, but in line with reported by Dirsha *et al.* [62].

The ADF content of maize stover of the current study were greater than that reported by Chalchissa *et al.* [87] (51.72%) and Dirsha *et al.* [62] (47.6%). Whereas the ADF content of *teff* straw (46.8%) and wheat straw (58.1%) reported by Chalchissa *et al.* [87] was lower than *teff* straw and higher than wheat straw in ATJK district (Table 7). These variations in ADF contents of crop residues were associated with the differences in temperature, varietal difference, crop management, and soil type. High ADF contents in crop residues might be associated with lower digestibility since digestibility of feed and its ADF are negatively correlated (McDonald *et al*., 2002). The highest concentration of lignin found in haricot bean straw followed by wheat straw (Table 7). The lignin content of haricot bean straws found in the current result in the study district were lower than the results of 12.72% for pulse crops reported by Mekuanint and Girma [114] and 15.42% reported by Ahmed and Abule [18]. The ADL content of legume crop residues (haricot bean straw) recorded in this study was higher than the maximum level (7%) that limits DM intake and livestock production [132]. This may be due to stage of maturity, management, and environmental factors.

The average mean value of lignin contents in maize stover of the study area was greater than the value of 7% that limits DM intake [132]. The average mean value of ADL contents of natural pasture harvested of the current study was lower than the critical level (7%). The average mean value of ADL contents of natural pasture (5.95) in ATJK, district were lower than the value of 7.24 and 7.55% in lower altitude and 7.49 and 7.30% in mid-altitude, respectively reported by Ahmed and Abule [18].

In vitro dry matter digestibility

The IVDMD for maize stover in Adami Tulu Jidokombolcha (ATJK) district shown (Table 7) were lower than the value reported for maize stover (58.65%) by Chalchissa *et al.* [87]. The highest IVDMD content recorded in haricot bean straw (52.99±2.277) and the lowest from wheat straw (41.94±1.505) in ATJK district. The mean value of IVDMD obtained in the current study for wheat straw (41.94%) were in line with the value of cereal straws recorded in Gassera (41.92%) and Ginnir (42.22%) districts [114]. The mean values of IVDMD for cereal crop residues were lower than the minimum level required for quality roughages [137]. Lower IVDMD values observed in cereal crop residues, which are likely associated with their higher lignin content compared to the other feed resources. The lowest mean value of IVDMD obtained from unprotected communal grazing land in ATJK district. This difference may be due to overgrazing, few or no palatable, legume species composition, and higher unpalatable species indicating the degradation of grazing land. Generally, according to the current result, the nutritive value of the major feed resources evaluated were lower than the minimum requirements and this difference may be due to variety, location, and stage of maturity, and as well as environmental factors. The current result agree with [13] who reported high fiber and low crude protein contents of different feed resources could be related to varietal differences, climate, fertility of the land, stage of maturity at harvest, morphological fraction, method of harvesting and transporting, length and condition of storage.

3.7 Botanical Composition and Dry Matter Yield of Grazing Land in Study District

3.7.1 Herbaceous composition of grazing lands in study Districts

The highest proportion of grass DM yield obtained from unprotected communal grazing lands (62.43%) in ATJK district, which may be due to small share of total DM yield from the same area of land. The highest proportions of forbs observed in PPGL (24.03%) and PCGL (24.85%) in ATJK district. This showed that there was the degradation problem on grazing land of ATJK district. The lower proportion of legumes observed in unprotected communal grazing lands (UnPCGL) in both study districts might probably be due to climbing or sprawling growth habit, which makes them more susceptible to loss through grazing in the lower altitudes. 23 herbaceous species were identified and out of the grass species, 24, 51, and 25% were highly desirable, desirable, and less desirable as feed for livestock, respectively. The less desirable grass species increased in the vegetation due to severe overgrazing and they are generally indicators of declining range condition [185].

Table 7. Chemical composition of major feed ATJK

Wet	Feed types	DM	Ash	CP	NDF	ADF	ADL	IVDMD
	TS	91.87(±0.49)	10.65(±0.47)	4.06(±0.346)^{b}	77.22(±2.58)^{ab}	55.18(3.173)	10.89(±0.47)	45.73(±1.72)^{b}
	WS	91.21(±0.59)	10.37(±0.29)	3.78(±0.15)^{b}	71.94(±2.92)^{b}	49.12(±2.84)	11.36(±0.46)	41.94(±1.51)^{b}
	HCB	91.1(±.34)	9.81(±0.35)	6.51(±0.93)^{a}	63.50(±1.83)^{c}	52.63(±1.16)	10.58(±0.25)	52.99(±2.28)^{a}
	MS	92.10(±0.18)	10.75(±0.20)	3.51(±0.17)^{b}	79.74(±1.2)^{a}	55.83(±1.69)	10.77(±0.38)	43.83(±1.83)^{b}
Overall mean		91.57	10.39	4.47	73.100	53.19	10.90	46.12
	CV	1.15	8.137	27.79	7.50	10.87	8.93	9.845
	LSD	1.2724	1.0185	1.4951	6.6042	6.967	1.1719	5.469
	P-value	0.3009	0.2462	0.0016	0.0003	0.2066	0.5609	0.0024
Sign	**Feed type**	---	---	***	***	---	---	**
Wet	PPGL	91.92(±0.33)	10.73(±0.38)	5.6(±0.29)^{a}	67.51(±2.02)	48.54(±1.98)^{ab}	6.11(±0.55)	49.59(±0.79)
	PCGL	92.53(±0.18)	10.32(±0.21)	5.99(±0.21)^{a}	69.24(±1.87)	44.52(±3.29)^{b}	5.69(±0.51)	49.68(±0.56)
	UnPCGL	92.63(±0.46)	11.26(±0.57)	4.69(±0.17)^{b}	70.27(±0.79)	54.527(±0.25)^{a}	6.06(±0.55)	46.37(±1.4)
Overall mean		92.36	10.77	5.43	69.01	49.195	5.95	48.55
	CV (%)	0.91	9.41	10.40	5.87	13.16	22.07	4.97
	LSD	1.0362	1.2467	0.695	4.9828	7.9686	1.6174	2.9697
	P-value	0.3081	0.3042	0.0037	0.5054	0.0519	0.8337	0.0508
Sig	Grazing	---	---	**	---	---	---	---

*Means with different superscripts within a column and *** in rows are significantly different (P<0.05), —= Non-significance, DM = Dry matter; NDF = Neutral detergent fiber; ADF = Acid detergent fiber; ADL = Acid detergent lignin; CP = Crude protein; IVDMD = In vitro dry matter digestibility; Sign. =significant; CV = Coefficient of variation; PPGL = Protected private grazing land; PCGL= Protected communal grazing land; UnPCGL = Unprotected communal grazing land, TF = Teff straw, WS = Wheat straw, HCB = Haricot bean straw, MS = Maize stover*

According to the elders response, *Cynodon dactlon*, *Eragrostis teniufolia*, *Andropogon abyssinicas, Cenchrus ciliaris, Chloris pictnotrics, Aristida arsensinosis* are the common species in ATJK district. *Cynodon dactlon* is the dominant grass species in both protected and unprotected communal grazing areas and the dominant legume species were *Indigofera linnaei*, local *Seratro, Desmodium* (*Grean and Silver*) species and from forbs/weeds were *Acharants* species (*Amaranthaceaes* like *alternanthere pungens*), *Tribules*, *Teretures* (dominant on cultivated land), *Partinium*, *Leucas martinicensis* (*dargu adii*) and Cogogiisa/qarcabbaa (local name) in ATJK district. The most valued grass species identified by herders in ATJK district were *Cynodon dactlon, Eragrostis teniufolia, Chloris species, and Cenchrus ciliaris.* The availability of grasses like *Harpachne schimperi, Sporobouls pyramidalis*, *Chloris pictnotrics, Aristida arsensinosis* species were reported to be characteristics for degraded land, which faced heavy grazing pressure.

The study further indicated that *Psydrax schimpefiana* and clover species are fast disappearing and rarely seen. The current result also agreed with that reported by Zewdie [186] who indicated that unpalatable herbaceous species like *H. schimperi, S. pyramidalis, H. contortus, and Partinium* were invading the natural pasture while palatable species like *Cenchrus, Chloris, Bracharias,* and *Andopogon* were disappearing in Ziway (ATJK) district. As reported by Chadhokar [46] such incidences may be due to over grazing in the area and this has resulted in the domination of unpalatable species of grasses in the study area and the pasture to be dominated by unpalatable grass species. This may in turn affect the photosynthetic area of a plant as well as species composition in the area [146].

3.7.2 Dry matter yield from different grazing land in ATJK District

The average mean dry matter yields (ton ha^{-1}) of grass, legumes, and forbs obtained from PPGL, PCGL, and UnPCGL were shown (Table 8). The dry matter yield of grass obtained from PPGL and PCGL was significantly (P<0.001) higher than dry matter yield obtained from UnPCGL in ATJK district and the dry matter yield of legumes obtained from PPGL and PCGL was significantly (P<0.05) higher than the dry matter yield obtained from UnPCGL in ATJK district. The dry matter yield of forbs obtained from PCGL was significantly (P<0.05) higher than the dry matter yield of forbs from UnPCGL in ATJK district. The DMY of forbs obtained from PPGL and PCGL was significantly (P<0.05) higher than the UnPCGL in ATJK district. This showed that due to over grazing; all species present on UnPCGL were grazed by livestock species. The present result was higher than Beyene *et al*. (2010) were. This variation might be due to low livestock pressure, soil fertility, and rainfall in that area and the grazing area in ATJK district was degraded and invasive species have reduced the effective size of the pastureland. This result agrees with the reports of Gizachew [88] and Alemayehu [24].

In general, the conditions of the protected private and communal grazing /enclosure land areas were in good status, which implies that making enclosures is a practical method of improving the grazing area. Whereas, the unprotected communal grazing land of the study district were in poor condition for grazing animals like cattle and sheep, and this implies that there is a need to improve the condition of the grazing land. The result of this study further demonstrates that given proper management like resting of the grazing land, the grazing sites could improve [154].

Table 8. Mean DMY (ton ha^{-1}) and species proportion (%) from different grazing land

District	Grazing types	Mean DMY (tonha^{-1}) of herbaceous species			Total DMY
		Grass	Legumes	Forbs	(tonha^{-1})
ATJK	PPGL	2.427^{a} (58.33%)	0.734^{a} (17.64%)	1.00^{ab} (24.03%)	4.161
	PCGL	2.36^{a} (57.28%)	0.736^{a} (17.86%)	1.024^{a} (24.85%)	4.12
	UnCGL	1.187^{b} (62.57%)	0.26^{b} (13.71%)	0.45^{b} (23.72%)	1.897
Overall mean		1.99	0.58	0.824	
	CV (%)	32.67	49.13	45.18	
	P-value	0.0075	0.0148	0.0276	
Sign		**	*	*	

*PPP = Protected grazing land; PCGL = Protected grazing land; UnPCGL = Unprotected communal grazing land; CV = Coefficient of variation; NS = Non-significant; * = Significance at (P<0.05); ** = Significant at (P<0.001) across the column, DMY = Dry matter yield*

3.8 Perception of Household on Climate Change and Coping Mechanisms in Study District

Climate change by definition is vast and difficult to see from all perspective for a given region. The majority of the respondents in ATJK (78.3%) district indicated that frequent occurrences of drought were increasing from year to year (Figure 1) under annual rainfall and temperature trends and these results in a decreasing palatable herbaceous species and increasing forbs and those problems are the major indicators of climate change. This was in line with [42, 159] stated that effect of climate change on livestock production was measured through its effects on natural pastures, water sources, livestock diseases, and biodiversity. Similarly, few studies, which assessed farmers' perception elsewhere in Africa, have reported comparable findings [127]. National Meteorological Agency [125] reported that the average minimum temperature in Ethiopia has been increasing by 0.37^{O}C in lowland and by 0.3^{O}C in highlands per decade across the past 60 years in Ethiopian.

To cope up the drought problems to their livestock, the respondents in the study district undertake different mechanisms. Among those use of conserved feed and tree leaves, selling large ruminant, rearing small ruminant and poultry, herd diversification, and migration. This is in line with the reports from the other pastoral areas of Ethiopia and the East African countries [155].

Table 9 Perception and coping mechanisms to climate change in study district (n=60)

How you compare current climate change to 10 and above years ago?	**Respondents**
	ATJK
	(n= 60)
Temperature increasing	47(78.3%)
Temperature decreasing	0
The same	13(21.67%)
Drought coping mechanisms	
Use of tree leaves and conserved feeds	27(45%)
Sale of large ruminants and rearing small ruminants and poultry	18(30%)
Keeping mixed species	5(8.5%)
Migration	10(16.7%)

ATJK =Adami Tulu Jidokombolcha, n=respondents

3.9 Annual Rainfall and Temperature Trends in the Study District

The annual average rainfall and average annual minimum and maximum temperature trends from 1987 to 2017 of the study district are presented in Figure 1. In this study, the (annual rainfall and temperature) of 30 years in both districts indicates that as temperature increase, the annual rainfall decrease (Figure 1) and this current study agrees with the report of Kassie [98]. Hence, the result of the present study highlighted the possible impact of climate change on agriculture in the study area and this result agrees with the reports of Tsegaye *et al.* [163].

4. SUMMARY AND CONCLUSION

The study was conducted in ATJK districts, with the objectives to assess the major available grazing feed resource and examine their chemical composition and to assess community perceptions regarding the challenges and opportunities of available feed resource under climate change. The livestock feed resources were assessed by the formal and informal survey. A descriptive cross-sectional study were conducted to assess major available feed resource, quantity during the wet and dry season, feeding systems, and its constraints, effects of climate change on animal feeds under the current situation and coping strategies, and secondary information from the district and Zonal Agricultural and Rural Development offices were utilized. In the study district, 60 respondents purposively selected for the interview that had long experience and knowledge of livestock production. A structured questionnaire was prepared and pre-tested for its applicability before its administration.

Three grazing sites such as protected communal/enclosure protected private and unprotected communal grazing areas were selected using systematically stratified random sampling technique. Before harvesting, a quadrant of 0.25 m^2 was placed on grazing sites. From one grazing site, three samples apart from each and a composite of one sample per site from 0.25m^2 quadrants and three samples from different grazing lands at height of 0.5cm above the ground were harvested. The numbers of available crop residues (DM basis) were estimated from the total crop yields of the households, which was obtained from the questionnaire survey, using the conversion factors. The effects of climate on animal feed under the current situation were gathered from both primary and secondary sources of data, and the temperature and precipitation data of 30 years were collected from meteorology station of the Zone. Collected feed samples from natural pasture and crop residues were used for chemical composition evaluation.

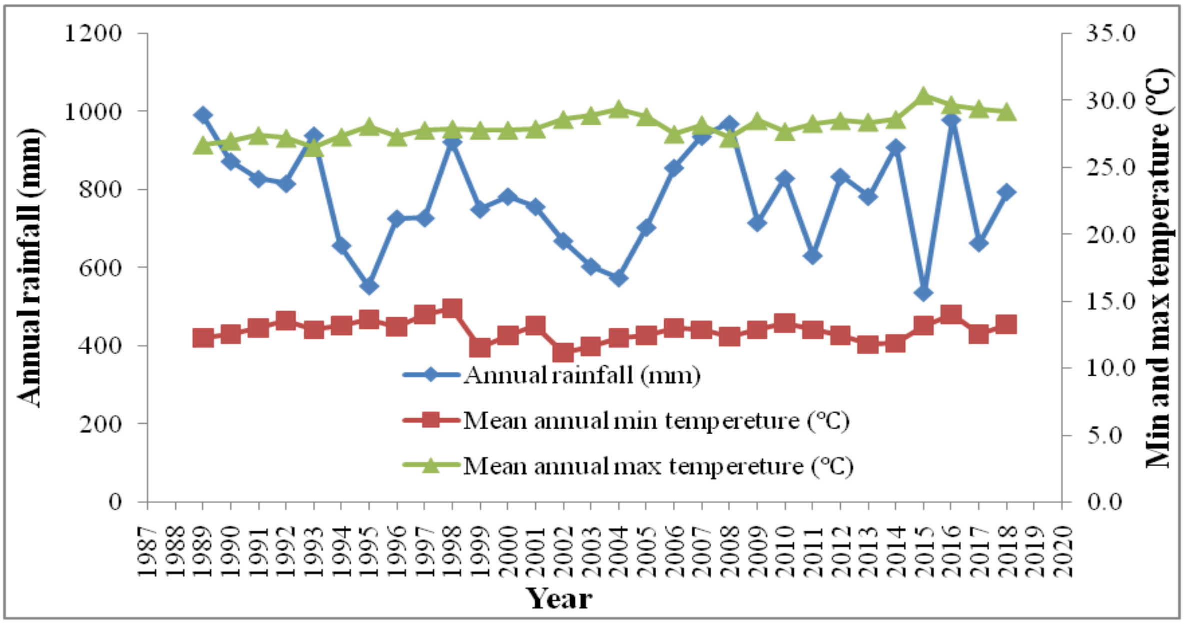

Fig. 1 Trends of annual rainfall and temperature for Adami Tulu Jido Kombolcha district for 30 years (1987-**2017)**

The average mean landholding per household was 2.27 ha hh^{-1} in ATJK. Of this, the total lands used for food crop cultivation was 2.61 ha hh^{-1} in ATJK district. According to the responses' of respondents, the shares of protected communal protected private and unprotected communal grazing area were 9.7, 1.02, and 0.6 ha, per household in ATJK district. About 50% of the respondents in ATJK district respond that the total number of cattle and herd composition was declining from time to time due to shortage of grazing land, increase of population density and expansion of cropland, shortage of feeds and water, and animal diseases. About 86.7% of the respondents respond that grazing land size was decreasing from time to time in ATJK districts.

Generally, 75% of the major feed resource during the dry season in the ATJK districts is crop residue, but during the wet season, natural pastures (46.67%) in ATJK was the major feed resource. From three sites of grazing lands in ATJK district, 23 herbaceous species were identified and *Cynodon dactlon, Eragrostis teniufolia, Andropogon abyssinicas, Cenchrus ciliaris, Chloris pictnotrics, and Aristida arsensinosis* were the common species. The DMY of grass obtained from PPGL and PCGL was significantly (P<0.001) higher than dry matter yield obtained from UnPCGL in ATJK district and the dry matter yield of legumes obtained from PPGL and PCGL was significantly (P<0.05) higher than the dry matter yield obtained from UnPCGL in ATJK district. The dry matter yield of forbs obtained from PCGL and PPGL were significantly (P<0.05) higher than the dry matter yield of forbs from UnPCGL in ATJK district.

Furthermore, the chemical composition of major feed resources from natural pasture and crop residues were determined. The highest (p<0.05) crude protein (CP) content was recorded from haricot bean straw (6.51±0.93) in ATJK district and the lowest from maize stover (3.51±0.165) in ATJK district. The highest NDF recorded for *teff* straw (77.22±2.58) in ATJK districts. The highest ADF contents were obtained from maize stover (55.83±1.69) and *teff* straw (55.18±3.17) in ATJK districts (p<0.05). The highest ADL content obtained from wheat straw (11.36±0.46) in ATJK district. The current study indicated that the statuses of grazing land declined, which may need immediate intervention. To improve degraded grazing land, there is a needs of rehabilitation and restoration of the grazing areas through establishment of community based enclosure or resting highly degrade/bared areas, re-seeding depleted grazing areas, developing water points on the grazing areas and introducing water harvesting mechanisms were crucial to improve the grazing land status of the study district.

4.1 Conclusion

As a conclusion, the main feed resource in the study district were crop residues and natural pasture, which are characterized with low quantity and quality, which did not match with the annual requirement of the animal and result in reduced livestock productivity and lower disease resistance. The major challenges of feed resources in the study area were inadequate to feed resource in quality and quantity, drought, weed, and forbs/weeds/bush encroachment, poor soil fertility, lack of seed and planting material. The analysis of meteorological data of 30 years in Adami Tullu Jiddo Kombolcha district indicated that as temperature increase, the annual rainfall decrease. Therefore, the increase in temperature will increase the rate of crop water use adding to the currently frequent water stress on crops and livestock showing the possible impact of climate change on the agriculture in the study area.

5. RECOMMENDATION

As grazing lands are shrinking from time to time-intensive pasture or forage development strategies especially in areas where dairy and fattening activities are practiced should be implemented.

SCOPE FOR FUTURE RESEARCH

Effects of species variability on the nutritive value, productivity, and nutrient composition of feed resource with the effects of other environmental factors such as soil and climatic factors should be investigated.

ACKNOWLEDGEMENTS

First, I thank the Almighty God for giving me patience throughout my life journey. My special and sincere gratitude goes to my major advisor Mengistu Urge (Pro) for his earnest and constructive comments throughout the analysis and preparation of the manuscript. I also remain thankful to my beloved families for their support.

REFERENCES

1. Abdissa Teshome, Amenti Chali, Kassaye Tolessa, Fiseha Tadese and Geremew Awas. 2011. Yield and yield components of sweet potato as influenced by plant density: In Adami Tulu Jido Kombolcha district, Central Rift Valley of Ethiopia. American Journal of Experimental Agricultur
2. Abule Ebro. 2003. "Range land evaluation in relation to pastoralist's perceptions in the Middle Awash Valley of Ethiopia." PhD diss, University of the Free State.
3. Abule Geda. 2015. Changes in Grazing land management and implications on livestock production in west shoa zone. ILRI, Ethiopia.
4. Adami Tulu Agriculture Research Center (ATARC) Meteorological station. 2018. Monthly and annual rainfall (precipitation), maximum and minimum temperature records of 1989-2018 year of meterology from Adami Tulu agriculture Research Center, OARI, Ethiopia.
5. Adami Tulu Agriculture Research Center Meteorological station, 2018.
6. Adami Tulu Jido Kombolcha (ATJK) district Annual reports of Livestock Development and Health Bureau. 2018. Livestock population and size of grazing land in Adami Tulu Jido Kombolcha District, East Shoa Zone, Ethiopia.
7. Adane Kitabe and Berhan Tamir. 2003. Effect of Stage of Harvesting and Fertilizer Application on Dry Matter Yield and Quality of Natural Grass Land in the Highlands of Northern Shoa, Oromia Region.
8. Admasu Terefe, Abule Ebro and Tessema Zewdu. 2010. Livestock-range land management practices and community perceptions towards rangeland degradation in South Omo zone of Southern Ethiopia. Livestock Research for Rural Development 22(1).
9. Adugna Tolera and Said, A. N. 1994. Assessment of Feed Resources in Welayta Sodo. Ethiopian Journal of Agricultural Sciences.
10. Adugna Tolera, Alemu Yami and Dawit Alemu. 2012. Livestock feed resources in Ethiopia: Challenges, Opportunities and the need for transformation. Ethiopia Animal Feed Industry Association, Addis Ababa, Ethiopia.
11. Adugna Tolera. 1990. Animal production and feed resource constraints in Wolayita Sodo and the supplementary value of Desmodium intortum, Stylosanthes guianensis and Macrotyloma axillare when fed to growing sheep feeding on a basal diet of maize stover. MSc, Agricultural University of Norway, Norway.
12. Adugna Tolera. 2007. Feed resources for producing export quality meat and livestock in Ethiopia.Ethiopia Sanitary and Phytosanitary Standards and Livestock and Meat Marketing project (SPS-LMM).
13. Adugna Tolera. 2008. Feed resources and feeding Meat Marketing Program (SPS-LMM), Texas A & M management. Ethiopia Sanitary & Phytosanitary University System. Standards and Livestock & Meat Marketing Program 66. McDonald P., R..A. Edwards, J.F.D. Greenhalgh, (SPS-LMM). Texas Agricultural Experiment Station C.A. Morgan, L.A. Sinclair and R.G. Wilkinson (TAES)/Texas A & M University. Animal Nutrition. 7th ed. PrenticeHall, London. Addis Ababa.
14. Adugna Tolera. 2009. Livestock feed supply situation in Ethiopia. Preceding of the 16th Annual Conference of the Ethiopian Society of Animal Production, Addis Ababa. 21-38.
15. AdugnaTolera. 2012. Potential for Development of Alternative Feed Resources in Ethiopia. An Assessment Report prepared for ACDI/VOCA. Addis Ababa Ethiopia.
16. Agajie Tesfaye, Yirga Chilot, Alemayehu Mengistu, Elias Zerfu and Aster Yohannes. 2001. Smallholder livestock production systems and constraints in the highlands of North and West Shewa zones. In Proceedings of the 9th annual conference of the Ethiopian Society of Animal Production (ESAP). Addis Ababa, Ethiopia.
17. Agassa Anyana and Gufu Oba. 2008. "Herder Perceptions on Impacts of Range Enclosures, Crop Farming, Fire Ban and Bush Encroachment on the Rangelands of Borana, Southern Ethiopia." Human Ecology. 36.3. 201-215.
18. Ahmed Hassen and Abule Ebro. 2006. Assessment and utilization practices of feed resources in basona worana wereda of north shoa. PhD dissertation, Haramaya University.
19. Alebachew A and Woldeamlak B. 2011. A Climate Change Country Assessment Report for Ethiopia. Submitted to Forum for Environment. Epsilon International R and D. Addis Ababa, Ethiopia.
20. Alemayehu Mengistu and Sissay Amare. 2003. Integrated Livestock Development Project (ILDP)."Livestock Feed Resources Survey. North Gondar, Ethiopia.
21. Alemayehu Mengistu. 1998. Natural pasture Improvement Study. Ministry of Agriculture of the Government of Ethiopia and Finland

Government. Small Scale Dairy Development Project. Unpublished Project Report. Addis Ababa, Ethiopia.
22. Alemayehu Mengistu. 2003. Country pasture/Forage resources profiles: Ethiopia. Food and Agriculture Organization of the United Nations (FAO). Web site: http://www. fao. org/ag/agp/agpc/doc/counprof/ethiopia/Ethiopi a,htm.
23. Alemayehu Mengistu. 2004. Pasture and Forage Resource profiles of Ethiopia. 19. Ethiopia/FAO. Addis Ababa, Ethiopia.
24. Alemayehu Mengistu. 2006. Range management for east Africa: concepts and practices. Addis Ababa University, Addis Ababa, Ethiopia.
25. Alemu Yami, Zinash Silashi and Seyoum Badhiye. 1989. The potential of crop residues and agro-industrial by-products as animal feed. In The Third National Livestock Improvement Conference. IAR, Addis Ababa, Ethiopia, pp.
26. ALI, M. U. S. H. I. R. and NEKA, M. U. L. U. G. E. T. A. 2012. Livestock husbandry and economic-sustainability of small farmers in peri-urban areas: a case study from West Gojjam region, Ethiopia. Ethiopian Journal of Environmental Studies and Managemen.
27. Amaha Kassahun. 2006. Characterization of rangeland resources and dynamics of the pastoral production systems in the Somali region of eastern Ethiopia (Doctoral dissertation, University of the Free State).
28. AOAC (Association of Official Analytical Chemists). 1990. Association of Official Analytical Chemists methods of analysis.12th ed. Washington, DC.
29. AOAC (Association of Official Analytical Chemists). 1995. Official Methods of Analysis (16th ed.) Association of Official Analytical Chemists, Inc. Arlington, Virginia, USA.
30. Arse Gebeyehu, Feyisa Hundessa, Gurmessa Umeta, Merga Muleta and Girma Debele. 2013. Assessment on challenges and opportunities of goat farming system in Adami Tulu, Arsi Negelle and Fantale districts of Oromia Regional State, Ethiopia. African Journal of Agricultural Research 8, no. 1 26-31.
31. Aumont, G., Caudron, I., Saminadin, G., and Xandé, A. 1995. Sources of variation in nutritive values of tropical forages from the Caribbean. Animal Feed Science and Technology.
32. Baars, R.M.T.; E.C. Chileshe and D.M. Kalokoni. 1997. Technical Note. Range Condition in high cattle density areas in the Western Province of Zambia. J. Range management. Grasslands.
33. Bayush Tsegaye, Adugna Tolera and Trygve Berg. 2008. Livestock production and feed resource constraints in Akaki and Lume districts of Central Ethiopia. Outlook on Agriculture 37, no. 1: 15-21.
34. Bedasa Eba. 2012. Study of Smallholder Farms Livestock Feed Sourcing and Feeding Strategies and their Implication on Livestock Water Productivity in Mixed Crop-Livestock Systems in the Highlands of the Blue Nile Basin, Ethiopia. MSc. thesis Submitted to the School of Graduate Studies. Haramaya University.139.
35. Behnke R. and Metaferia F. 2011. The contribution of livestock to the Ethiopian economy. Addis Ababa, Ethiopia: IGAD Livestock Policy Initiative.
36. Bekele Shiferaw. 1991. Crop livestock interactions in the Ethiopian highlands and effects on sustainability of mixed farming: A case study from Ada district. An MSc Thesis, Agricultural University of Norway. 35-65.
37. Belay Duguma and Geert Paul Janssens. 2016. Assessment of feed resources, feeding practices and coping strategies to feed scarcity by smallholder urban dairy producers in Jimma town, Ethiopia.
38. Belay Duguma, Azage Tegegne and Hegde, B. 2012. Smallholder livestock production system in Dandi district, Oromia Regional State, Central Ethiopia. Global Veterinarian, 8 (5).
39. Belaynesh Debalkie. 2006. Floristic composition and diversity of the vegetation, soil seed bank flora and condition of the rangelands of the jijiga zone, Somali Regional State, Ethiopia. An MSc Thesis Presented to the School of Graduate Studies of Alemaya University.
40. Berhanu Gebremedhin. 2009. Feed marketing in Ethiopia: Results of rapid market appraisal. Vol. 15. ILRI (aka ILCA and ILRAD).
41. Beruk Yemane and Tafesse Mesifin. 2000. Pastoralism and agro-pastoralism: Past and present. pp. 54-65. Proceeding of the 8th Annual Conference of Ethiopia Society of Animal production Addis Ababa, Ethiopia.
42. Beruk Yemane. 2003(b). Drought and Famine in the Pastoral Areas of Ethiopia. pp. 117 134. Proceedings of Pastoralism and Sustainable Pastoral Development. Addis Ababa, Ethiopia.
43. Beyene Teklu, Tegene Negesse and Ayana Angassa. 2010. Effects of farming system on Floristic composition, yield and nutrition content of forage at the natural pasture of Assosa Zone (Western Ethiopia). Tropical and Subtropical Agroecosystems, 12(3).

44. Bilatu Agza, Binyam Kassa, Solomon Zewdu, Eskinder Aklilu and Ferede Alemu. 2013. Forage yield and nutritive value of natural pastures at varying levels of maturity in North West Lowlands of Ethiopia, Ethiopian Institute of Agricultural Research, Animal Science Research Process, and Ethiopia, World Journal of Agricultural Sciences Vol. 1 (3), pp. 106-112, http://wsrjournals.org/journal/wjas.
45. Bryman, A. 2008. Social research methods. 3rd Edition, Oxford University Press., New York.
46. Chadhokar, P.A. 1984. Non-conventional feed resources for livestock in soil and water conservation program. Community Forestry and Soil Conservation Development Department, Ministry of Agric. FAO. Addis-Ababa, Ethiopia.
47. Chollet, Simon, Serge Rambal, Adeline Fayolle, Daniel Hubert, Didier Foulquié, and Eric Garnier. 2014. "Combined effects of climate, resource availability, and plant traits on biomass produced in a Mediterranean rangeland."Ecology; 95, no. 3.
48. Clary, Jeffrey. 2008. "Rainfall seasonality determines annual/perennial grass balance in vegetation of Mediterranean Iberian."Plant Ecology 195.1: 13-20.
49. CSA (Central Statistical Agency). 1998. Agricultural Sample Survey.1997/98.Bulletin 193, Vol. IV, CSA, Addis Ababa. 561.
50. CSA (Central Statistical Agency). 2005. Statistical abstracts, Addis Ababa, Ethiopia.
51. CSA (Central Statistical Agency). 2011. Agricultural Sample Survey, Volume II: Report on Livestock and livestock characteristics (Private peasant holdings). Statistical Bulletin 505. Central Statistical Agency (CSA), Federal Democratic Republic of Ethiopia, Addis Ababa.
52. CSA (Central Statistical Agency). 2013. Agricultural Sample Survey, Volume II: Report on Livestock and livestock characteristics (Private peasant holdings). Statistical Bulletin 570. Central Statistical Agency (CSA), Federal Democratic Republic of Ethiopia, Addis Ababa.
53. CSA (Central Statistical Agency). 2017. Agricultural Sample Survey 2017, Volume II Report on Livestock and Livestock Characteristics (Private and Peasant Holdings) Statistical Bulletin 570. Addis Ababa.
54. Dawit Assefa, Ajebu Nurfeta, Sandip Banerjee. 2013. Assessment of feed resource availability and livestock production constraints in selected kebeles of Adami Tullu Jiddo Kombolcha district, Ethiopia. African Journal of Agricultural Research, 8(29).
55. De Leeuw, P.N. and J.C. Tothill. 1990. The concept of rangeland carrying capacity in Sub-Saharan Africa-myth or reality. Pastoral Development Network Paper 29b. Overseas development Institute, London.
56. De Sherbinin, A. 2002. A CIESIN Thematic Guide to Land Land-Use and Land Land-Cover Change (LUCC).
57. Dereje Duressa, Debela Kena, Wakgari Keba, Zelalem Desta, Gutema Berki, Gerba Leta, Adugna Tolera. 2014. Assessment of livestock production system and feed resources availability in three villages of Diga district, Ethiopia. ILRI (International Livestock Research Institute).
58. Dereje Tsegaye and Tesfaye Lemma. 2008. Livestock production systems in Darolabu, Habro and Boke Districts of Western Hararghe. Commercialization of Livestock Agriculture in Ethiopia. Proceedings of the 16th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia. Ethiopian Society of Animal Production, Addis Ababa, Ethiopia.
59. Deribe Galati, Abubeker Hassan, Tsedeke. K, Birhanu, T., Bassa, Z. and Jimma A. 2013. Chemical Composition and Digestibility of Major Feed Resources in Mixed Farming System of Southern Ethiopia. World Applied SciencesJournal 26(2): 267-275.
60. Dirbaba Dugasa and Belachew Hurrissa. 2009. Live Animal Transport Services in Ethiopia: Current practices and future options. Norman Borlaug Institute for International Agriculture Working Paper 17th-TP-027-2009. Texas, US: College of Agriculture and Life Sciences at Texas A & M University, Texas AgriLife Research, and the Texas AgriLife Extension Service.
61. Diressa Tsegayea, Stein R. Moe, Paul Vedeldc, Ermias Aynekulu. 2008. Land-use/cover dynamics in Northern Afar rangelands, Ethiopia; Department of Ecology and Natural Resource Management, Norwegian University of Life Sciences.
62. Dirsha Demama, Ashenafi Mengistu and Gebeyehu Goshu. 2018. Feed resources assessment, laboratory evaluation of chemical composition of feeds and livestock feed balance in enset (Ensete ventricosum)-based mixed production systems of Gurage zone, southern Ethiopia.
63. Duncan, A. J., Bachewe, F., Mekonnen, K., Valbuena, D., Rachier, G., Lule, D., Bahta, M., and Erenstein O. 2016. Crop residue allocation to livestock feed, soil improvement and other

uses along a productivity gradient in Eastern Africa Agriculture, Ecosystems and Environment 228, 101-110.

64. Dzowela, B. H. 1990. Preamble to the Meeting. In: B.H. Dzowela A.N. Said, Asrat Wendem-Agenehu and J.A. Ketegile (eds). Proceedings of the First Joint Workshop on Series on Conference and Workshop Proceedings of Commission for Development Studies at the Austrian Academy of Sciences: 2008/1.
65. EARO (Ethiopian Agricultural Research Organization). 2001. Feeds and nutrition research strategy. EARO, Addis Ababa. 40.
66. Ehui, S., Benin, S., Williams, T., Meijer, S. 2002. Food security in Sub- Saharan Africa to 2002, socio-economic and policy research working paper 49, ILRI (International Livestock Research Institute), Nairobi, Kenya. 60.
67. Elias Mulugeta, Berhanu Gebremendihin, Hoekstra, D and Jabbar M. 2007. Analysis of Ethio-Sudan cross –border cattle trade: The case of Amhara Regional State. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 4. ILRI (International Livestock Research Institute), Nairobi, Kenya.41.
68. Endale Yadessa, Abule Ebro, Lemma Fita and Getnet Asefa. 2016. Feed resources and its utilization practices by smallholder farmers in Meta-Robi District, West Shewa Zone, Oromiya Regional State, Ethiopia. Acadamic Research. Journal of Agricultural. Science. Res. 4(4): 124-133
69. Endale Yadessa. 2015. Assessment of Feed Resources and Determination of Mineral Status of Livestock Feed in Meta Robi District, West Shewa Zone, Oromia Regional State, Ethiopia. MSc Thesis Submitted to the School of Graduate Studies of Ambo University, Ambo University, 122.
70. Ensminger, M.E., Oldfield J. E., Heinemann, W.W. 1990. Feeds and Nutrition the Ensminger Publishing Com-pany, USA. 593–666.
71. Ertiro, B. T., Twumasi-Afriyie, S., Blümmel, M., Friesen, D., Negera, D., Worku, M., Abakemal, D., and Kitenge, K. 2013(a). Genetic variability of maize stover quality and the potential for genetic improvement of fodder value. Field Crops Research.
72. Ethiopian Economic Association (EEA). 2012. Report on the Ethiopian Economy. Addis Ababa, Ethiopia: Apple Printing Press.
73. FAO (Food and Agriculture Organization). 1987. Master Land Use Plan, Ethiopian Range Land/Livestock Consultancy Report Prepared for the Government of the People’s Democratic Republic of Ethiopia. Technical Report. G/ETH/82/020/FAO, Rome.
74. Firew Tadese. 2007. Evaluation of alternative feed resources for ruminants under arid zones of the tropics and sub-tropics: Proceedings of the 3rd PANESA workshop held at Arusha, Tanzania.
75. Funk C, Rowland J, Eilerts G, Emebet K, Nigist B, White L and Galu G. 2012. A climate trend analysis of Ethiopia.
76. Funte Senbeto, Tegene Negesse and Getahun Legesse. 2010. Feed resources and their management systems in Ethiopian highlands: The case of Umbulo Whaco watershed in Southern Ethiopia."Tropical and subtropical agro-ecosystems 12(1): 47-56.
77. Gashaw Gedda. 1992. Assessment of Feed resources base and performance of crossbred dairy cows distributed to Smallholder in the Selale Dairy Development Project Area, MSc Thesis Presented to the School of Graduate Studies of Alemaya Universiity of Agriculture.
78. Gashu Geremew, Tegene Negesse and Aster Abebe. 2017. Assessment of Availability and Nutritive Values of Feed Resources and their Contribution to Livestock Nutrient Requirements in Chire District, Southern Ethiopia.
79. Gelayenew Bizelew, Ajebu Nurfeta, Getnet Assefa and Getahun Asebe. 2016. Assessment of livestock feed resources in the farming systems of mixed and shifting cultivation, Gambella Regional State, Southwestern Ethiopia. Global Journal of Science Frontier Research: Agriculture and Veterinary, Volume 16, Issue 5, Version 1.0.
80. Gemedo Dalle, Maass, B L and Isselstein, J. 2006. Rangeland condition and trend in the semi-arid Borana lowlands, Ethiopia. *African Journal of Range and Forage* Science 23.
81. Gemedo Dalle. 2004. Vegetation Ecology, Rangeland Condition and Forage Resources Evaluation in the Borana Lowlands, Southern Oromia, Ethiopia. PhD Thesis, Georg-August Universität Göttingen, Germany. Cuvillier Verlag Göttingen.
82. Getachew Asaminew and Abate Tedila. 1993. Crop-livestock interaction and implications for animal traction research in the Ethiopian highlands. In: proceedings of the 4th National Livestock Improvement Conference (NLIC) Held in Addis Ababa, Ethiopia.
83. Getachew Eshete. 2002. An assessment of Feed Resources, Their Management and Impact on Livestock productivity in the Ginchi

Watershed Area. MSc. Thesis. Alemaya University of Agriculture, Alemaya. 171.

84. Getahun Degu. 2012. Assessment of the livestock extension service in Ethiopia: the case of southern region. International Journal of Scientific and Technology Research 1.10: 24-30.
85. Getnet Assefa. 1999. Feed Resource Assessment and Evaluation of Forage Yield, Quantity and Intake of Oats and Vetches Grown in Pure Stands and in Mixtures in the highlands of Ethiopia. MSc thesis submitted to the Swedish University of Agricultural Sciences.83.
86. Gezahegn Kebede, Getnet Assefa, Fekede Feyisa and Alemayehu Mengistu. 2015. Some management and improvement practices of natural pasture in the mid and high altitude areas of Ethiopia. Pasture and Range Research Development in Ethiopia, 55-70.
87. Girma Chalchissa, Yoseph Mekasha, Mengistu Urge. 2014. Feed Resources, Quality and Feeding Practices in Urban and Peri-Urban Dairy Production of Southern Ethiopia. Trop. Sub-trop. Agroecosyst, 17(3):539-546.
88. Gizachew, L. 2009. Status of feed resources in the arid and semi-arid lowlands of Ethiopia. In Proceedings of sub-regional workshop on managing east African rangelands for better response to feed crisis. FAO, Addis Ababa, Ethiopia (pp. 17-26).
89. Goering H.K. and P.J. Van Soest. 1970. Forage fiber analysis (apparatus, re-agents, procedures and some applications). USDA Agricultural Handbook no. 379: 1-20, ARSUSDA, Washington, D.C.
90. Gryseels, G. 1988. Role of Livestock on a Mixed Smallholder Farms in the Woredas near Debre Birhan. A PhD dissertation Presented to Wageningen Agricultural University, The Netherlands. 249p.
91. Hennessy, D.W., P.J. Williamson, and R.E. Darnell. 2000. Feed intake and liveweight responses to nitrogen and/or protein supplements by steers of Bos taurus, Bos indicus and Bos taurus x Bos indicus breed types offered a low quality grass hay. Journal of Agricultural Science 135:35-45.
92. Hussen, SA, Chahroudi A, Boylan A, Camacho-Gonzalez AF, Hackett S, Chakraborty R. 2015. Transition of youth living with HIV from pediatric to adult-oriented healthcare: A review. Future Virology. 9(10):921–929.
93. Huston, J.E., H. Lippket, T.D.A. Forbes, J.W. Holloway, and R.V. Machen. 1999. Effects of supplemental feeding interval on adult cows in Western Texas. Journal of Animal Science, 77:3057-3067.
94. ILCA (International Livestock center for Africa). 1990. Livestock Systems Research Manual. Vol.1. ILCA Working Paper ILCA, Addis Ababa, Ethiopia.
95. ILRI (International Livestock Research Institute). 2005. Metema pilot learning site diagnosis and program design. ILRI, Addis Ababa, Ethiopia.
96. IUCN. 2010. Building Resilience to Climate Change: Ecosystem-based adaptation and lessons from the field. (eds.) Gland, Switzerland: IUCN. Retrieved from http://data.iucn.org/dbtw-wpd/edocs/.
97. Janke, H. E. 1982. Livestock production systems and livestock development in tropical Africa. Kieler Wissenchafts Verlaguavk. Keil, West.
98. Kassie Belay. 2014. Climate variability and change in Ethiopia: Exploring impacts and adaptation options for cereal production. Wageningen University.
99. Kearl, LC. 1982. Nutrient Requirement of Ruminants in Developing Countries. International Feed stuffs Institute, Utah Agricultural Experiment Station. Utah State University, Longman 84322. USA, 381.
100. Kebede Tesfaye and Aynalem Haile. 2010. Assessment of on-farm Breeding Practices and Estimation of Genetic and Phenotypic Parameters for Reproductive and Survival Traits in Indigenous Arsi-Bale Goats. Diss. Haramaya University. Dire Dewa, Ethiopia. 8.
101. Kellems RO, Church DC. 1998. Livestock Feeds & Feeding. (4th edition.). Prentice-Hall, Inc., New Jersey, USA. 573.
102. Kenenisa Gebrselassie and Meles Tulu. 2016. An assessment on feed resources and feed related problems in Adami district, Ethiopia.
103. Kocho, T and Geta E. 2011. Agro-ecologic mapping of livestock system in smallholder crop-livestock mixed farming of Wolaita and Dawuro districts, Southern Ethiopia. Livestock. Res. Rural Dev. 23(51).
104. Kossila, V. 1988. The availability of crop residues in developing countries in relation to livestock populations. 29-39. In: J. D. Reed, B. S. Capper and P. J. H. Neate (eds.). Proceedings of the Workshop on Plant Breeding and Nutritive Value of Crop Residues. Addis Ababa, Ethiopia, ILCA.
105. Lenz, T.I., and J.M. Facelli. 2006. Correlations between environmental factors, the biomass of exotic annual grasses and the frequency of

native perennial grasses. Australian Journal of Botany 54:655-667.

106. Lishan Tsehay. 2007. Woody and herbaceous species composition and the condition of the rangelands in Shinile zone of condition of the rangelands in Shinile zone of Somali regional.

107. Little, D. A. 1982. Nutritional limits to animal production from pastures. Proceeding of an International Workshop Held at st. Lucia, Queens land, Australia. Commonwealth Agricultural Bureaux, Farnham Royal,

108. Lume District Livestock and Fishery Resource and Agriculture and Rural Development Office of Eash Shoa Zone. 2018. Annual reports on land use type and livestock population, East Shoa, Ethiopia.

109. Lupi A. and Kibert K. 2019. Analysis of main growing Seasonal (Kirmet or Genna) rainfall and dry spell occurrence in semi-arid central rift valley of Oromia regional state, Ethiopia. J Horti Sci and Crop Res 1(1): 1

110. MacDonald, M. and Simon, J. 2011. 'Climate, Food Security and Growth: Ethiopia's Complex Relationship with Livestock', New York, Brighter Green.

111. Malede B. and Takele A. 2014. Livestock Feed Resources Assessment, Constraints and Improvement Strategies in Ethiopia. Middle-East Journal of Scientific Research 21 (4): 616-622, 2014. ISSN 1990-9233.

112. McDonald, P., Edwards, R.A., Greenhalgh, J.F.D., Morgan, C.A. 2002. Animal Nutrition (6th edition). Pearson Educational Limited. Edinburgh, Harlow, Great Britain. 544.

113. Mekasha Aklilu, B. Gerard, Tesfaye Kindie, Nigatu Lisanework, and A. J. Duncan. 2014. "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 & Environment 188: 150-162.

114. Mekuanint Gashaw and Girma Defar. 2017. Livestock feed resources, nutritional value and their implication on animal productivity in mixed farming system in Gasera and Ginnir Districts, Bale Zone, Ethiopia. International Journal of Livestock Production 8, no. 2: 12-23.

115. Menbere Samuel, Azage Tegegne and B. P. Hegde. 2008. "Labour availability and use pattern in smallholder livestock pro-duction system in Yerer watershed of Adaa Liben district."ESAP Proceedings.

116. Mesfin Rehrahie. 2001. Biological and economical evaluation of feeding urea treated teff and barley straw based diets to crossbred milk cows in the highlands of Ethiopia. M.Sc. Thesis. Swedish University of Agricultural science, Uppsala, Sweden.

117. Milford, R. and Minson, DJ. 1966. The relation between the crude protein content and the digestible crude protein of tropical pasture plants. J. Br. Grassland Society 20:177-183.

118. Minister of Agriculture (MoA). 1984. Livestock Sector Review (LSR). Annex volume 1, Ministry of Agriculture. Addis Ababa. Ethiopia.

119. Minister of Agriculture (MoA). 2010. Ethiopia's agricultural sector policy and investment framework (PIF 2010–2020). Addis Ababa, Ethiopia.

120. Ministry of Agriculture Fisheries and Food (MAFF). 1984. Energy allowances and feeding systems for ruminants. Reference Book 413. HMSO, London, UK. 85.

121. Mitiku DB. 2011. Numerical Groundwater Flow Modeling of the Meki River Catchment , Central Ethiopia: A Master thesis submitted to the school of Graduate studies Institute of Technology Addis Ababa University, Ethiopia. 1–111.

122. Morton B. 2007. The evolution of the watering pot shells (Bivalvia, Anomalodesmata: Clavagellidae and Penicillidae). Records of the Western Australian Museum. 24: 19-64.

123. Mulu Shitahun. 2009. Feed resources availability, cattle fattening practices and marketing system in Bure Woreda, Amhara Region, Ethiopia (An MSc. thesis submitted to the School of Graduate Studies, Mekelle University).

124. Musa, H. H., G. H. Chen, J. H. Cheng, B. C. Li, and D. M. Mekki. 2006. Study on carcass characteristics of chicken breeds raised under the intensive condition. *International. Journal of Poultry. Science*. 5(6):530-533.

125. National Meteorological Agency (NMA). 2007. Climate change national adaptation programme of action (NAPA) of Ethiopia: Technical Report, National Meteorological Agency, Addis Ababa.

126. Negassa Asfaw and Mohammad Jabbar. 2008. Livestock ownership, commercial off-take rates and their determinants in Ethiopia. ILRI (aka ILCA and ILRAD), Nairobi Kenya: ILRI

127. Nyanga, P.H., F.H. Johnsen, J.B., Aune and T.H. Kalinda. 2011. Smallholder Farmers' Perceptions of Climate Change and Conservation Agriculture: Evidence from Zambia. *Journal of Sustainable Development*

128. ONRS (Oromia National Regional State). 2011. Program of Plan on Adaptation to Climate

Change. February, 2011. Finfinne (Addis Ababa). 97.
129. Owen E and Jayasuriya M C N. 1989(a) .Use of crop residues as animal feeds in Developing countries. Research and Development in Agriculture, Longman. Volume 6, Number. 3, pp. 129-138.
130. Peacock, J.M., M.E. Ferguson, G.A. Alhadramis, I.R. McCann, A. Al Hajoj, A. Saleh, and R. Karnik. 2005. Conservation through utilization: a case study of the indigenous forage grasses of the Arabian Peninsula. Journal of Arid Environments 54:15–28.
131. Perez Corona, M.E., B.R. Vazquez De Aldana, B.G. Criado, and A.G. Ciudad. 1998. Variations in nutritional quality and biomass production of semiarid grasslands. *Journal of Range Management.* 51:570-576.
132. Reddy RMG, Rao MM, Murthy SKK. 1998. A multiple regression model for predicting groundnut yields in arid zones using weather parameters. Trop Agric 75(4): 321-331.
133. Sampaio, C.B., E. Detmann, M.F. Paulino, S.C.V. Filho, M.A. de Souza, I. Lazzarini, P.V. Rodrigues Paulino, and A.C. de Queiroz. 2010. Intake and digestibility in cattle fed low-quality tropical forage and supplemented with nitrogenous compounds. Tropical Animal Health and Production 42:1471-1479.
134. Samuel, M., Azage Tegegne and B.P. Hegde. 2008. Labour availability and use pattern in smallholder livestock production system in Yerer watershed of Adaa Liben district: In Proceedings of the 16th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia.
135. SAS Institute. 2013. SAS system for windows, Version 9.3. SAS Institute Inc. Carey, NC, USA.
136. Scholtz, P. H., R. S. Harris, S. J. Clemett, K. L. Thomas-Keprta, and M. Zarate. 2014. Preserved flora and organics in impact melt breccias, Geology, 42, 515-518.
137. Seyoum Bediye and Fekede F. 2008. The Status of Animal Feeds and Nutrition in the West Shewa Zone of Oromiya, Ethiopia. PP. 27-49. In Proceedings of the Workshop ‘Indigenous Tree and Shrub Species for Environmental Protection and Agricultural Productivity, Holetta Agricultural Research Centre, Ethiopia.
138. Seyoum Bediye, Getinet Assefa, Abate Tedila and Dereje Fikadu. 2001. Present status and future direction in feed resources and nutrition research targeted for wheat based crop-livestock production system in Ethiopia.
139. Singh, G.P. and S.J. Oosting. 1992. A model for describing the energy value of straws. Indian dairyman XLIV: 322-327.
140. Sisay Amare. 2006. Qualitative and Quantitative Aspects of Animal Feed in Different Agro ecological Areas of North Gonder. MSc. Thesis. Alemaya University, Dire Dawa.
141. Sisay Belete. 2017. Effects of Phosphorus Fertilizer and Inoculation on Yield and Nutritive Values of Grain and Haulm of Selected Grain Legumes in Mixed Crop-Livestock Production System of Ethiopia. MSc. Thesis, Hawassa University, Hawassa, Ethiopia
142. Solomon Bogale, Solomon Melaku and Alemu Yami. 2008. Potential use of crop residues as livestock feed resources under smallholder farmers’ conditions in Bale highlands of Ethiopia. Tropical and Sub-tropical Agro-ecosystems 8(1).
143. Solomon Desta and Layne Coppock. 2016. Pastoral System Trends and Small Ruminant Production in the Borana Plateau of Southern Ethiopia- Department of Rangeland Resources, Utah State University, Logan, Utah, USA.
144. Statical packages for the social sciences version 20 (SPSS). 1996. Cary, North Carolina.
145. Sternberg, M., M. Gutman, A. Perevolotsky, E.D. Ungar, and J. Kigel. 2000. Vegetation response to grazing management in a Mediterranean herbaceous community: A functional group approach. Journal of Applied Ecology 37:224-237.
146. Stoddart, L.A., A.D. Smith, and T.W. Box. 1975. Range management. 3rd Edition. McGraw-Hill, New York.
147. Tadesse Getachew, Tamrat Bekele and Sebsebe Demissew. 2008. Dryland woody vegetation along an altitudinal gradient on the eastern escarpment of Welo, Ethiopia. SINET: Ethiopian Journal of Science 31, Terefe Admasu. 2006. Pastoralists perceptions on rangelivestock management practices and range land assessment in Hamer and BennaTsemay districts of South Omo Zone. An MSc Thesis Presented to the School of Graduate Studies of Alemaya University, Ethiopia. 159p.
148. Tesemma Bekele. 1993. Useful trees and shrubs for Ethiopia Identification, Propagation and Management for Agricultural and Pastoral Communities. Regional Soil conservation Unit. Technical Handbook No. 5. 474.
149. Tesfaye Alemu. 1999. The role of crop residues as livestock feed resources in semi-arid areas of Adami Tulu District, Ethiopia. An MSc Thesis

Presented to the University of Nairobi, Kenya. p 90.

150. Tesfaye desalew. 2008. Assessment of feed resources and rangeland condition in Metema district of North Gondar Zone, Ethiopia. MSc. Thesis Haramaya University.
151. Tesfaye Moreda. 2016. Assessment of Beef Cattle Production, Management Practices and Marketing System in Lume District of East Shoa, Zone, Ethiopia (Msc Thesis) at Hawassa University College of Agriculture Hawassa, Ethiopia.
152. Teshager Ayalew, Duguma Belay and Tolemariam Taye. 2013. Smallholder cattle production systems in three Districts of Ilu Aba Bora zone of Oromia Regional State, Southwestern Ethiopia. American-Eurasian Journal of Scientific Research 8.1: 38-46.
153. Teshome Abate, Abule Ebro and Lisanworke N. 2009. Pastoralist’s perceptions and rangeland evaluation for livestock production in South Eastern Ethiopia. Livestock Research for Rural Development 21(7): http://www.lrrd.org/lrrd21/7/abat21101.htm.
154. Teshome Abate. 2007. Traditional utilization practices and condition assessment of the rangelands in Rayitu district of Bale zone, Ethiopia. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University, Ethiopia.129.
155. Tessema Zewdu, K., W.F. Boer, R.M.T. 2011. "Changes in soil nutrients, vegetation structure and herbaceous biomass in response to grazing in a semi-arid savanna of Ethiopia."*Journal of Arid Environments*. 75. 662-670.
156. Tessema Zewdu, Aklilu Agidie and Ameha Sebsibe. 2003. Assessment of the livestock production system, available feed resources and marketing situation in Belesa woreda: A case study in drought prone areas of Amhara Region."Challenges and Opportunities of Livestock Marketing in Ethiopia 165.
157. Thornton PK, Gerber PJ. 2010. Climate change and the growth of the livestock sector in developing countries. Mitigation and adaptation strategies for global change. 169-84.
158. Thornton, P. and Herrero, M. 2008. Climate Change, Vulnerability, and Livestock Keepers: Challenges for Poverty Alleviation. In: Livestock and Global Climate Change Conference Proceeding, Tunisia.
159. Thornton, P.K., van de Steeg, J., Notenvaert, A. and Herrero, M. 2009. ‘The impacts of climate change on livestock and livestock systems in developing countries: a review of what we know and what we need to know’, *Agricultural Systems*, vol. 101, no. 3, pp. 113–127
160. Tilley, J. and R.A. Terry. 1963. A two stage technique for the in vitro digestion of forage crops. J Br Grassl
161. Tothill, J.C., R.M. Jone and N.G. Hargreaves. 1978. BOTANAL: A field and computing package for assessment of plant biomass and botanical composition. Ecology and Management of World savannas.
162. Tsegaye Gemechu, Guta Wakbulcho and Tesema Adamu. 2015. The Current and Future Trend of Rainfall and Its Variability in Adami-Tulu Jido-Kombolcha Woreda, Central Rift Valley of Ethiopia.
163. Tsegereda Fekadu. 2010. Assessment of traditional cattle fattening practices and feedlot performance of Hararghe highland cattle. MSc. Thesis presented to school of graduate studies of Haramaya University.
164. Ulfina Galmesa, Habtamu Alamayo, Jiregna Desselegn, and Chala Marara. 2013. Utilization of brewer’s waste as replacement for maize in the ration of calves.
165. V.G. Allen, C. Batello, E.J. Berretta, J. Hodgson, M. Kothmann, X. Li, J. McIvor, J. Milne, C. Morris, A. Peeters, M. Sanerson . 2011. An international terminology for grazing lands and grazing animals. Grass Forage Science(66) 2-28 and the Forage and Grazing Terminology Committee.
166. Van Soest, P. J. 1967. Development of a comprehensive system of feed analysis and its application to forage. *Journal of Dairy Science.* 48: 818.
167. Van Soest, P.J. and J.B. Robertson. 1985. Analysis of forage and fibrous foods. A laboratory manual for Animal Science 613. Cornell University, USA.
168. Varvikko, T., Khalili, H. 1993. Wilted tagasaste (Chamaecytisus palmensis) forage a replacement for a concentrate supplement for lactating crossbred Friesian X Zebu (Boran) dairy cows fed low quality native hay. Animal. Feed Science. Technology. 40, 239–250.
169. Vazquez, O.P., and T.R. Smith. 2000. Factors affecting pasture intake and total dry matter intake in grazing dairy cows. *Journal of Dairy Science* 83:2301-2309.
170. Wang, Chang Ting, Rui Jun Long, Qi Ji Wang, Lu Ming Ding, and Mei Ping Wang. 2007. "Effects of altitude on plant-species diversity and productivity in an alpine meadow, Qinghai–Tibetan plateau."Australian Journal of Botany 55, no. 2.

171. World Bank. 2010. The social dimensions of adaptation to climate change in Ethiopia. Development and climate change discussion papers no. 14. Washington, DC. USA
172. Xinshen Diao. 2010. Working Paper 294. Agricultural Innovations, Production, and Household Welfare in Africa.
173. Yayneshet Tesfaye. 2010. Ethiopia Sanitary & Phytosanitary Standards and Livestock and Meat Marketing Program (SPS-LMM) Texas A & M University System: Feed Resources Availability in Tigray Region, northern Ethiopia, for Production of Export Quality Meat and Livestock.
174. Yemane Beruk and Tafesse Mesfin. 2000. Pastoralism and Agro-pastoralism: past and present. Conference of Ethiopian Society of Animal Production, 8, Addis Abeba (Ethiopia), 24-26 Aug. Ethiopian Society of Animal Production.
175. Yemenzwork Endale, Abayneh Derero, Mekuria Argaw and Catherine Muthuri. 2017. Farmland tree species diversity and spatial distribution pattern in semi-arid East Shewa, Ethiopia, Forests, Trees and Livelihoods, 26:3.
176. Yeshitila Admassu, Tessema Zewdu and Azage Tegene. 2008. Availability of livestock feed resources in Alaba Woreda, Southern Ethiopia. In Proceedings of the 16th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia.
177. Yeshitila Admasu. 2008. Efficiency of livestock feed resources utilization and forage development in Alaba Woreda, Southern Ethiopia. MSc. Thesis, Haramaya University, Dire Dawa Ethiopia. 128.
178. Yihalem Denekew. 2004. Assessment of Botanical Composition and Stage of Harvesting of Selected Natural Pasture for Optimum Utilization as Hay at Andassa Livestock Research Center, Northwestern Ethiopia. MSc Thesis Presented to the School of Graduate Studies of Alemaya University. 69.
179. Yitaye Alemayehu, Azage Tegegne and Mohammed Yosuf. 2001. Chemical composition and nutritive values of major feed resources in three peasant associations of Awassa Woreda, Southern Ethiopia.
180. Yitaye Alemayehu, Maria, W., Azage Tegegn. and Werner, Z. 2007. Urban and peri- urban farming systems and utilization of the natural resources in the North Ethiopian Highlands.
181. Yitaye Alemayehu. 1999. Livestock production systems, Feed Resources and Feed Allocation Practices in three Peasant Associations of the Awassa Woreda. MSc Thesis Presented to the School of Graduate Studies of Alemaya University. 99.
182. Yoseph Feye. 2007. Pastoralists perception towards range resource utilization and condition assessment in Gawane District of Afar Regional State, Ethiopia. A thesis submitted to the department of Animal Science, School of graduate studies, Haramaya University, Ethiopia.
183. Yoseph Mekasha, Mengistu Urge, Mohammed Yosuf and Merga Bayisa. 2010. Effect of strategic supplementation with different proportion of agro-industrial by products and grass hay on body weight change and carcass characteristics of tropical Ogaden bulls (Bos indicus) grazing native pasture.
184. Yvan, O and Tesema Zewudu. 2005. Assessment of grazing lands potentialities in Ordola surrounding Erer district of Shinilie Zone of Somali Regional State of Ethiopia, Handcap international, Addis Ababa, Ethiopia.
185. Zewdie Wondatir. 2010. Livestock production systems in relation with feed availability in the Highlands and Central Rift Valley of Ethiopia, MSc thesis submitted to the school of animal and range sciences, School of graduate studies Haramaya University, Dire Dewa, Ethiopia .31.