LIVES WORKING PAPER 27

Feed resources in the highlands of Ethiopia: A value chain assessment and intervention options

Feed resources in the highlands of Ethiopia: A value chain assessment and intervention options

Solomon Gizaw, Abule Ebro, Yayneshet Tesfaye, Zeleke Mekuriaw, Yoseph Mekasha, Dirk Hoekstra, Berhanu Gebremedhin and Azage Tegegne

International Livestock Research Institute

June 2017

© 2017 International Livestock Research Institute (ILRI)

ILRI thanks all donors and organizations who globally supported its work through their contributions to the CGIAR system

This publication is copyrighted by the International Livestock Research Institute (ILRI). It is licensed for use under the Creative Commons Attribution 4.0 International Licence. To view this licence, visit https://creativecommons.org/licenses/by/4.0.

Unless otherwise noted, you are free to share (copy and redistribute the material in any medium or format), adapt (remix, transform, and build upon the material) for any purpose, even commercially, under the following conditions:

ATTRIBUTION. The work must be attributed, but not in any way that suggests endorsement by ILRI or the author(s).

NOTICE:

For any reuse or distribution, the licence terms of this work must be made clear to others.
Any of the above conditions can be waived if permission is obtained from the copyright holder.
Nothing in this licence impairs or restricts the author's moral rights.
Fair dealing and other rights are in no way affected by the above.
The parts used must not misrepresent the meaning of the publication.
ILRI would appreciate being sent a copy of any materials in which text, photos etc. have been used.

Editing, design and layout—ILRI Editorial and Publishing Services, Addis Ababa, Ethiopia.

Cover photo—ILRI

ISBN: 92–9146–501–1

Citation: Gizaw,S., Ebro, A., Tesfaye, Y., Mekuriaw, Z., Mekasha, Y., Hoekstra, D., Gebremedhin, B. and Tegegne, A. 2017. *Feed resources in the highlands of Ethiopia: A value chain assessment and intervention options.* LIVES Working Paper 27. Nairobi, Kenya: International Livestock Research Institute (ILRI).

Patron: Professor Peter C Doherty AC, FAA, FRS
Animal scientist, Nobel Prize Laureate for Physiology or Medicine–1996

Box 30709, Nairobi 00100 Kenya
Phone +254 20 422 3000
Fax +254 20 422 3001
Email ilri-kenya@cgiar.org

ilri.org
better lives through livestock

ILRI is a CGIAR centre

Box 5689, Addis Ababa, Ethiopia
Phone +251 11 617 2000
Fax +251 11 667 6923
Email ilri-ethiopia@cgiar.org

ILRI has offices in East Africa • South Asia • Southeast and East Asia • Southern Africa • West Africa

Contents

Tables

Figures

Acronyms

AIBP	Accelerated Irrigation Benefits Program
AIBPs	Agro-industrial by-products
DM	Dry matter
FGD	focus group discussion
PA	Peasant association
SNNP	Southern Nations, Nationalities and Peoples
TLU	Tropical livestock unit

Acknowledgement

The data for this study was collected by the Livestock and Irrigation Value Chain for Ethiopian Smallholders project (LIVES) of the International Livestock Research Institute's (ILRI). LIVES project is financed by Global Affairs Canada (GAC).

Executive summary

Feed shortage has remained to be the most limiting factor in livestock production in Ethiopia. Despite the large and diverse livestock genetic resources, the economic contribution of the livestock sector to the livelihoods of the livestock keepers is very low compared to its potential. Feed cost accounts for over 50% of the total production and marketing costs in any livestock enterprise. The feed types available and feed resource management and utilization practices of livestock keepers need to be identified and the feed balances for specific geographic regions and agro-ecological zones need to be estimated to develop appropriate market oriented intervention strategies. This working paper aims, through a value chain analysis approach, to assess the available feed resources, farmers' utilization and management of feed resources, and feed marketing , and estimate the feed balance in the highlands of Ethiopia based on a survey conducted in 116 peasant associations (PAs) sampled from 31 districts in the four highland regions of Oromia, Southern Nations, Nationalities and Peoples (SNNP), Amhara and Tigray. The paper also presents results of LIVES project interventions in feed resources development, management, conservation, utilization and marketing in these regions.

In this study, the average grazing land resource in a district was estimated to be 8,973.9 ha. However, grazing land availability varied across districts and agro-ecological zones, ranging from only 574 ha in Bensa district in SNNP region state to 29,738 ha in Ahferom district in Tigray. Due to a rapid increase in human population and increasing demand for food, grazing lands are steadily shrinking due to the conversion of prime grazing lands to crop lands. As a result, grazing is restricted to marginal areas with low farming potential such as hill tops, swampy areas and roadsides. Agro-ecology was found to be a determinant factor for the relative availability of grazing resources. Availability was higher in drier areas, the proportion of grazing resources to total land area being 56.5%, 48.2% and 40.5% in dry *kola*, dry *dega* and dry *weina dega* compared to 24.6% in moist *kola*, 28.5% in moist *dega*, 29.3% in wet *dega* and 30.5% in the wet *weina dega* districts. Grazing lands, particularly communal lands, are poorly managed. Hay making and use of standing hay is one of the rational grazing resource management practiced in some districts, particularly on private grazing lands. However, the practice is limited to very few PAs.

Crop residue is the major livestock feed in Oromia, Amhara and Tigray, whereas in the SNNP region grazing lands and crop residues are the major sources of livestock feed. The relative contributions of the various cereal, pulse and vegetable/horticultural crop residues varies depending on agro-ecological variations. Utilization and management of crop residues by livestock keepers was found to be wasteful in most surveyed districts and there is very little or no use of crop residue improvement technologies such as urea treatment. The contribution of other feed resources, including AIBPs and non-conventional feeds (e.g. green fodders such as weeds, atella local brewery by-products) to livestock feeding is very low due to improper collection, storage and high costs in the case of agro-industrial by-products (AIBPs).

Feed marketers/suppliers identified and surveyed in this study were feed traders, cereal processors, traditional cereal/pulse mills, feed mills, oil extraction plants, large scale hay/straw marketers, and small-scale crop residue and green fodder marketers. The feed types traded in the surveyed districts were hay, green fodder, cereal crop residues, pulse crop residues, mill residues, vegetable and fruit residues, cereal bran, pulse bran, oil seed cakes, and formulated rations. Use of commercial feeds by smallholder livestock producers is limited largely to crop residues and hay, the share of AIBPs in annual purchased feeds being the least. The major challenges in feed marketing raised by feed businesses included shortage of finance, inadequate feed supply from producers, and lack of technical knowledge in feed formulation.

The feed balance in the highlands of Ethiopia is generally negative. In Oromia, the feed supply met demand only in Dugda district. In all the other districts, the demand for maintenance requirement exceeded supply. In Tigray, the available total feed supply at 70% and 100% utilization is 447,155 tonnes and 638,792 tonnes, respectively. Only two districts (Ganta Afeshum and Kilte Awlaelo) are able to produce feeds that just meet the maintenance needs of existing livestock. In SNNP region, only Mirab Abaya district meets the feed requirements for maintenance. In Amhara, in all surveyed districts in North Gondar and South Wollo, the feed demand exceeds the supply. In West Gojjam zone, the dry matter (DM) biomass obtained from crop residues, aftermath grazing, natural pasture and forestland surpassed the annual dry matter requirement of the existing livestock population. However, this does not mean that the existing feed fulfills nutritional requirement of livestock since the major contributor is crop residue which is poor nutritionally.

Although there is shortage of feed in general, there are feed resources that are available but underutilized due to improper collection, storage, and low adoption of feed quality improvement technologies. The effective interventions in feed development, improvement, utilization and efficient delivery of commercial feeds to smallholders presented in this paper are applicable in the highlands of Ethiopia under smallholder conditions and need to be scaled out to meet the gap in the current feed balance.

Introduction

Despite the large and diverse livestock genetic resources, the economic contribution of the livestock sector to livelihoods of the livestock keepers in Ethiopia is very low (e.g, Adugna 2007; Aklilu et al. 2013). Among the major problems affecting livestock production and productivity in Ethiopia, feed shortage in terms of quantity and quality is the leading problem (Adugna 2007). Furthermore, of the major input costs incurred in any livestock production, feed cost accounts for over 50% of the total production and marketing costs. Although there is an overall livestock feed shortage in the country, there are many instances where available feed resources (conventional and non-conventional feeds) are not properly utilized by farmers. For instance, there are by-products of horticultural crops that are not properly documented and efficiently utilized. Therefore, there is a justified need to pay due attention to the feed resource availability, conservation, utilization and marketing across the various agro-ecological and geographic regions.

The feed types available, feed resource management and utilization practices of livestock keepers need to be identified and the feed balance for specific geographic regions and agro-ecological zones need to be estimated so that appropriate intervention strategies can be developed. Market oriented livestock development can only be realized once the technological, organizational and institutional opportunities and challenges are properly documented and innovative approaches to feed development and improvement identified.

The LIVES project initiated a feed resources assessment study in the highland regions of Ethiopia in 2014 to contribute to the documentation of feed resources in the project intervention zones in Ethiopia. The project also designed and implemented feed interventions in the project locations. This working paper aims, through a value chain analysis approach, to assess the available feed resources, farmers' utilization and management of feed resources, estimate the feed balance and feed marketing in the highlands of Ethiopia. The paper also presents results of LIVES interventions in feed resource management, conservation, utilization and marketing.

Materials and methods

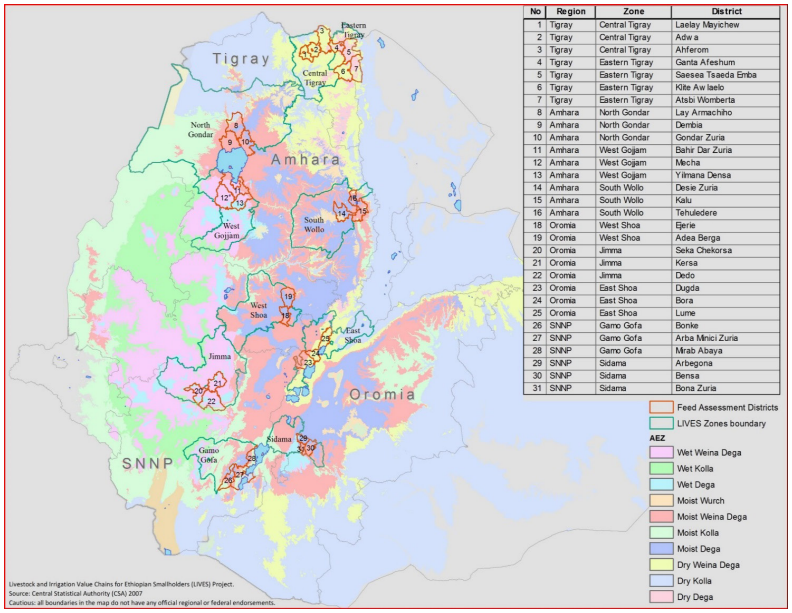
Feed resource assessment

Description of study location

This study was conducted in LIVES project intervention regions, zones and districts. The project zones include North Gondar, West Gojam and South Wello in Amhara, East Shoa, West Shoa and Jimma in Oromia, Gamo Gofa and Sidama in SNNP region and eastern and central zones in Tigray. In each zone, the project has three interventions districts, with one additional district in eastern Tigray, with a total of 31 intervention districts (Table 1 and Fig. 1). Three PAs within each district and a total of 116 PAs were selected purposively based on accessibility, agro-ecology and production system. A total of 894 farming households for questionnaire survey, one focus group discussion (FGD) in each of 116 PAs (one FGD consisting of 13–15 people), and 102 input/service providers were involved in the study.

The study locations represented the major agro-ecological zones in the midland and highland regions of the country (Fig. 1). The dry, moist and wet highlands were represented by three, five and two districts with average altitude of 2397, 2617 and 2574 m, average temperature of 16.3, 13.75 and 14.0 ^{0}C, and average rainfall of 579.3, 1213.5 and 1677 mm, respectively. The dry, moist and wet mid-highlands were represented by six, eight and four districts with average altitude of 1995, 1981 and 2083 m, average temperature of 18.5, 18.3 and 17 ^{0}C, and average rainfall of 704.5, 1102 and 1636 mm, respectively. The farming systems in all the locations was described as mixed crop livestock system. All types of farm animals are kept in all the study locations. The major crops grown in Amahar, Oromia and Tigray are cereals and legumes. In Sidama zone of SNNP state Enset is the dominant food crop grown. In Arba Minch zone of SNNP state and Jimma zone of Oromia state, cotton and coffee are also widely grown.

Figure 1. Administrative and agro-ecological location of the study area.



No	Region	Zone	District
1	Tigray	Central Tigray	Laelay Maychew
2	Tigray	Central Tigray	Adw a
3	Tigray	Central Tigray	Ahferom
4	Tigray	Eastern Tigray	Ganta Afeshum
5	Tigray	Eastern Tigray	Saesea Tsaeda Emba
6	Tigray	Eastern Tigray	Kilte Aw laelo
7	Tigray	Eastern Tigray	Atsbi Womberta
8	Amhara	North Gondar	Lay Armachiho
9	Amhara	North Gondar	Dembia
10	Amhara	North Gondar	Gondar Zuria
11	Amhara	West Gojam	Bahir Dar Zuria
12	Amhara	West Gojam	Mecha
13	Amhara	West Gojam	Yilmana Densa
14	Amhara	South Wollo	Desie Zuria
15	Amhara	South Wollo	Kalu
16	Amhara	South Wollo	Tehuledere
18	Oromia	West Shoa	Ejerie
19	Oromia	West Shoa	Adea Berga
20	Oromia	Jimma	Seka Chekorsa
21	Oromia	Jimma	Kersa
22	Oromia	Jimma	Dedo
23	Oromia	East Shoa	Dugda
24	Oromia	East Shoa	Bora
25	Oromia	East Shoa	Lume
26	SNNP	Gamo Gofa	Bonke
27	SNNP	Gamo Gofa	Arba Minici Zuria
28	SNNP	Gamo Gofa	Mirab Abaya
29	SNNP	Sidama	Arbegona
30	SNNP	Sidama	Bensa
31	SNNP	Sidama	Bona Zuria

Table 1. Administrative regions, zones, districts and PAs selected for assessment of feed resources in Ethiopia

Region	Zone	District	Peasant associations (PAs)
Oromia	East Shoa	Lume	Tede Dildama, Biyo Bisika, Tabu Ra-ee, Jugo Gudedo, Tikur Gebru, Shara Dibandiba
		Dugda	Walda Hafa, Meja-lalu, Mekuye Abu, Jawi Bofo, Abono Gabrieal, Wayo Gabriel, Bakale Girsa, Walda Mekedela
		Bora	Berta Sami, Tuji Dako, Malima Berie, Tuka Langano, Dalota, Elen-Bika,
	Jimma	Dedo	Bulo, Badeso, Bilo, Buyo, Baltu, Gemina Dire
		Kersa	Gibe, Kitimbile, Harsu, Bulbul Ahewa, Mezoriya Merewa
		Seka-Chekorsa	Ula Uke, Onsooshe, Sakela, Loga, Xabo Goto, Satt
	West Shoa	Ejere	Ilu-Aga, Basso, Damotu, Chirri, Kusaye, Arabsa
		Ada-Berga	Maru Chebot, Chancho Berte, Sire Berga, Ula Gora, Reji Mekoda, Itaya
SNNP	Gamogofa	Arbaminch Zuria	Genta mecha, Kollashara, Elgo
		Mirab abaya	Fura, Delbo, Faragosa
		Bonke	Geresa zala, Dembile fusa, Algude
	Sidama	Arbegona	Shafamo, Rikame, Chucho
		Bensa	Hache, Gonjebe, Shantagolba
		Bonazuria	Bona Kike. Gobacho, Olonso hore
Amhara	N. Gondar	Gondar Zuria	Chihra, Zengaj, Ambachira
		Dembia	Aberjeha, Gebeba, Salj Darna
		Lay Armachiho	Chira Anbezo, Chimera lomiye, Kerker Bale-Egzer
	W. Gojjam	Bahir Dar Zuria	Andasa, Wogelsa, Kimbaba
		Mecha	Amarit, Brakat, Enguti
		Yilmana densa	Abika, Goshyie, Mosobo
	S. Wollo	Desie Zuria	Serdem, Asegedo, Gelsha
		Kalu	Serdem, Asegedo, Gelsha
		Tehuledere	Serdem, Asegedo, Gelsha
Tigray	Central	Adwa	Mariam Shewito, Debregenet, Gendebta & Betehanes
		Ahferom	Sero, Endamariam, Agamo, & Laelay Migaria Tsemri
		Laelay Maichew	Dura, Medego, Dereka & Adi Tsehafi
	Eastern	Atsbi-Womberta	Barka Adisebha, Adi Mesanu, Golgol Naele & Habes
		Ganta Afeshum	Hadnet, Wuhdet, Golagenahti & Sasun
		Kilte Awlaelo	Genfel, Aynalem, Negash & Mesanu
		Saesie Tsaeda Emba	Guila Abenea, Hadinet, Maimegelta & Tseqanet

Sampling strategy and data collection

Feed resource assessment

Primary and secondary data were collected to assess the feed resources in the four highland states of Ethiopia. Primary data were collected through individual interviews with semi-structured questionnaires and focus group discussions. PAs and households for individual interviews were selected purposively. PAs were selected based on accessibility, agro-ecology and production system. Households were selected systematically to represent equal number of respondents per district that have small, medium and large farm land size, which varied across the four states (≤2, 2–3 and >3 ha. in Oromia; <0.5, 0.5–1 and >1 ha in Tigray; 1, 1–1.75 and >1.75 ha in Gamogofa zone, and <1, 1–2 and >2 ha in Sidama zone). A total of 243 in Amhara, 144 in Oromia, 108 in SNNP region and 63 households in Tigray were interviewed to gather information on household characteristics, land holding, livestock resources, crop production, livestock feed resources, livelihood, feed utilization, constraints and possible solutions related to feed resources. One FGD was conducted in each of the 116 PAs. A single FGD had 7–12 people, who were drawn from people of different age groups, sex and experience on feed production and marketing. The FGD included experts, development agents and farmers.

Secondary data were collected from zonal and district offices of agriculture. Furthermore, Information from published and unpublished documents was also used. The type of information gathered from secondary source of information include cropland and crop yield, size of grazing land, livestock population by age and species, size of land covered by improved forage. In addition, discussion with district livestock experts and field observations were made to assess the feed situation firsthand and to triangulate information obtained from group discussions and individual interviews.

Estimation of feed balance

Estimation of available feed: The quantity of feed in dry matter obtained annually from different land use types was calculated by multiplying the hectares of land under each land use type in the year 2013/14 and 2014/15 obtained from district agricultural offices by its respective conversion factor. Appropriate conversion factors were used depending on the context in each state and zone for natural pasture, aftermath grazing, forestland, improved forages, and crop residues (FAO 1984; FAO 1987; Kossila, 1984, 1988; De Leeuw et al. 1990; PADS 2005; Adugna 2007; Fekade 2007; Fekede et al. 2015; Yoseph et al 2015b). The quantity of potentially available crop residues for animal consumption was estimated accounting for wastages by multiplying estimated feed availability by utilization factors (Kossila 1988; Adugna and Said 1994; Adugna 2007; Abule et al. 2016). The contribution of stubble grazing to ruminant feed was estimated by multiplying the total area covered with cereal crops by 0.5 t/ha, while the contribution of feeds from bush land and forest (private and public) was estimated by using total area covered by woodland/browse multiplied by 0.7 t/ha (FAO 1984). The contribution of locally available feeds to total ME and CP supply was estimated by multiplying the quantity of each (DM basis) with the corresponding chemical constituent obtained from literature.

Estimation of feed balance: Feed demand in each state was estimated by considering all ruminant livestock species reported by the district offices of agriculture and converting to tropical livestock units, TLU (Janke 1982). The daily DM requirement for maintenance of one TLU is estimated to be 2.5% of the body weight (ILCA 1991), i.e. 6.25 kg DM daily or 2.28 tonnes DM per year. The contribution of locally available feeds to total ME and CP supply was estimated by multiplying the quantity of each (DM basis) with the corresponding chemical constituent obtained from literature. The total livestock feed produced from different feed sources was estimated using the methods indicated above. The feed balance for each district was estimated by subtracting the demand for maintenance requirement of the livestock population in the district (tonnes DM/ year) from the available feed DM (tonnes/ year).

Feed agribusiness assessment

A survey was conducted in all the sampling zones including their respective capital cities to assess the feed agribusiness practices, constraints and opportunities. Feed traders, oilseed and cereal/pulses millers, feed manufacturers, feed shops, livestock producers and livestock experts were interviewed using semi-structured questionnaire and FGDs. Information on type and amount of feed purchased and sold, the type of buyers, seasonal dynamics of feed prices and existing capacity gaps of feed traders were considered in the questionnaire. Feed agribusinesses (feed shops, cereal and oil mills, straw/grass sellers, large scale feed manufacturers) interviewed included 25 in Tigray, 23 in Amhara, 6 in SNNP region and 59 in Oromia.

Data analysis

Data collected from individual interviews on available feed resources, seasonality and major crops and livestock species were analysed using FEAST (Duncan et al. 2012). Information generated from group discussions on feed resources, feeding practices and related opportunities and challenges was analysed using descriptive statistics such as percentages and frequencies. Similarly, data on feed agribusiness was analysed using descriptive statistics.

Developing interventions

The LIVES project has been formulating feed interventions in the four regional states where the feed resources assessment was assessed. The interventions topics were fodder development, feed utilization improvement and conservation, and feed agribusiness. The approach was introduction of technological, institutional/organizational value chain interventions and evaluating through action research and documentation of evidences on the interventions, capacity development of farmers and extension experts, knowledge management and promotion. The interventions targeted the various nodes of the feed and livestock value chains. The interventions were evaluated on the projects intervention households in the 31 project districts in the four regions.

Results and discussion

Feed resources, management, utilization and marketing

Feed resources

Grazing and browsing resources

Grazing resources include grazing land properly designated as communal grazing lands, small private lands mainly kept for hay production rather than grazing, forest lands, hillsides and hill tops, bush lands, grazing resources available under tree crops such as coffee and stubble and fallow grazing. The average grazing resources in a district in the current study was estimated to be 8,973.9 ha. However, it varies across districts and agro-ecological zones, ranging from only 574 ha in Bensa district to 29,738 ha in Ahferom district (Table 2). Due to a rapid increase in human population and increasing demand for food, grazing lands are steadily shrinking due to the conversion of prime grazing lands to crop lands. As a result grazing is restricted to marginal areas with low farming potential such as hill tops, swampy areas and roadsides. The role of grazing lands as a major livestock feed resource is diminishing because of shrinking grazing land size. For instance, communal grazing land was ranked to contribute the least to the basal diets of livestock compared to crop residue, hay, concentrates, local brewery by-products (Attela and Brint), improved forage in West Gojam, and less than crop residues in West Shoa (Gizaw et al. 2016a). However, there are reports (Firew 2007; Seyoum et al. 2008) which maintain the importance of grazing lands as the major basal feed for cattle in the highlands of Ethiopia.

Agro-ecology was found to be a determinant factor for the relative availability of grazing resources (Table 2). Availability was higher in drier areas, the proportion of grazing resources to total land area being 56.5%, 48.2% and 40.5% in dry *kola*, dry *dega* and dry *weina dega* compared to 24.6% in moist *kola*, 28.5% in moist *dega*, 29.3 in wet *dega* and 30.5% in the wet *weina dega*. A similar finding was reported by Gizaw et al. (2015b) where the average ratio of communal lands to total lands increased from 0.062 in wet areas through 0.062 in moist areas to 0.127 in dry agro-ecologies in the Ethiopian highlands.

The availability of grazing resources varies across regions (Table 2). The size of grazing resources (grazing lands proper and forest lands) as percentage of the total land area were calculated to be 17.2%, 20.7%, 55.6% and 40.9% in the SNNP, Oromia, Tigray and Amhara regions, respectively. This variation could be due to the favourable conditions for crop farming in SNNP and Oromia. There are also variations across zones in availability of grazing resources. In North Gondar, South Wollo, West Gojjam, East Shoa, Jimma, West Shoa, Gamogofa, Sidama, Central and eastern zones, the available grazing resources are 45.6%, 32.3%, 44.7%, 12.2%, 25.2%, 26.9%, 17.7%, 16.7%, 63.0%, and 50.1% of the total land area, respectively. These data indicate that in areas where irrigated agriculture is practiced and perennial cash crops (e.g. east Shoa) are the dominant crops and population pressure is higher (e.g. Gamogofa, Sidama), the availability of grazing is limited.

Availability of grazing land proper varies across districts and PAs. For instance, in Tigray 13 to 25 (Ahferom district) grazing lands were identified during the survey. Half of the 1,228 ha grazing land in central zone was found in Ahferom district, whereas of the 16,068 ha in eastern zone 7,588 ha is found in Atsbi Womberta district. In Saesi

Tsaeda Emba district, all of the administrative PAs have a designated grazing land area that is used for grazing and hay making on the basis of cut-and-carry system. In Ganta Afeshume and Kilte Awlaelo districts five PAs have no such designated grazing lands. In Oromia, coffee plantations provide extra source of grazing. It was estimated in this study that in Dedo, Kersa and Seka Chekorsa districts of Jimma zone the coffee plantations provide about 3,894.7, 7,278.6 and 11,288.9 tonnes DM per year, respectively. In SNNP region, the contribution of communal grazing is larger in Gamogofa zone while the use of private grazing is common in Sidama. In highland agro-climate such as Bonke, Bensa, Bonazuria and Arbegona districts of Sidama zone, tethering around homestead and backyard is also common due to shortage of grazing lands. In Gamogofa zone (Mirab abaya and Arbaminch zuria districts), bush lands/forests are important sources of feed for livestock.

Stubble grazing is available right after crop harvest at the end of September and/or first week of October and continues until the aftermath is completely exhausted in January/February in Tigray. In Oromia, the stubble grazing starts from September in east Shoa, at the end of October/November in west Shoa and Jimma zones and lasts till February/March/April. In the first few days of stubble grazing, farmers in Tigray are reluctant to open grazing of their stubbles for other people's livestock. The rule of thumb is that land owners permit others to use the stubble only after the remaining aftermath is apparently of low quantity and quality. In Oromia, the crop aftermath is open to communal grazing. In Tigray, it is not uncommon to observe a reduction in stubble grazing due to the partial introduction of a mandatory 'zero-grazing' policy in some of the districts, whereas some districts are still making use of aftermath grazing in areas not included in 'zero grazing' policy.

Table 2. Agro-ecological characteristics of the study areas and grazing resources (grazing land proper and forest land) and grazing land as percentage of the total land area

Region	District	Agro-ecology	Total land (ha)	Grazing resource (%)	Grazing land (%)
Amhara	Dembia	Moist mid-highland	82,934	15.5	26.1
	Gondar Zuria	Moist mid-highland	71,190	24.0	64.1
	Lay Armachiho	Dry lowland	67,979	15.3	46.5
	Desie Zuria	Moist highland	45,276	25.3	86.0
	Kalu	Moist mid-highland	100,301	0.9	4.7
	Tehuledere	Moist mid-highland	25,628	2.3	6.2
	Bahir Dar Zuria	Wet mid-highland	98,966	27.9	62.8
	Mecha	Wet mid-highland	61,237	24.0	48.8
	Yilmana densa	Wet highland	90,567	10.8	22.6
Oromia	Bora	Moist mid-highland	37,544	8.3%	11.3
	Dugda	Dry mid-highland	95,965	8.3	13.1%
	Lume	Dry mid-highland	80,220	6.7	12.3
	Dedo	Wet highland	153,647	5.5	14.9
	Kersa	Wet mid-highland	57,802	22.7	44.2
	Seka Chekorsa	Wet mid-highland	87,715	8.4	16.4
	Adea Berga	Moist highland	90,773	16.0	40.4
	Ejere		90,887	4.9	13.4
SNNP	Arbaminch Zuria	Moist mid-highland	131,740	2.7	5.5
	Bonke	Moist mid-highland	79,200	13.7	32.2
	Mirab abaya	Moist lowland	115,964	3.1	15.3
	Arbegona	Moist highland	28,786	28.1	42.6
	Bensa	Moist highland	50,742	1.1	1.2
	Bona zuria	Moist mid-highland	21,256	5.7	6.4

Region	District	Agro-ecology	Total land (ha)	Grazing resource (%)	Grazing land (%)
Tigray	Adwa	Dry mid-highland	68,531	7.4	37.1
	Ahferom	Dry mid-highland	133,979	22.2	121.6
	Laelay Maichew	Dry mid-highland	42,348	10.4	30.3
	Atsbi Womberta	Dry highland	147,096	5.2	58.1
	Ganta Afeshum	Dry highland	31,902	12.9	38.9
	Kilte Awlaelo	Dry mid-highland	123,523	6.4	40.0
	Saesea Tsaeda Emba	Dry highland	163,814	7.8	63.6

Source: District agricultural development offices.

Crop residues

The major crop residues produced in the surveyed districts could be broadly grouped into cereal, pulse, fruit, root crops, vegetables and sugar cane residues (Tables 3 and 4). In SNNP region, the total DM crop residue obtainable from the surveyed districts was 209,906, 82,284, 101,084, 133,091, 174,025 and 127,159 tonnes from Bensa, Bona-Zuria, Arbegona, Mirab-Abaya, Arbaminch and Bonke districts, respectively. Among crop residues, the contribution of cereal residue is the largest in Bonke (84.7%) followed by Bona zuria (41%) and Arbaminch zuria (38.1%) and lowest in Bensa (13%) district. Barley and wheat straw are important cereal straws in Bonke and Arbegona districts while maize stover is important crop residue in Bona zuria, Bensa, A/minch zuria and Mirab abaya districts. The dominant crop residues in Sidama highlands are enset leaf and stem, which accounted for about 50-83% of the total dry matter supply from crop residues. Enset leaf is rich in crude protein (>16% CP), which makes it an important source of supplementation to low quality feeds (Nurfeta et al. 2008). Similarly, feed resources derived from fruits such as banana and mango had the largest contribution (40.6–59.8%) to total dry matter supplied from crop residues in Mirab abaya and Arbaminch zuria districts.

In Tigray central and eastern zones, the average cereal crop residues produced was 1,199,947 and 2,038,046 qts., respectively (Table 3). Wheat straw is by far the most dominant crop residue in all districts except Adwa and Laelay Maichew where teff straw contributed the largest residue. Wheat residue is accounted for about 41% of the total residue produced in Tigray. A less common crop in other parts of Ethiopia but widely farmed in the central and eastern zones of Tigray is hanfets, a crop which inherits the characteristics of wheat and barley. The total pulse residue is estimated at 146,890 quintals, about 66% of it contributed by the eastern zone districts. Faban bean is the most dominant crop contributing to about 61% across the seven districts.

In Tigray, about 63% of the total crop residue in the region is contributed from the eastern zone and the remaining 37% from the central zone districts. Wheat residue is by far the most dominant source in Tigray, accounting for about 41% of the total residue. About 66% of the 146,890 qt. pulse residue produced in the two zones is from the eastern zone districts, with faba bean dominating all pulses across the seven districts.

In Amhara region sampled districts, the feed supply from cereal crop residue and pulse and oil crop residue were estimated to be 2,022,024 and 73,108 tonnes, respectively. The highest cereal and legume/oil crop residue is produced in the wet highland zone of West Gojam zone amounting to 1,279,383 and 73,108 tonnes per year, respectively. Maize, barley, teff and Finger millet provide the bulk of crop residue in the region producing 1,146,859, 193,080, 182,132 and 167,672 tonnes of residue per year, respectively. The highest residue providers are Faba bean, Grass pea and Noug in order of importance.

In Oromia, a total 1,335,448.43 tonnes/year of crop residue is produced in the study districts. Cereals, pulses and oil crops, respectively, contribute 89.53%, 9.40% and 1.06 % of the total residue. Maize in Jimma zone, West Shoa zone, Dugda and Bora districts, wheat in Lume district, contribute for the largest proportion of cereal crop residues. The largest pulse residue is obtained from beans in Ada-berga, Seka-Chekorsa and Dedo districts, from haricot bean in Dugda, Bora and Kersa districts, and from chick pea in Lume district. Oil crops are produced in West Shoa and Jimma zones where the major source of residue comes from linseed followed by Noug.

Table 3. Estimated cereal crop residue production (tonne) in 24 districts in Oromia, Amhara and Tigray regions in Ethiopia

	Teff	Barley	Wheat	Maize	Sorghum	Finger millet	Hanfets+	Rice
Ada-Berga	26,908	19,025	44,300	15,920	23,307			
Ejere	31,090	22,799	61,777	5962	2213			
Dugda	61,711	5763	84,994	167,603	8249	437		
Bora	25,137	4088	35,382	47,803	4050			
Lume	54,476	5497	81,153	5873				
Seka-Chekorsa	7754	12,064	21,126	57,054	3291			
Dedo	13,641	13,448	28,437	70,970	6811	104		
Kersa	8045	9446	12,619	79,571	5709	39		
Gondar Zuria	29673	17,872	23,300	48,391		2600		
Dembia	12,088	83,476	16,451	107,666	31,083	28,763		21,863
Lay Armacho	14,870	19,199	39,048	11,046				
Dessie zuria	12,402	8059	19671	15,177		5652		
Kalu	4330	770	4767	12,877	109,520	755		
Tehuledere	9057	4032	9312	18,570		304		
Bahir dar Zuria	24,877	7196	5300	237,252	234	39,935		8393
Mecha	14487	18647	25,225	477,107		79,866		
Ylmana densa	60,349	33,830	18,115	218,774		9798		
Adwa	621	65	544	201	199	195	140	
Ahferom	9172	1486	19,621	2323	4628	2095	3770	
Laelay Maichew	22,330	3816	17,262	10,373	16,599	4555		
Atsbi-Womberta	615	16,440	29392	3001		210	22,931	
Ganta Afeshum	798	7564	20,683	2532	2375	1143	4116	
Kilte Awlaelo	1762	6460	21,118	2595		2722	9130	
Saesie Tsaeda Emba	1416	12,035	23,475	3663		866	6764	

+A mixture of wheat and barley

Table 4. Estimated pulse and oil crop residue production (tonne) in 24 districts in Oromia, Amhara and Tigray regions in Ethiopia

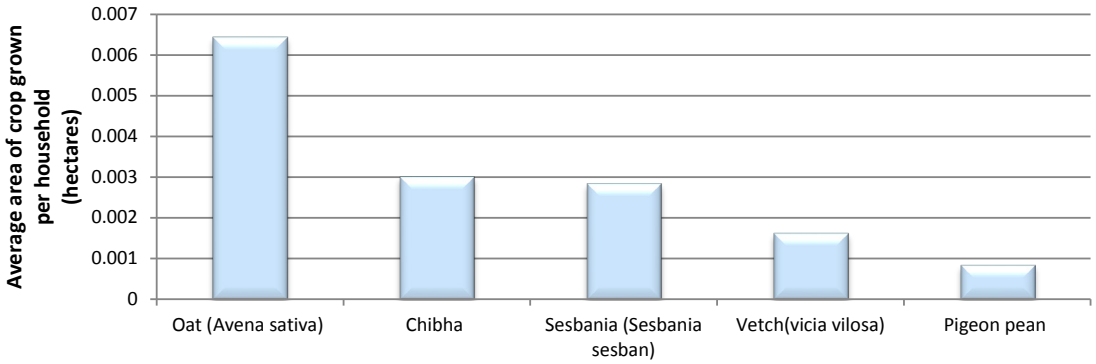
District	Faba bean	Field peas	Chick peas	Lentil	Haricot bean	Soy bean	Green bean	Grass pea	Noug	Lin seed
Ada-Berga	5610	657	546	211				1106	1918	1823
Ejere	1819	344	5098	1767	429		13	2544	271	2421
Dugda	2582	1300	1858	390	6901		7079	113		
Bora	751	648	509	247	14751	1132	13			
Lume	2470	880	26,939	3516	3744			448		
Seka-Chekorsa	3855	2586			2098				44	824
Dedo	10,450	1168							135	879
Kersa	1797	989	1246		4719	305			2511	3275
Gondar Zuria	2236.7	374.4						621	2492.8	
Dembia	3204	26.52	3192.24					342	377.6	
Lay Armacho	3350.16								662.4	
Dessie zuria	1203.84	293.4						0	1573.6	
Kalu	133.2	401.28						373.68	68	
Tehuledere	210	1004.4						0	341.28	
Bahir dar Zuria	6252.48	278.4	4617.6					10,319	9180	
Mecha	3073.2	1659.84						1404	3072	
Ylmana densa	2411.52	1246.32						6921.6	189.6	
Adwa	50	2	1	3						
Ahferom	1249	155	27	237						
Laelay Maichew	2514	127	379	195						
Atsbi-Womberta	2425	1433		472						
Ganta Afeshum	1679	528		721						
Kilte Awlaelo	277	60	155	86						
Saesie Tsaeda Emba	806	752	121	126						

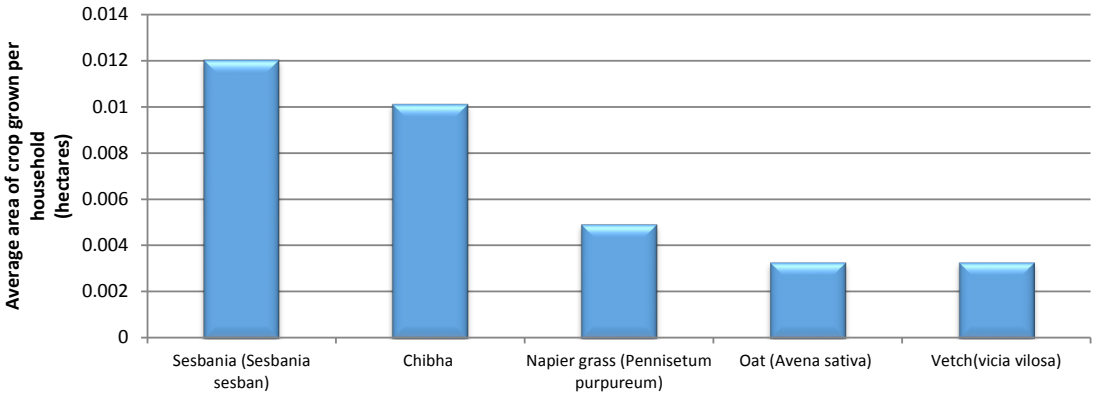
Residues produced in limited areas: 12, 67 and 31 tonnes respectively of Fenugreek in Ahferom, Laelay Maichew and Kilte Awlalo. 16 tonnes of sesame in Ada berga and 16 tonnes of ground nut in Dedo districts.

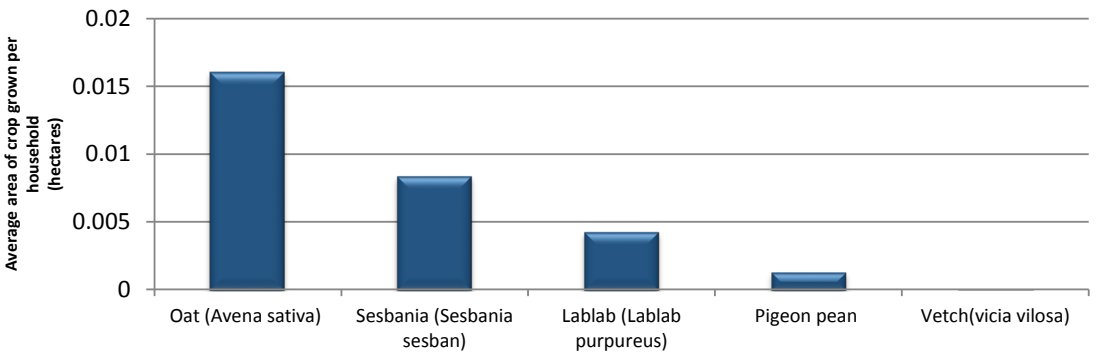
Cultivated fodder

Various improved forage crops have been introduced by various institutes including the Ministry of Agriculture, regional Livestock development Agencies, research centres, Universities and non-governmental development partners in the past four decades. Fodder seed multiplication sites have also been established by district seed multiplication sites and farmers training centres. However, improved fodder production is generally highly limited. The major bottleneck to improved fodder production is the small land holdings which is too small in many parts of the country even for sustaining smallholders' livelihoods from crop agriculture. In Amhara, improved forages were grown by very few households on very small plots of land, soil conservation structures and as farm boundaries (Figure 2). The major reasons cited by farmers included shortage of land, unavailability of quality seed, knowledge and skill gap and damage by free roaming animals. Most of the forage crops are localized in soil and water conservation structures. Only 14 and 8% of the surveyed households in South Wollo and West Gojjam benefited from fodder development on soil and water conservation structures. Fodder development on farm plots is highly limited. For instance less than 2% of the households in West Gojjam practiced improved forage development in a very small plot of land or on farm boundaries.

Figure 2. Fodder crops grown in North Gondar (top), South Wollo (middle) and West Gojjam zones, Amhara







In Oromia region, Sesbania sesban, Vetivar grass, Setaria verticellata, Elephant grass (Pennisetum perpureum), Rhodes, Dasho grass, Oats, Lablab, Cowpea, Alfalfa, vetch, and Pigeon pea have been introduced. Nevertheless, forage development by smallholder farmers is negligible. Overall, the production and utilization of improved forage for livestock feed by farmers in the three zones is very small (Figure 3). The contribution of improved forages to the livestock feed in the study districts was the highest at Ejere (1,448.8 tonnes/year) and the lowest at Kersa (176 tonnes/year).

One of the key issues in the development of forage is acquisition of appropriate forage materials in the right quantity and quality. This study examined the forage multiplication sites available in the study zones. In Dugda district of East Shoa, there is a farmer and Eden PLC which produce forage seeds of different kinds (11 different forage materials in the farmer field and five grasses, six herbaceous legumes and two fodder trees in the Eden PLC). Because of the absence of regular market, the farmer is discouraged in producing forage seeds which is also the case in Bora district. Similarly, three FTCs (Malima Berie, Berta Sami and Tuka langano peasant associations) and one farmer at Berta sami in Bora undertook efforts to produce forage seeds (lablab, Pigeon pea, Cowpea and Alfalfa) but did not show much success because of shortage of rain, facilities, equipment and the lack of proper management. There is no any forage multiplication site at Lume. The forage multiplication site at Ejere (West Shoa zone) multiplies elephant grass and tree Lucerne. In Ada-Berga, there is no forage multiplication site. There are nine FTCs in Jimma zone which multiply Rhodes and Napier grasses. Efforts are made by livestock agencies of the eight districts to strengthen forage development in FTCs and farmers' fields. In most instances, however, the FTCs are not well equipped, are faced with shortage of land, irrigation water, farm implements, running costs, fence, and shortage of improved seeds.

Different forage materials are distributed to the farmers by the extension system although their practical implementation is not as expected. At Lume, farmers plant Oats, Oats and Vetch, Vetch, Napier grass, Cowpea, Sesbania, and Leucena. In the three districts of Jimma zone, the common forage materials used are Napier grass, Vetivar grass and Sesbania. The most common forage materials at Ejere and Ada-berga (west Shoa zone) in order of their area coverage are Oat, Vetch and Napier grass while Dasho grass, Sesbania, fodder beet, tree Lucerne, Vetivar and alfalfa are also planted by farmers. Although different forage development strategies were introduced in the study zones in the past, the most widely observed strategy at the currently under field condition in west Shoa is backyard while in East Shoa different strategies are reported (Table 5). Generally, cultivated forage based dairy development is mainly observed around the urban/peri-urban areas in Ejere and Ada-berga. Uptake and adoption of improved forages has largely been limited by lack of market-orientation of livestock production.

Figure 3. Number of households planting fodder crops.

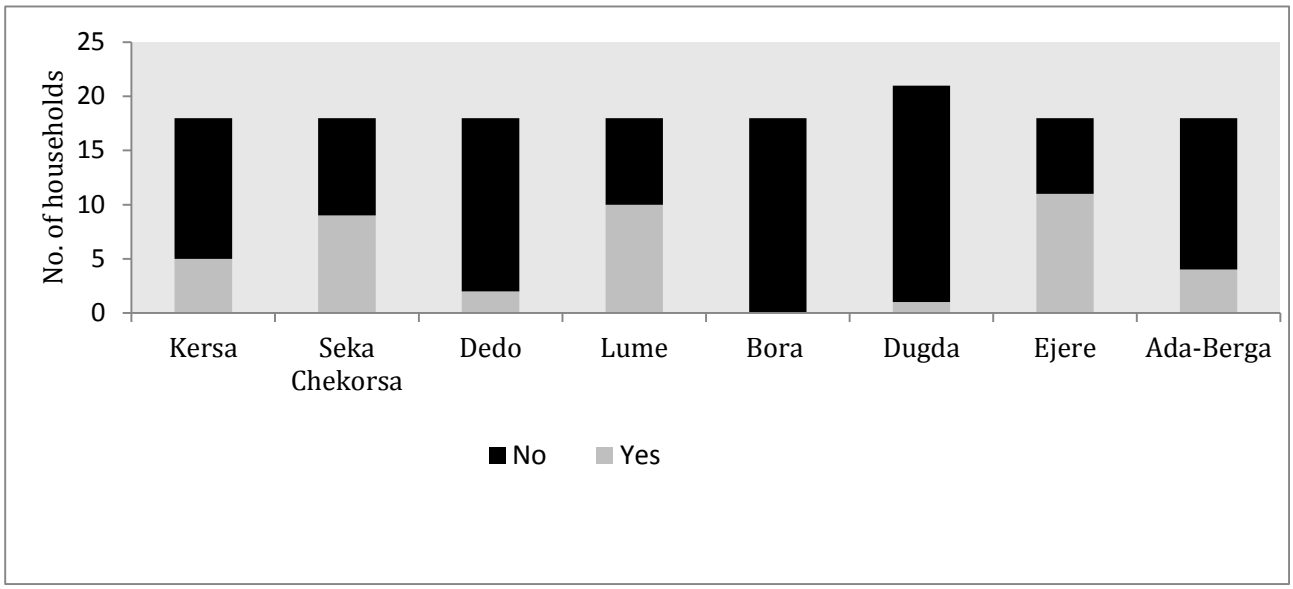


Table 5. Forage development strategies in in west and east Shoa zones in Oromia

Zone	District	Fodder development strategies (% farmers)			
		Backyard	Alley cropping	Along watersheds	Intercropping on bunds
West Shoa	Ada-Berga	80	5	5	10
	Ejere	85	5	5	5
	Dugda	25	20	25	30
East Shoa	Bora	25	20	25	30
	Lume	25	20	25	30
	Overall	65	20	5	10

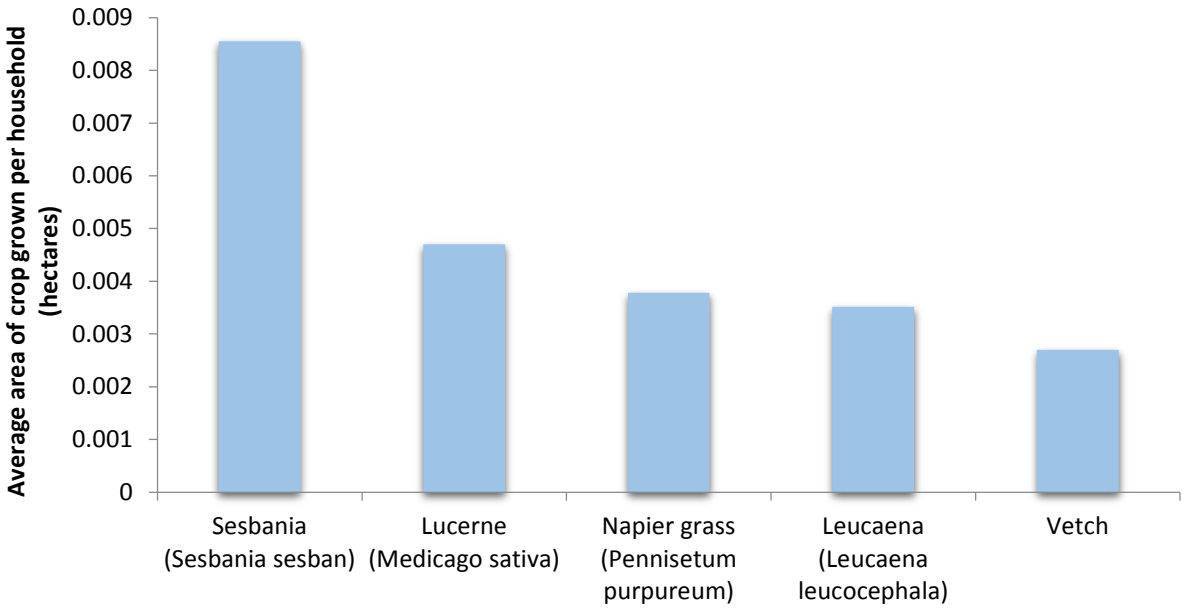
In SNNP region, Sidama highlands, few fodder species, mainly Desho, Elephant grass and Sesbania, were introduced through governmental and non-governmental organizations along fences/boundary. However, the adoption rate is very low. In Gamogofa zone, Desho and Mercho grasses were grown around soil conservation structures in some parts of Bonke district. Shortage of planting materials of improved forages are among the major factors limiting improved forage development in the region. Efforts by the extension system to establish farmer based cuttings and seed supply system is very limited.

In Tigray, cultivated forage crops grown in the study districts were sesbania, leucaena, Napier grass, alfalfa, tree lucerne, vetch, cowpea, lablab and pigeon pea. Sesbania, leucaena, and Napier grass are among the most frequently used for feeding livestock. From grass species, Napier (Pennisetum purpureum) and rarely Rhodes (Chloris gayana) are commonly distributed to forage growers. From legumes the most frequent species are sesbania (Sesbania sesban), leucaenia (Leucaenia leucocephala), and alfalfa (Medicago sativa). The dominant forage development strategies practiced in all project districts are backyard development, alley cropping, intercropping and gully treatment. Ten out of 28 PAs (i.e about 38.5%) responded that a combination of three strategies (backyard development, alley cropping, and gully treatment) are used by most forage growers. Forage productivity is generally low, the average yield being about 430 kg/ha. About 39% of the surveyed PAs used improved forages for feeding dairy cows and fattening of oxen and small ruminants. Lack of access to forage planting materials, land and water shortages are among the main problems hindering forage development.

Until now, broad use of such improved forage species in Tigray regon is constrained by the absence of agro-ecologically suitable and diverse species/varieties/accessions, limited number of public and private forage genetic material multiplication sites, absence of a comprehensive improved forage management and utilization guidelines, and lack of feeding packages that incorporate improved forage species. Except in a few cases, the success rate of introducing improved forage crops into the farming community is generally not to one's expectation and a lot needs to be done to expand the adoption of different forage species by the farmers. This is particularly true in irrigated fields where the share of improved forage crops is generally low, although the eastern zone is in a better position than the central zone. Area allocated to the major fodder crops is shown in Figure 4. In principle, each district imposes a certain quota for growing improved forage species in the irrigable land of smallholder farmers. In defacto, most of the visited districts are far from achieving a desired level of integration of forage into irrigation, and farmers do not seem to adhere to such imposed prescriptions. One of the key factors that determine farmers' choice of crops to be planted in irrigated areas is current commodity market value. Thus, it is not surprising that most of the irrigable lands found across different districts in Tigray are covered with marketable crop commodities and the share of improved forage crops is generally lower than desired by the extension system.

In Tigray, 11 public forage genetic material multiplication sites with an average size of 0.56 ha were identified during the survey, serving more than 130,000 households living in the seven districts. The nursery sites are not supported by proper research and are operating with insufficient budget and manpower, and the overall management does not guarantee production of quality planting materials. Private farmers who sale Napier cuttings and produce alfalfa seeds on contract basis are also emerging in some districts.

Figure 4. Area allocated by farmers for the major fodder crops in Tigray.



Agro-industrial by-products (AIBPs)

Agro-industrial by products are among the important types of feed resources used for livestock feeding in many parts of the country. In the study areas, the use of agro-industrial by products was less common and its contribution to total ruminant diet is negligible mainly due to lack of access, lack of awareness, and cost. However, livestock producers in urban and peri-urban areas with exotic dairy breeds supplement their animals with these by-products. The major agro-industrial by-products available in Tigray are wheat bran, sesame cake, noug cake and cotton cake; in SNNP wheat bran, noug seed cake, linseed cake and concentrate mix which are prepared for dairy, cattle fattening and poultry; in Oromia noug cake, linseed cake, cotton seed cake, by-products of cereal mills such as wheat bran; and in Amhara, noug seedcake, cotton seedcake, whole cottonseed, brewery by-product, wheat bran and pulse bran.

The availability of AIBPs varied across regions and districts. In Tigray central zone, there is no consistent and stable supply of AIBPs. Respondents from one PA in Adwa and two in Ahferom districts scored availability as low. Similarly, respondents from two PAs in Adwa and one in Ahferom complained that AIBPs are not available. Ten out of sixteen PAs in the eastern zone of Tigray rated AIBPs availability as being medium. In North Gondar zone of Amhara, 75% the smallholder farmers surveyed do not feed agro-industrial by-products for their livestock because of high price and limited availability in the local market. Although Dashan brewery factory located in Gondar town is a major source of livestock feed, smallholder farmers are not using it because of lack of awareness. Brewery by-products are mainly sold to commercial dairy farmers located in Gondar town. South Wollo zone has relatively higher number of agro-industries. There are three large flour mills in Dessie town alone, which contributes to the concentrate supply of the zone. There is also Brewery factor at Kombolcha (BGI). Nevertheless, the supply is very small in relation to the demand. Only 5% of the smallholders are likely to use agro-industrial by-product mainly wheat bran in the zone. In West Gojjam Zone, about 20% of the households utilize AIBPs to feed their livestock. In Oromia region Jimma zone, the use of AIPBs as feed source is nil partly because of lack of access to such feeds. However, there is a cereal/ pulses powder residue (floor waste) locally called 'bulule' obtained from traditional mill. The chemical composition of bulule analyzed in this study revealed that the residue has a crude protein content of 8.16% (slightly above the minimum nitrogen requirement of microbes in the rumen) and organic matter of 93.64%. The use of AIBPs as a feed source is also very small in Ejere and Ada-berga districts of West Shoa zone. This is partly because of less access to such feed types and the high price of the feeds. The available quantity of AIBPS is higher in Lume district than in the others because of the presence of cereal processing mills and oil extracting mills. The use of AIPBs in PAs far from the major towns is very negligible. Details on type and volume of agro-industrial by-products marketed in the study area is described under feed agri-business section.

Non-conventional feeds

The major non-conventional feeds identified in the surveyed districts in SNNP region were traditional liquor residue (katikala and borde atella), spoiled grains and crop thinning in Gamogofa zone and vegetable waste, bamboo leaf, kocho residue and atella in Sidama highlands of SNNP region. In Amhara, non-conventional feed include by-products of local drinks, namely atela and brint in North Gondar, vegetable and Khat leftover in South Wollo, and atela and brint in West Gojjam. In Tigray region, atella (home-made brewery by-product) is more common in the central zone districts while cactus cladodes feeding is a traditional feed in the eastern zone districts. Cladodes/pods of cactus pear (Opuntia ficus indica) are traditionally used as livestock feed during the dry season and drought periods. Vegetable leftovers are used as supplements during the irrigation season and include cabbage, tomatoes, salads, and potato vines. The major non-conventional feed resources in Oromia are chat geraba (Khat edulis), banana leftover/leaves, enset leftover, cabbage and mango fruit rejects, residues of coffee in Jimma zone, backyard grown cabbage and some shrubs such as Grewia (Verona) and acacia in West Shoa, and by-product of local brewery (atela) in East Shoa zone. Khat residue (Khat edulis), residues of Enset (Ensete ventricosum), banana leftover/leaves, enset leftover, cabbage and mango fruit rejects, residues of coffee and some trees of different species like acacia are fed during the dry seasons in Jimma zone. There is a high quantity of coffee bulb production in the three districts but not used as animal feed because farmers feel that the chemical used in processing coffee will create bloating in the animals. In addition, there is knowledge gap on its proper use by farmers and the extension system. It is used as compost, sold by farmers and a large quantity of the residue is burned which may have negative impact on the environment/climate.

Utilization, management and improvement

Grazing land management and utilization

There are variations in the ownership and management of grazing lands across regions and districts. In Oromia, grazing lands are utilized and managed either communally or privately, with 18.9% and 81.1% of the grazing lands being owned communally and privately, respectively (Table 6). In the past, there were more communally owned lands than private lands. The size of private grazing lands range from 0.25–0.5 ha/household. Field observations showed that private grazing lands were in better condition than communal ones. Tethering is common on private grazing lands, whereas open grazing/free grazing is practiced on communal lands. There is a limited practice of rotational grazing by dividing the grazing areas into different paddocks in Dedo district. There is also a practice of stock exclusion from grazing during the main growing season using traditional by-laws and/or fence. In Kersa, the main system of grazing land utilization of private grazing lands include standing hay, open grazing and cut and carry. This has a very important policy implication for improving the management of grazing lands. The major problems related to private grazing are land shortage, lack of hay making experience, competition with crop production, poor conservation and over grazing of the lands resulting from land shortage and poor management. Over grazing, lack of proper ownership, land allocation for youth and unemployed people are some of the common problems indicated in communal grazing lands. No management intervention was introduced on the communal grazing lands and very limited on private grazing lands either (Table 8). Farmers in FGD and experts suggested reducing herd size, improving utilization of crop residues, privatizing/sharing the grazing land, and rehabilitation of the grazing lands (resting, reseeding, fertigation) to resolve some of the issues with communal grazing lands.

In Tigray region, most grazing lands in the central zone are communal and utilization is based on agreed bylaws. In the eastern zone, grazing lands are privatized and utilization is based on individual basis (Table 7). Evaluated on four ordinal scales (excellent, good, fair, and poor) using aboveground biomass as a proxy indicator of the health of the grazing lands, three of the seven districts, where grazing lands are used communally, are rated as fair while all grazing lands currently used on individual basis had good rating.Grazing lands in Atsbi-Womberta district having higher scores than grazing lands in the other districts. The contribution of grazing lands to livestock feeding depends on ownership and condition of the grazing lands; grazing lands owned privately and are in good condition contributing more to animal feeding. Dependency of smallholder farmers on feeds derived from grazing lands varies from 5-8 months, which is associated with the size and productivity of the grazing land. In Atsbi and Saesie Tsaeda Emba districts where the largest grazing is available, the dependency is eight and seven months, respectively. The

two common forms of utilization applied are cut-and-carry and direct grazing (Table 7). It is unfortunate that most grazing systems in the central and eastern zones received little attention in terms of the choice of improvement interventions (Table 10). Most of the interventions lacked proper planning and repeatability. For instance, mechanical removal of less valued plants is only applied sporadically after the density surpasses a threshold. Soil nutrient management is seldom considered as part of the overall management of grazing lands. Smallholder farmers and district experts are generally insensitive to the regular management of morbid grass (Serdi), which deters new plant growth the following growing season.

In SNNP region, the grazing lands in the highlands of Sidama and Bonke are distributed across the diverse topography extending from downstream flood plains to upstream plateau. Limited access to bottom land grazing during the rainy season, low productivity of natural pasture in upstream plains, invasive weeds such as Argemone mexichne in the highland and bushes and other unpalatable species in lowland communal grazing areas are the major challenges limiting the utilization of grazing lands in this region. According to focus group discussants the condition of natural grazing lands in about 89% of the sampled PAs in Gamogofa zone was poor. The predominant feeding system across all the surveyed districts was grazing on communal/private grazing land. However, about 33% of the sampled households in Sidama zone use shifting grazing from one plot of land to other since they have more than one plot of grazing land located in different areas. Moreover, unlike Gamogofa, land renting exclusively for grazing is common in Sidama highlands as reported by about 56% of the sampled households. In some areas of Arbaminch zuria district livestock walk about 6–14 km (round trip) per day to access communal grazing land, which depletes energy available for production. Although less common, stall feeding was practiced by few households, particularly, in urban and peri-urban areas with improved dairy genotype. Cut and carry of green feeds and hay from bush lands/forest was observed in Mirab abaya and Arbaminch zuria districts.

In Amhara North Gondar zone, grazing land is utilized from June to September and closed for production of hay from October to December. The common practice of grazing land utilization is free grazing. Very few households (about 5%) use cut-and carry system. Natural pasture contributes 50% to the total feed supply for livestock. Productivity has been decreasing from year to year due to over-gazing related to increased farm land and livestock population per unit area. In South Wollo, there is very limited or no communal grazing land. However, farmers allocate small plot of land for grazing purpose. Grazing land in West Gojjam zone is dominantly communally owned. The major mode of utilization of communal grazing lands is free grazing. In fact there is tendency of shifting from communal grazing to cut-and-carry system of feeding in some PAs of the zone. Most of the communal grazing lands are poorly managed. The communal grazing lands are also diminishing in size for various reasons.

Table 6. Ownership type, form of utilization and condition of communal and private grazing lands in East Shoa, West Shoa and Jimma zones of Oromia region

District	Ownership (%)		Form of utilization		Condition	
	Communal	Private	Communal	Private	Communal	Private
Lume	10	90	FG	FG	Very poor	Fair/poor
Bora	15	85	FG	FG, CC and SH	V.poor/poor/fair	Good/fair/poor/v. poor
Dugda	20	80	FG	FG, P	V.poor/poor/good	Good
Ejere	20	80	FG	H, SH, CC, FG, E	Poor	Good/fair
Ada-berga	20	80	FG	H, SH, CC, FG, E	Poor	Good/fair/poor
Dedo	15	85	FG	T, CC, SH, FG	Poor	Good/fair/poor
Kersa	30	70	FG	SH, CC, FG, T	Poor/fair	Good/poor
Seka-Chekorsa	21	79	FG / T	T, SH, CC, FG	Poor/at best fair	Good/fair

FG free grazing, CC cut and carry, SH standing hay, H hay, P paddocking, E enclosed in growing season and communal grazing in dry months, T tethering

Table 7. Common grazing interventions in the central and eastern zones, Tigray.

District	Major problems		Types of interventions	
	Communal	Private	Communal	Private
Adwa	Late harvesting, trespassing		Enclosing, weeding and gully treatment	
Ahferom	Weed, late harvesting, poor storage conditions, erosion	Gully formation	Enclosing and (re) seeding	Enclosing, weeding, (re)seeding
Laelay Maichew	Late harvesting		Enclosing, weeding, erosion control	
Atsbi Wemberta		Erosion and weed infestation		Enclosing, weeding, (re)seeding
Ganta Afeshum	Late harvesting	Late harvesting	Enclosing and (re) seeding	Enclosing, weeding, (re)seeding, water harvest structure and fertilizing
Kilte Awlaelo	Free grazing		Grazing and weeding	
Saesie Tsaeda Emba	------	Erosion & acute forage seed supply	------	Enclosing, weeding, (re)seeding

Table 8. Major problems and common interventions in West Shoa, Jimma and East Shoa zones

District	Major problems		Interventions	
	Communal	Private	Communal	Private
Lume	No proper grazing land/relaxation only	Shortage of land due to competition with crop and investment Overgrazing/no rest		
Bora	Diminishing size/over grazing no ownership and improvement interventions	Reduction in size/Over grazing		
Dugda	Diminishing size Over grazing	Lack of adequate knowledge and advice from the extension		Addition of manure, rotational grazing
Ejere	Overgrazed/degraded No management intervention Low biomass	Shortage of land/over grazing		Addition of manure and fertilizer
Ada-berga	Overgrazed/degraded; no management interventions; low biomass affected by cement factory chemicals	Land shortage/overgrazing, rainfall shortage		Addition of manure and fertilizer
Dedo	Improper use, no time for resting	Land shortage, no improved management practices, Lack of awareness how to use the private grazing lands		Enclosing
Kersa	Land shortage/over grazing/land degradation, expansion of farm land and eucalyptus trees, no proper management	Improper use, land shortage		
Seka-Chekorsa	Land shortage/over grazing/land degradation, expansion of farm land, no proper management	Land shortage/overgrazing, lack of hay making experience, competition with crop production, poor conservation		

Hay making: Hay making and use of standing hay is another grazing resource management and utilization practice. There are variations in these practices across regions and zones. In Oromia, hay making is not practiced in Jimma zone due to the long rainy season which is favourable for almost year round green feed supply and unfavourable for hay making. In East Shoa, hay making used to be practiced 8–10 years ago, but not anymore, except standing hay by some farmers. Hay making is well practiced in West Shoa zones on plots of 0.25 ha/ household. The practice involves closing the grazing land from June to October/November until the hay is harvested and letting communal grazing until it is closed again in June. Hay is fed from April to June and accounts for 15% of the feed supply in the surveyed districts of West Shoa.

Table 9. Contribution, utilization and status of grazing lands in central and eastern zones.

District	Ownership (%)		Condition		Contri-	Dependency	Form of utilization		Frequency of utilization	
	Communal	Private	Communal	Private	bution	(months)	Communal	Private	Communal	Private
Adwa	75	25	Fair		<25%	7	Cut-and-carry	Cut-and-carry	3	2
Ahferom	85	15	Fair	Good	<25%	6	Cut-and-carry	Cut-and-carry	2	2
Laelay Maichew	90	10	Good		25-50%	6	Cut-and-carry		3	
Atsbi Wemberta	10	90		Good	25-50%	8		Cut-and-carry		2
Ganta Afeshum	--	100		Good	25-50%	4		Cut-and-carry and direct grazing	1	1
Kilte Awlaelo	65	35	Fair		<25%	7	Free grazing		1	
Saesie Tsaeda Emba	--	100		Good	25-50%	7		Cut-and-carry and direct grazing		3

In Tigray region, of the total grazing lands available in each district, the proportion of land allocated for hay making ranges from 0.1 to 0.9 ha. The largest portion of grazing land allocated to hay making is found in Atsbi district where hay is produced on an average of 300 ha of land in 12 grazing lands. The minimum hay lands are found in Laelay Maichew, Adwa and Ahferom districts with an average 5.2, 14.0 and 14.3 ha of the land in 8, 12 and 16 grazing lands, respectively. An estimated 120–700 households/district are involved in hay making, the largest being in Saesie Tsaeda Emba and the smallest in Laelay Maichew district. When an entire grazing land of an administrative PA is partitioned in to eligible households, on average a household allocates 0.25 ha for hay making and is able to harvest 350–1,200 kg of grass hay annually. This is barely sufficient for one–two months of continuous feeding of selected classes of livestock. The right time for making good quality hay is September-October, although some extend this to November. In rare cases, as in Saesie Tsaeda Emba district, hay making involves the spraying of salt solutions (1.5:200 litres of water) after each layer to improve its keeping quality and palatability. There is very little consideration of the plant stage of maturing for hay making as there is no optimum time set for cutting grass hay. Conserving grass as standing hay is practiced in Adwa, Atsbi and Ganta Afeshum districts. Hay is used for feeding during the months of January/February/March/December and May/June/March and standing hay in September/October/March—October/November/March.

In SNNP, hay making is hardly practiced. However, standing hay is collected from area closure mainly from bush lands and forests in Mirab abaya and Arbaminch zuria districts of Gomu Gofa zone. In Amhara region, hay making is more common in South Wollo zone than in West Gojam and North Gondar. Almost 85% of the households practice hay making. Hay making is also common in West Gojam zone. According to this survey, about 70% of households practice hay making. Hay production is significantly increasing due to the rising price of concentrate feeds price and grass hay.

Crop residue utilization and management

This survey found that not all crop residues produced is used as animal feed. In Jimma zone, about 20% of the sampled households sell teff straw for wall plastering. Sorghum stover is mainly used for fencing and fire wood. Bean straws is not commonly used as animal feed. Irrigated maize stover and thinned maize is a good source of green feed during the dry season. Maize stover is harvested and piled for feeding during periods of feed shortage, but most of it is left in the field for stubble grazing. Poor storage facility and effect of termites are the most serious problems related to crop residue utilization (Table 9). Improvement of crop residues (e.g. urea treatment) is rarely practiced except spraying salt solution to improve palatability by some farmers. Generally, availability of green fodder during most part of the year reduces the importance and proper utilization of crop residues as livestock feed in Jimma zone. In West Shoa zone, management and utilization of crop residues is much better than in Jimma; about 70% of the households conserve crop residues properly, though the remaining 30% of the households keep crop residues stack outside exposing to spoilage by urine, manure and exposure to sunlight (Table 10). Compared to West Shoa and Jimma zones, the use of crop residues as livestock feed is higher in East Shoa, especially in Lume district where crop residues from cereals and pulses are fed mixed to improve their utilization (Table 12).

In Tigray region, invariably across districts, crop residue storage conditions are poor (Table 12). Crop residues are kept outside with little protection and in some districts improper stacking and extended storage for up to 3–5 months exposed crop residues to termite damage, wastage and nutrient leakage. Table 14 summarizes contribution of crop residues and major constraints to use technologies to improve crop residues.

In SNNP, the crop residue management practice is manual chopping of enset, banana and sugar cane top, leaf and stem. Urea treatment and ensiling of crop residues is not common. In semi-arid areas, crop residues are conserved for the dry season, but these are collected late after removal of the cob/grains and piled outside for a long time. Similar crop residue utilization and management practices were reported for Amhara region.

Table 10: Problems related to the utilization of crop residues in West Shoa, East Shoa and Jimma zones, Oromia

District	Major problems related to crop residue utilization			Improvement
	Collection and transportation	Storage problem	Feeding problems	
Ada-berga	Labour shortage, lack of proper collection; transport and road problem	Stack outside, spoilage with urine, manure and rain	Treating feeds, use of proper feeding places and feeding troughs not widely used	Feeding with Atela and salt Concentrate and legume supplementation very limited
Ejere	Labour shortage, transport and road; lack of proper collection	Stack outside, spoil with urine, manure and rain	Improving but wastage is there, resistance to the use of technologies by farmers	Feeding with Atela,and salt; Mixing with concentrate, legumes very limited
Dugda	Lack of timely collection due to shortage of labour	Lack of knowledge and capacity to properly store	No proper feeding place and feeding trough, eat plastic, no treatment and processing	Chopping,
Bora	Lack of timely collection due to shortage of labour	Stack outside; lack of knowledge and capacity to properly store feeds,	No processing of feeds except traditional chopping of maize, no feeding troughs and proper feeding place	Occasionally feed by mixing with wheat bran for oxen
Lume	Lack of timely collection due to shortage of labour	Stack outside though properly piled	No processing of feeds, access and input supply shortage, no treatment and conservation	Piling by mixing cereal and legumes straws Spraying salt dissolved in water
Seka-Chekorsa	Lack of awareness, high cost, little practice of collection,	Lack of awareness, lack of storage facilities, termites, poor storage practice	Lack of knowhow, no treatment, lack of proper use (wastage), feeding related problems	Thinning and treating with salt dissolved water
Dedo	Lack of awareness, high cost, little practice of collection,	Lack of awareness, lack of storage facilities, termites, poor storage practice	Lack of knowhow, no treatment, lack of proper use (wastage), feeding related problems	Thinning of maize and sorghum
Kersa	Lack of awareness, high cost, little practice of collection,	Lack of awareness, lack of storage facilities, termites, poor storage practice	Lack of knowhow, no treatment, lack of proper use (wastage), feeding related problems	Thinning of maize and sorghum

Table 11. Management of crop residues in the central and eastern zone, Tigray

District	Storage problems	Feeding problems	Improvement practices
Adwa	Pest /Termites	Absence of trough; coarse particle size	Legume supplementation and urea treatment
Ahferom	Late storage	Absence of trough; coarse particle size	Mixing chopped hay with crop residues and concentrate supplementation
Laelay Maichew	Pest /Termites	Absence of trough; coarse particle size	Concentrate and atella supplementation, cactus cladodes
Atsbi Wemberta	Late storage, Stack outside, pests, termites	Absence of trough; coarse particle size	Mixing with oilseed cakes and bran and manual chopping of stovers
Ganta Afeshum	Pest /Termites	Absence of trough; coarse particle size	Mixing cactus cladodes (after singing spines with fire) with crop residues and atella, concentrate supplementation
Kilte Awlaelo	Stack outside, pests, birds	Absence of troughs; coarse particle size	Providing cactus cladodes after singing spines with fire, concentrate supplement
Saesie Tsaeda Emba	Stack outside	Absence of trough; coarse particle size	Providing cactus cladodes after singing spines with fire, concentrate supplement

Table 12. Crop residue utilization and improvement in the central and eastern zones in Oromia

District	Constraints to methods of improving crop residues			
	Physical	Chemical	Concentrate supplement	Legume supplement
Ada-berga	lack of knowhow, no chopping, labour shortage	lack of knowhow, finance and access to ingredients	Lack of knowhow, finance, and concentrates, quality problem and high price	Lack of knowhow, land and seed shortage
Ejere	lack of knowhow, labour shortage, lack of equipment	lack of knowhow, finance and access to ingredients	lack of knowhow, finance, and access to concentrates	lack of knowhow, the shortage of seed and land
Dugda	Knowhow, Labour, Finance, lack of commitment	Finance, access and knowhow), lack of commitment, time shortage,	finance, access, knowhow	Knowhow
Bora	Knowhow, Finance, Labour, shortage of water	Finance, knowhow and awareness, access to ingredients, not properly practicing	Finance, access to concentrate and knowhow	Access to seed and knowhow Lack of getting convinced; moisture problem inance
Lume	Labour, land knowhow	finance and know how (supply, access, knowhow)	Knowhow, High price and supply problem Access and knowhow	Knowhow, Seed shortage, Access and knowhow
Seka-Chekorsa	lack of knowhow and shortage of land	lack of knowhow, finance and access to ingredients	lack of knowhow, finance, and access to concentrates	lack of knowhow
Dedo	lack of knowhow and shortage of land	lack of knowhow, finance and access to ingredients	lack of knowhow, finance, and access to concentrates	lack of knowhow
Kersa	Lack of knowhow and shortage of labour	Lack of knowhow, finance and access to ingredients	lack of knowhow, finance, and access to concentrates	lack of knowhow, access to legumes, shortage of land

Table 13. Crop residue utilization and improvement in the central and eastern zones in Tigray

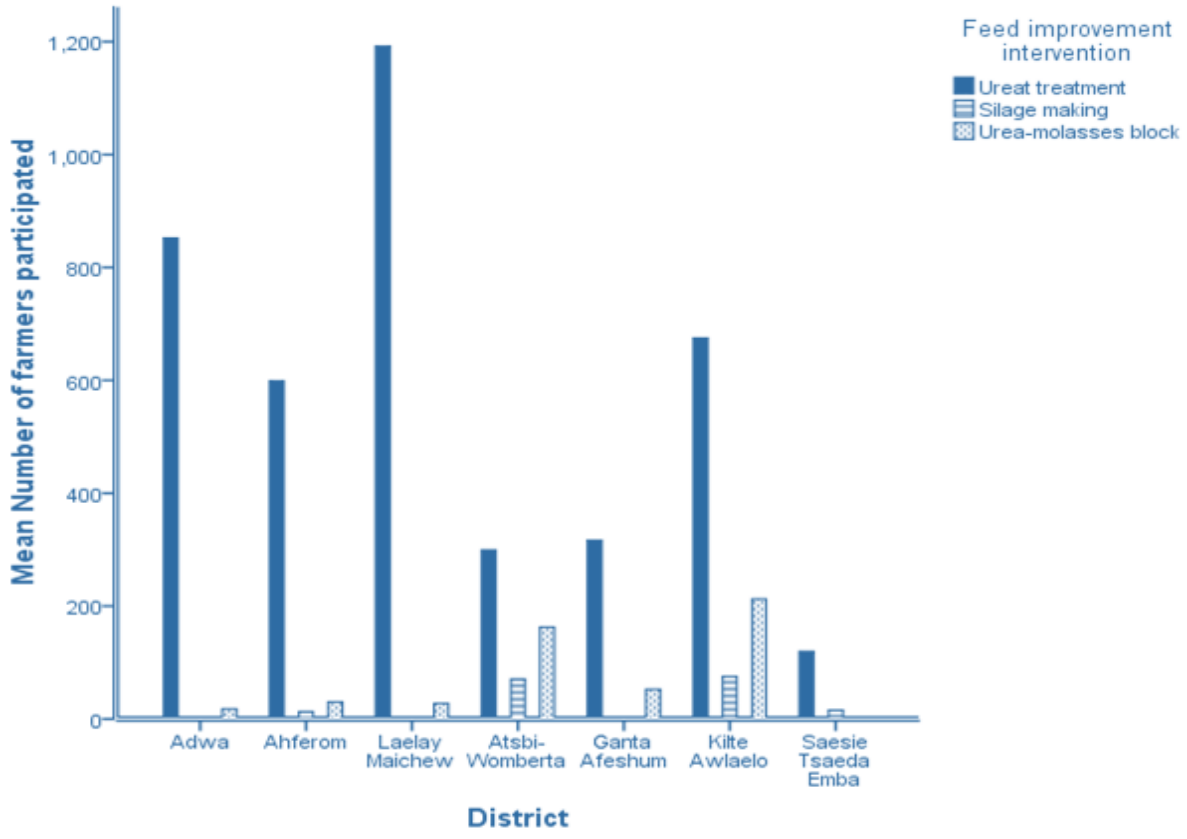
District	Max. months of use	Contribution to livestock feeding (%)	Constraints to improving residues			
			Physical	Chemical	Concentrate supplement	Legume supplement
Adwa	9	50–75	Commitment	Finance, access, knowhow	Finance, access, knowhow	Knowhow and commitment
Ahferom	7	50–75	Commitment	Access and commitment	Finance and access	Knowhow
Atsbi Wemberta	8	50–75	Commitment	Knowhow		
Ganta Afeshum	8	50–75	Access	Knowhow	Finance	Knowhow
Kilte Awlaelo	12	50–75	Access	Finance, Access, Knowhow	Finance	Finance and land
Laelay Maichew	12	50–75	Access	Access and knowhow	Finance	Land
Saesie Tsaeda Emba	9	25–50	Labour	Knowhow	Finance	Water shortage

Feed improvement and conservation

Feed improvement interventions such as urea treatment, silage making and Urea Molasses Multi-nutrient Block (UMMNB) have been introduced by several development partners in most parts of Ethiopia, including in areas covered by this survey. The interventions have not been introduced in some areas like Jimma zone of Oromia region and North Gondar zone of Amhara region. In areas where the interventions have been introduced, only few farmers tried the technologies after training/demonstration but could not adopt the technologies sustainably due to lack of inputs (molasses and urea), lack of continual support from the extension system, and the high cost of ingredients. In Tigray, the conservation and preservation of green feeds in the form of silage is not widely practiced; insignificant numbers of

farmers have adopted urea treatment of crop residues, and urea-molasses blocks have not been adopted as a regular livestock feeds. Figure 5 shows number of farmers adopting feed improving technologies. In SNNP region, apart from chopping of leaf and stem of enset, banana and sugar cane, no feed improvement is practiced including urea treatment and ensiling of crop residues.

Figure 5. Number of farmers participated in feed improvement technologies (Average of two years 2005–2006 EC).



Feed Balance, contribution of feed resources and seasonal availability

Feed balance

Based on the assumptions given in the materials and method section, the livestock populations in TLU and the available feed from different sources (grazing land and other grazing resources, crop aftermath, crop residues, vegetables and fruits residues, agro-industrial by-products and improved forages) feed balances (supply and demand) were estimated for the 31 districts in the four regions surveyed. In Oromia (Figure 6), the overall livestock feed supply and demand ratio was above unity for Dugda district only indicating the supply met the demands. In all the other districts the demand for maintenance requirement exceeded the supply. In Tigray (Figure 7), the total feed demand for an estimated 293,209 TLU is 698,107 tonnes, and the available total feed supply at 70% and 100% utilization is 447,155 tonnes and 638,792 tonnes, respectively. Only two districts (Ganta Afeshum and Kilte Awlaelo) are able to produce feeds that just meet the maintenance needs of existing TLUs. This amount of feed is sufficient to support the existing stocks only for 8 and 11 months at 70% and 100% utilization efficiency, respectively. In SNNP (Figure 8), only Mirab Abaya district meets the feed requirements for maintenance. The feed resources available in Mirab abaya should be interpreted with caution since the area is prone to drought due to erratic rainfall where crop failure is common. On the other hand, farmers close to Lake Abaya, which is adjacent to the district, are able to produce high value crops such as banana and mango through irrigation, which might have increased irrigated crop residue supply such as banana leaf and stem in the district.

In Amhara (Figure 9), severe feed shortage was observed in Gondar Zuria district in North Gondar zone. This might be due to the higher livestock density in the district. In all the districts of South Wollo, there is a very big gap between demand and supply of livestock feed which could be hardly fulfilled from agro-industrial by-products. The gaps in Kalu and Tehuledere could be filled with AIBPs. In West Gojjam zone, the DM biomass obtained from crop residues, aftermath grazing, natural pasture and forestland surpassed the annual dry matter requirement of the existing livestock population. However, this does not mean that the existing feed fulfills nutritional requirement of livestock since the major contributor is crop residue which is poor nutritionally. The focus of feed resource development in these districts should be on quality improvement such as treatment of crop residues, supplementation with forage legumes, concentrates and mineral mixes.

The current feed balance indicates that there is huge gap between demand and supply for most districts surveyed in this study. Thus, efforts should be made to improve feed availability (improved production and productivity) both in terms of quantity and quality and feed conservation and utilization in the study districts. These included improved rain-fed fodder production strategy using high yielding forage materials suitable to the respective agro-ecologies, farming system and land scape. Integrating improved forage development with irrigation (e,g, use of irrigation structures, intercropping with irrigated food crops etc.) is also important to produce high quality yearlong feed supply. In areas where grazing is common, introduction of appropriate improved grazing land development techniques such as top dressing with urea could enhance the productivity of the grazing land. Proper harvesting, transporting and storage of crop residues, and enhancing the utilization of low quality feeds through chopping, urea treatment and ensiling is important to improve the availability and quality of crop residues. This study did not estimate non-conventional feed resources such as atella, household waste, crop thinning etc. which could undermine the total available feed resources in the respective districts. Moreover, it was based on secondary information obtained from different sources.

Figure 6. Feed balance in Oromia.

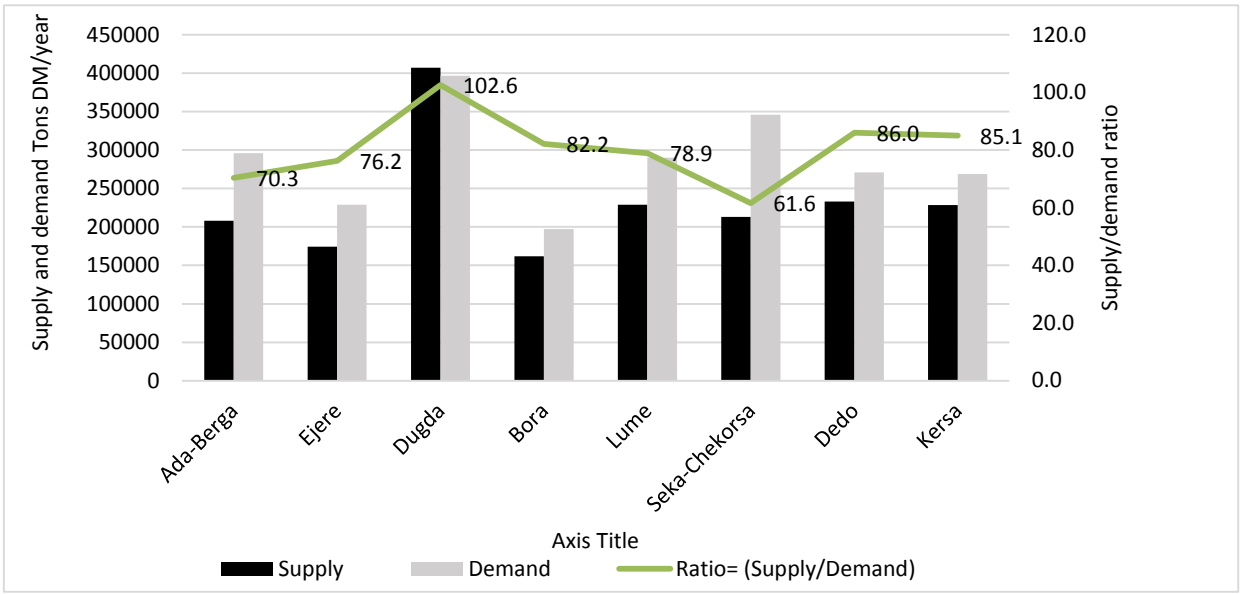


Figure 7. Feed demand and supply pattern for seven districts in the central and eastern zones in Tigray.

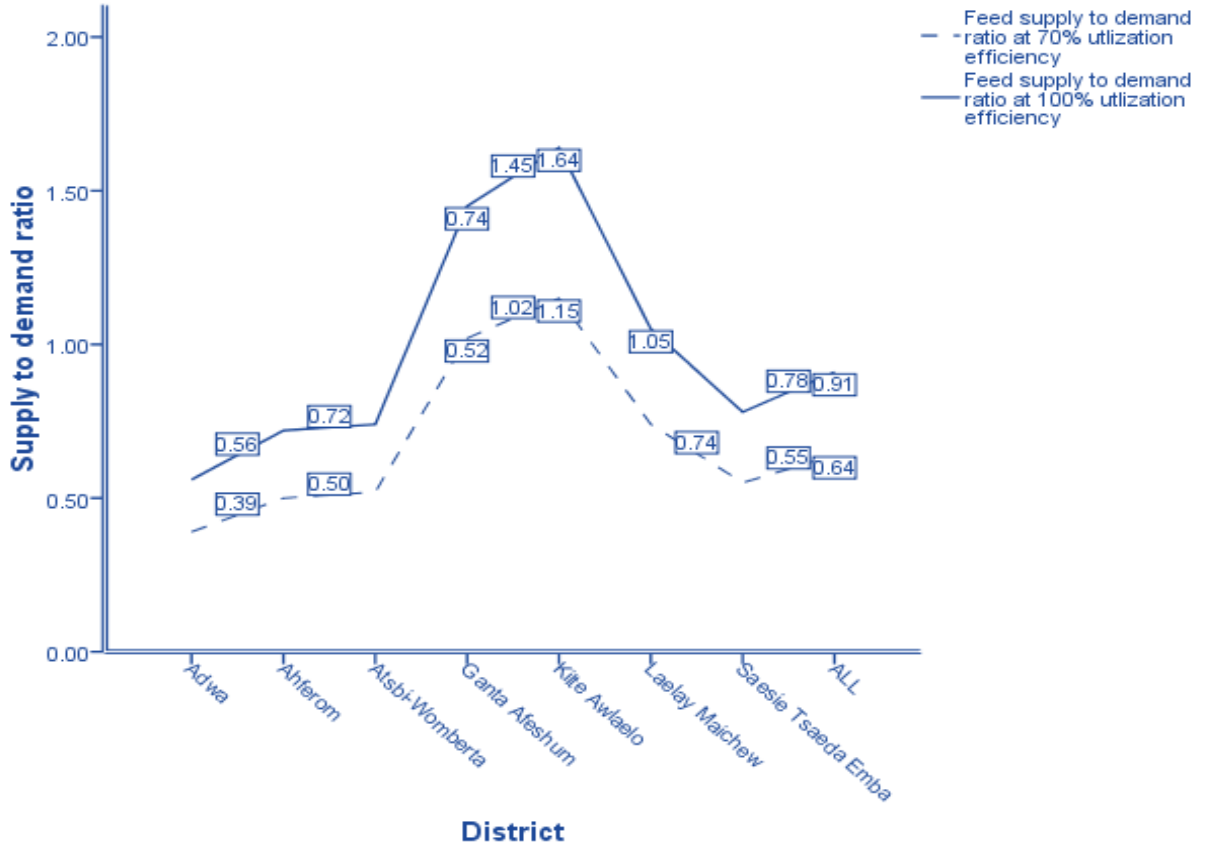


Figure 8. Total available feed, maintenance requirement and deficit (required minus available feed) in SNNP.

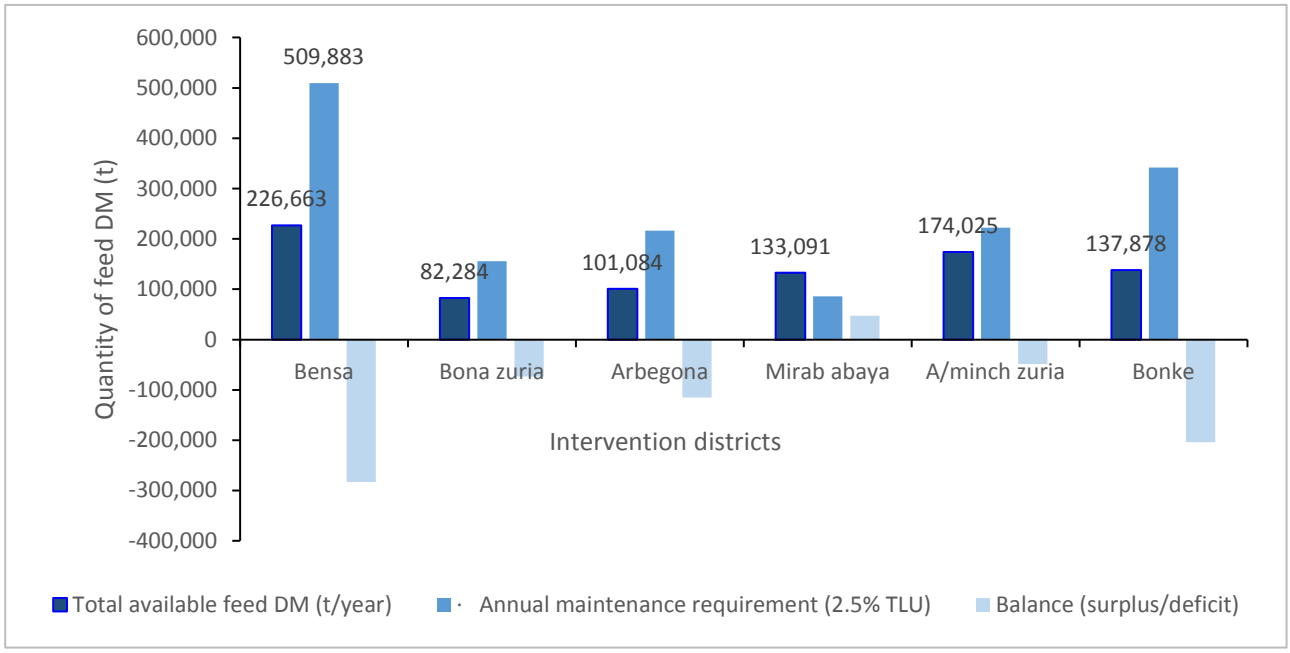
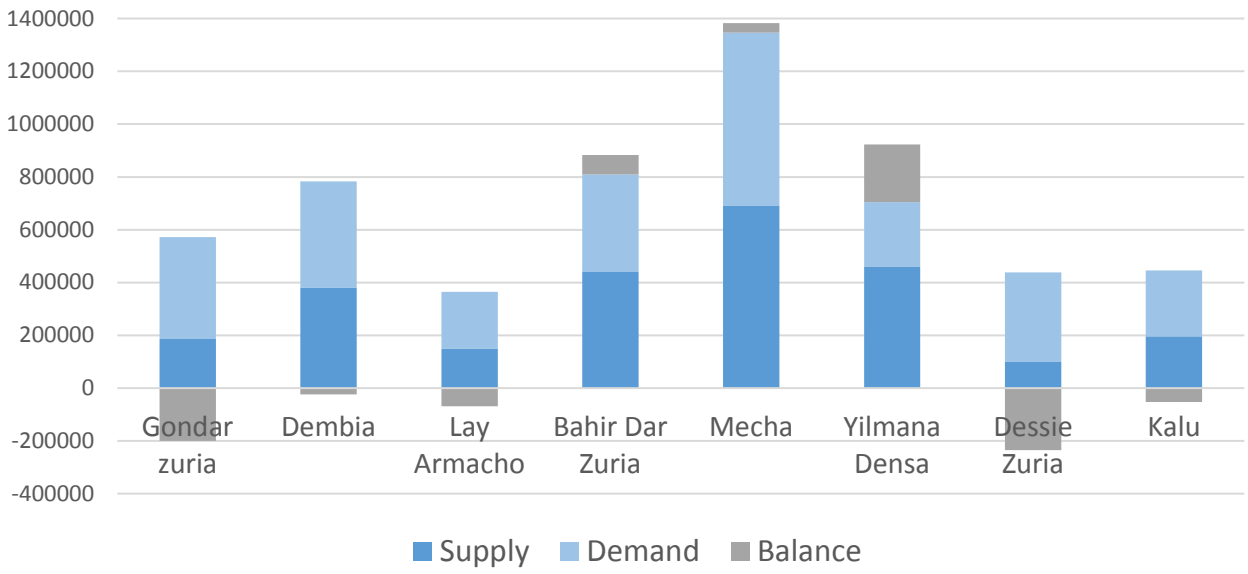


Figure 9. Total available feed, maintenance requirement and deficit/excess (required minus available feed) in Amhara.



Relative contribution of feed resources

Crop residues

Crop residues are by far the most common feeds in cereal growing regions of Oromia, Amhara and Tigray. The overall contribution exceeded 50% of the livestock feeds in these regions. This result is consistent with other studies (Tesfaye 2006; Adugna et al. 2012). The high contribution of crop residues to livestock feeding reflects the level of integration between crop and livestock farming. It was estimated in the current study that crop residues in the central and eastern zones of Tigray could sustain livestock for 7-12 months, and contribute to 50-75% of the livestock demand of an average household. The contribution to livestock feeds from grazing land, conserved and standing hay, improved forages and agro-industrial by-product supplements is much lower than the share of crop residues. However, there are variations in the contribution of crop residues among the zones and districts. While cereal residues are the major source of crop residues in general, residues from horticultural crops are particularly important in Jimma and part of East Shoa zones of Oromia region. With improvement in the methods of utilization of these residues (e.g. drying and ensiling) and capacity development of the users would lead to sustainable integration of livestock and horticulture crop production. In Tigray, a unique cereal residue, Hanfets, contributes to 15% of livestock feeds in the region. In Amhara North Gondar zone, crop residues meet 49.9% of the feed requirement for livestock maintenance, whereas contribution from crop aftermath fulfills about 6.5% of the maintenance requirement. In South Wollo zone, the contribution of Belg season crop is highly limited because of low crop productivity and frequent crop failure during this season. The straw, stover and haulms produced during the Meher season contribute to only about 30.5% and crop aftermath grazing 5% of the annual feed demand. The contribution of crop residue as livestock feed in West Gojam is immense, particularly in Yilmana Densa district where crop residues could contribute to about 144.8% of the livestock feed demand in the district. Contrary to the other regions, in SNNP region the crop residues from annual crops contribute the least ranging from 10.4 to 14%, except in Bonke district where there is shortage of grazing land and crop residues contribute to 35% of the annual DM requirements (Table 14).

Grazing land

The contribution of grazing lands to livestock feeding is generally declining due to expansion of arable farming (Yoseph et al. 2015a). However, its contribution varies across regions and districts. In Tigray, the contribution ranged from less than 25 to 50% depending on the condition of the grazing lands which in turn depends on the ownership pattern of the grazing lands. Privately owned lands are generally in better condition than communally owned lands.

In Amhara, natural pasture is a very important source of feed for livestock. However, there is seasonal fluctuation in availability and quality of the natural pasture. Besides, the size of natural pasture is declining from time to time due to encroachment by crops and settlement. In many of the PAs, use of natural pasture for grazing is being discouraged to safeguard soil and water conservation structures. Thus, in the long run, contribution of natural pasture for grazing may decline substantially. In SNNP region (Table 14), grazing fallow land and stubble grazing had significant contribution to livestock feed in Bonke district while the contribution of bush land to total livestock diet was dominant in Mirab abaya and Arbaminch zuria districts. Communal grazing is common in Mirab abaya and A/minch zuria districts, while private grazing is practiced in the other districts. The contribution of grazing land in DM to total livestock diet, according to the response of sampled households, ranged from 28.4% in Bonke to 39-41.6% in Arbegona and A/minch zuria districts. Communal grazing is more common in Gamogofa zone whereas private grazing is more common in Sidama. In highland districts (Bonke, Bensa, Bonazuria and Arbegona), tether feeding is more common and enset and other collected feeds (Table 6) have become important feed sources due to shortage of grazing land (Yoseph et al. 2015a).

Table 14. Mean contribution (%) of locally available feed resources to total dry matter, ME and CP of the sampled households in SNNP region

	Gamogofa zone			Sidama zone		
	Arbaminch zuria	Bonke	Mirab Abaya	Arbegona	Bonazuria	Bensa
Dry matter						
Annual crop residues	12.2	35.0	23.3	10.4	12.4	14.0
Cultivated fodder	0.1	0.9	0	0	0.4	0.3
Grazing	41.6	28.4	36.8	39.0	31.9	36.8
Purchased feeds	0.9	0.4	0.4	0.1	0.3	1.2
Collected fodder*	45.3	35.3	39.5	50.5	55.0	47.6
Metabolizable energy						
Crop residues	10.5	32.9	22.1	8.5	11.9	12.0
Cultivated fodder	0.5	0.1	0.0	0.0	0.3	0.3
Grazing	39.7	28.1	35.4	37.4	30.0	35.2
Purchased	1.3	0.3	0.7	0.2	0.3	2
Collected fodder*	48.0	38.7	41.8	53.9	57.5	50.5
Crude protein						
Crop residues	11.5	32.6	22.1	8.7	11.7	12.0
Cultivated fodder	0.8	0.4	0.0	0.0	0.5	0.3
Grazing	39.7	28.1	35.4	37.4	30.0	35.2
Purchased	1.3	0.3	0.7	0.2	0.3	2
Collected fodder*	46.7	38.7	41.8	53.7	57.5	50.5

*Fodder materials from communal areas other than grazing, roadsides, wastelands, forest/bush lands, leaf and stem of banana and enset, crop thinning.

Cultivated fodder

The contribution of cultivated fodder as livestock feed is very small in all the current study areas. For instance, the contribution of improved forages to the livestock feed in Oromia was as low as 176 tonnes/year in Kersa district and the highest contribution was also only 1448 tonnes/year in Ejere district. In Tigray study districts the contribution of improved cultivated fodder is less than 25% of the total feed requirement. The overall feed supply to demand ratio in four districts in Tigray eastern zone is 0.64 and 0.92 when utilization efficiency is set at 70 and 100%, respectively. The contribution in SNNP region ranged from 0.0 to 0.9% of the total DM requirements. These low contributions are despite the presence of evidences on the beneficial effects of multi-purpose trees on dry matter intake and body weight gains (Kaitho et al. 1998; Melaku et al. 2004). Fekadu et al (2015) from their work in many parts of Ethiopia identified lack of market oriented specialized livestock production to catalyse forage development, crop-biased extension system, lack of reliable supply of forage seed/planting material and free livestock grazing system as the major factors limiting cultivated forage production and utilization.

Agro-industrial by-products

The contribution of agro-industrial by products to livestock feed balance in the study areas is negligible, particularly in rural areas. This is in agreement with the report of Adugna et al. (2012). AIBPs are available mainly in the urban and peri-urban dairy and fattening systems. The low level of AIB use is mainly due to the high cost, limited availability in the local market, and lack of awareness.

Seasonality of feed availability

Fodder and crop residue availability is governed by seasons of the year, particularly rainfall patterns which are very similar across regions, except in Sidama and some parts of Oromia. Variations in availability of feed resources is not only in terms of quantity but also in the type of feed. During the rainy season, the major feed resources for livestock in Arbegona and Bensa districts are grazing natural pasture supplemented with enset leaf and green feeds while in Gamogofa zone it was grazing and crop residues supplemented with green feeds. Conversely, the contribution of grazing natural pasture during the dry season decreases while grazing on stubble and feeding crop residues increases in Gamogofa zone. In the Sidama highlands, although the dry season covers short period, grazing remains the major source of feed supplemented with enset leaf and stem. In Bona zuria and parts of Bensa district, where there is shortage of grazing land, livestock are supplemented with crop residues as well during the dry season (Figure 10).

Figure 10. Distribution of rainfall and feeding calendar according to respondents' perception in SNNP.

In Amhara (Figure 11), green fodder is more available during the rainy season and immediately after the rainy season whereas crop residues are more abundant immediately following crop harvest. Overall feed biomass availability is higher from July to December whereas the least total biomass is observed from May to June. Strategic feeding management is needed in the zone so that additional feed can be provided for livestock in the months of May and June. In Oromia (Figure 12), crop residues and crop aftermath grazing are the major feed resources to livestock in the dry season. Grazing is a major feed source during the rainy season. In Tigray (Figure 13), green fodders are the major contributors in the months of August, September and October, whereas during the rest of the year crop residues are the major feed sources. Grazing is limited to August-December and the use of AIBPs increases during the dry months. A major non-conventional feed Cactus cladodes is used/available during the months of April and May, May-July, March-May, January-March, January-May and February-May in the districts of Adwa, Ahferom, Laelay Maichew, Atsbi Wemberta, Ganta Afeshum, Kilte Awlaelo and Saesie Tsaeda Emba, respectively.

Figure 11: Available feed resources in North Gondar (top), South Wollo (middle) and West Gojjam (bottom) in Amhara.

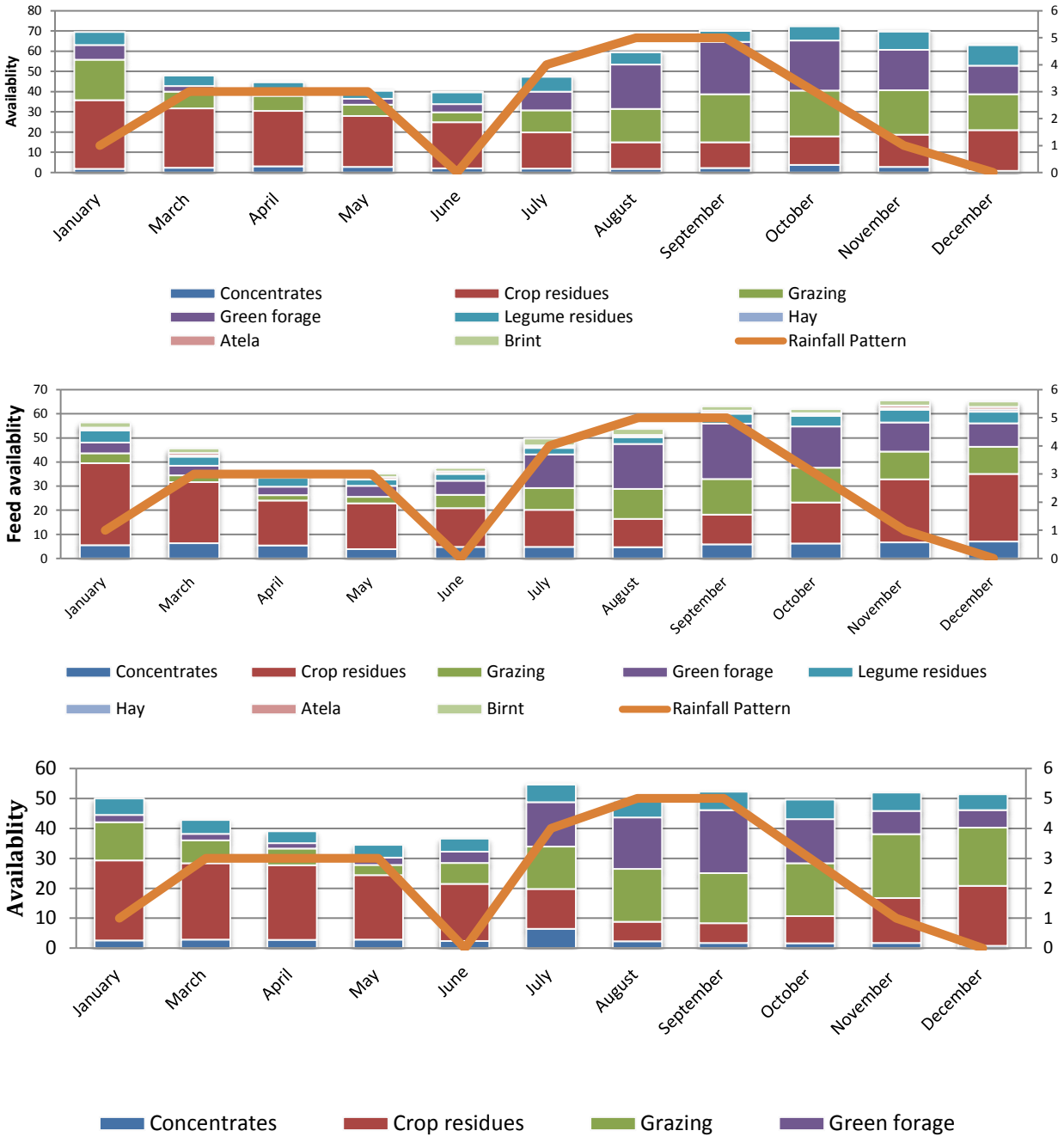


Figure 12. Feed availability in Oromia

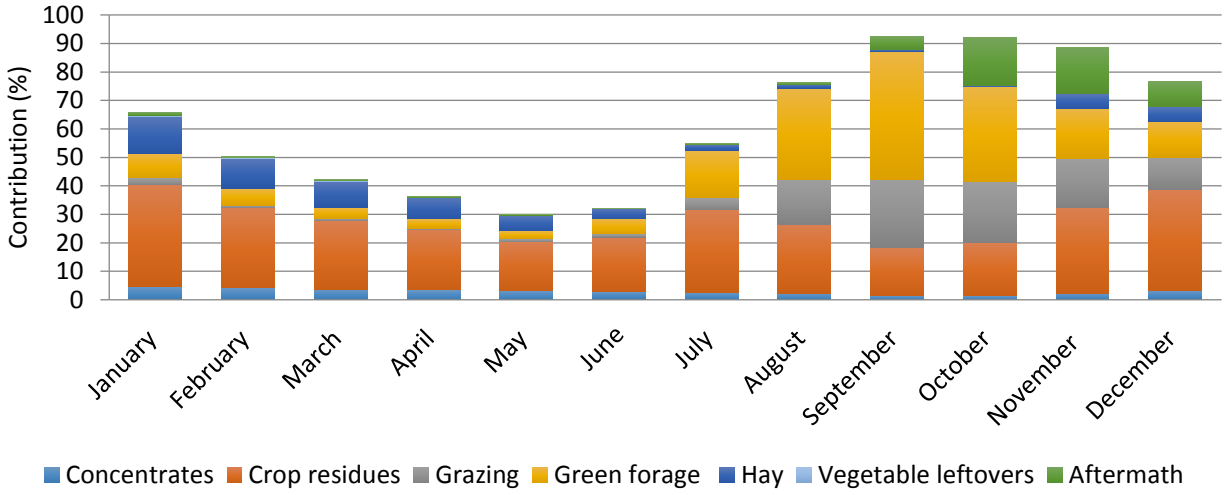
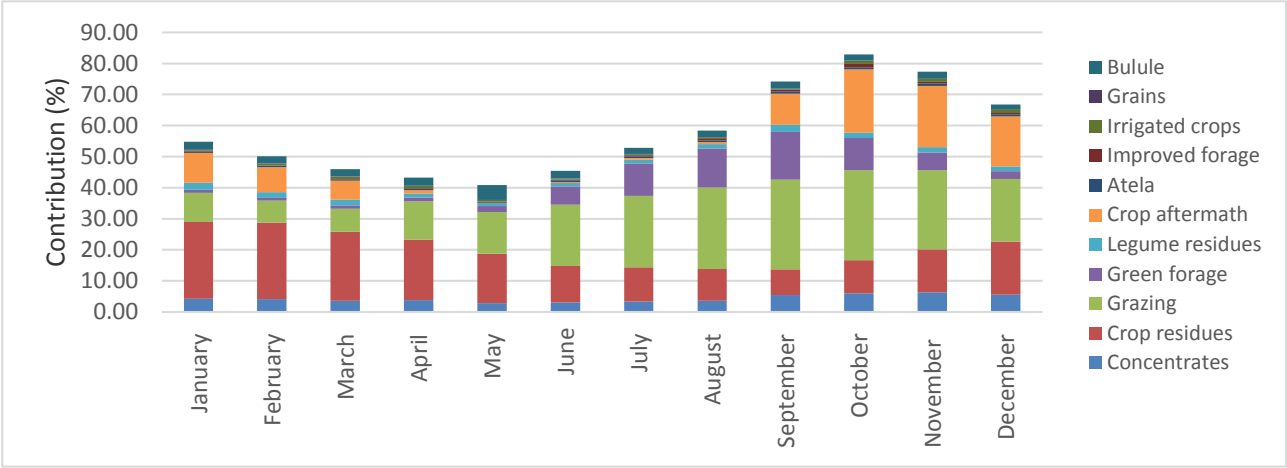


Figure 13. Feed availability in Tigray.



Feed marketing

Feed agribusinesses

Feed marketers/suppliers identified and surveyed in this study were feed traders, cereal processors, traditional cereal/ pulse mills, feed mills, oil extraction plants, traditional cereal mills, large scale hay/straw marketers, small-scale crop residue and green fodder marketers. In Oromia, feed market is relatively more accessible in East Shoa than in West Shoa and Jimma zones. There are 23 cereal and oil cake traders and five straw traders in East Shoa. The big feed suppliers including Lume-Adama union, Umer wheat flour, Addis-Alem agricultural development PLC feed mill, Addis Mojo food oil complex and two large scale hay/straw businesses are located in Mojo town. Livestock feed trading is a new and emerging business in West Shoa zone, with only two feed traders in Ejere and two in Enchini/Ada-Berga were found. No formal feed traders were identified in Jimma zone; and the only available marketed feed is a by-product of traditional grain mills that included blown flour and some left-over grain locally called Bulule. In Tigray, 19 feed traders, three cereal mills and one feed mill were identified. In SNNP, there were very few feed kiosks, flour mills (only in Arbegona district) and concentrate feed processors selling AIBPs and concentrate mixes in Sidama zone. Sidama ELTO farmers' cooperative union is the major supplier of concentrate feeds to the zone, but there is no oil

extraction plant supplying oil seed cakes. There are virtually no AIBPs and concentrate mix traders in Gamogofa zone, the major supply of concentrate feeds coming from Alema Koudjis from Debre Zeit in Oromia. Flour mills, feed processors and oil extraction plants are found in Arbamich town only. In Amhara, the majority of the business (57.1%) are oil processors; the rest are feed traders (28.6%) and pulse mill owners (14.3%) in North Gondar zone; In South Wollo zone, the majority of the businesses (66.7%) are feed traders, the rest are oil processors (11.1%), pulse mills (11.1%) and beer factory (11.1%). In West Gojjam zone, the majority of feed businesses are feed traders (66.7%), the rest are oil extraction owners (8.3%), pulse mill owners (8.3%) and livestock feed processors (16.7%). Most of the businesses are privately owned (83.3%) but few are owned by cooperatives (8.3%) and Union (8.3%).

Most of the feed businesses surveyed are small-scale private feed traders (86.4% in Oromia, 91.3% in Tigray, 77.8% - 85.7% in Amhara). The remaining 8.5%, 1.7% and 3.4% of the businesses in Oromia were partnerships, union/ cooperative and companies, respectively. The cooperative business in Tigray account for 4.1% of the businesses. About 49.2% of the feed marketers in Oromia are licensed businesses, 15.25% are unlicensed, and the traditional grain mills which account for 35.6% of the businesses do not have separate license for feed marketing. More than 95% of the businesses in Tigray were licensed. The majority of the businesses claim to conduct regular feed quality check in Oromia (87.9%) and Tigray (95.5%). In Oromia 18.4%, 8.8% and 25.0% and in Tigray 45.5%, 0.0% and 82.6% claimed to package their products, to label products and to provide advice to customers, respectively. Regular feed quality check is undertaken by most businesses while packing is undertaken by cereal mill, oil mill, feed mill and large-scale hay/ straw (baling) feed businesses. Although businesses claimed to provide advice to customers, only 6.3 and 0.0%, 9.4 and 8.7%, and 19.4 and 9.2% of the surveyed businesses in Oromia and Tigray respectively received training on processing, packaging/labeling and storage, respectively. In Amhara, surveyed businesses mentioned that there is no responsible body to control the quality of feeds. Packaging and labeling of feeds is unknown by all of the respondents. Reasons for lack of practice of packaging and labeling of feed are absence of regulatory body and lack of knowledge and skill on packaging and labeling. Although 60 - 78% of the businesses did not receive any training on feeding of livestock, about 50% of them believe that they are providing adequate advices to customers on how to use the purchased feed for feeding.

Commercial feed supply and prices

The feed types traded in the surveyed districts are hay, green fodder, cereal crop residues, pulse crop residues, mill residues, vegetable and fruit residues, cereal bran, pulse bran, oil seed cakes, and formulated rations. The types of feed traded varied between regions and districts depending on the type of crops grown and the presence or accessibility of cereal processing mills, oil extracting plants, and feed processors. In Amhara region, the major feed types traded in North Gondar zone are oil seed cakes owing to the region's being a major growing area for sesame, Noug and other oil crops and the presence of relatively more number of small-scale oil extraction plants. Oil seed cakes are relatively cheaper in North Gondar Zone than in South Wollo. The average volume of oilseed cakes and cereal bran sold in the zone in 2014 was 450 qt. and 362 qt., respectively, and the average selling prices per qt. were ETB 371.7 and 408.3, respectively. The major buyers of oil seed cakes are farmers (83.3%) followed by primary cooperatives (16.7%). Cereal bran buyers were farmers, primary cooperatives and traders equally. The demand for and hence the price of agro-industrial by-products is higher from March to May in North Gondar and January to May in South Wollo, and drops from July to October/November as green fodder is more available. About 77.8 % of the businesses surveyed fixed the price of feed not based on quality but based on cost of production and profit margin. In South Wollo, the major feeds marketed are hay, green fodder, sorghum stover, AIBP and brewery by-products. AIBPs account for only 3.6% of the purchased feed in the zone. Price ranges for cereal bran and oil seed cakes are ETB 230 – 375 and 250 – 400 per qt. In West Gojjam, the most common type of purchased feed is cereal bran (37.9%) followed by oil seed cakes (27.6%) and pulse bran (13.8%). Price ranges for cereal bran, oil seed cake and pulse bran were ETB 250-375, 300-385 and 400-400 per qt. respectively.

The major marketed feeds in SNNP are wheat bran and oil cakes. The major feeds marketed in Gamogofa zone are standing grass hay collected mainly from bush lands/forest and enclosed area, the major marketing hub for the zone being Arbaminch town. Green fodders like maize stover, green grass, banana stem and leaf, sugar cane top, and limited

volume of improved forages such as elephant grass are also marketed in the zone. In the Sidama highlands, the demand for AIBPs reaches peak from December to March and declines from July to September. However, retail prices remain constant across seasons. Prices (ETB/kg) of wheat bran, concentrate mixes and oil cakes during the survey period were 5.0 (5.6 in Arbegona), 6.0-6.5 and 6.0 (in Arbaminch) to 15.0 (in Bonke district).

Types, quantities and prices of feeds marketed in Tigray and Oromia are presented in Table 15. The largest quantity of wheat bran is traded in Adigrat town and the lowest is traded in Enticho town in Tigray. Similarly, the largest price was paid in Adigrat (probably due to the high demand by the large dairy industry in the area) while the lowest was in Axum town. The peak demand for AIBP is during January-May and the slack period is July-November. Similarly, the demand for and price of AIBPs increases during the dry seasons in Oromia. Wheat bran price is higher in West Shoa (Ejere ETB 452/qt and Enchini ETB 453/qt.) than in East Shoa (Modjo ETB 420/qt and Bora ETB 425/qt, Meki ETB415/qt).

Table 15. Feed types, volume and prices of feeds traded in 2014 in surveyed feed businesses in Oromia and Tiray regions

Product	Oromia			Tigray		
	Quantity Sold (qt)	Selling price ETB/qt	No of Businesses	Quantity Sold (qt)	Selling price ETB/qt	No of Businesses
Bulule*	57.4	295.5	18			
Wheat Bran	7602	413.9	26	4706	356.9	21
Wheat short				559	371	5
Pulse bran				140	425.0	2
Noug cake	1644	650	4	240	810.0	3
Linseed cake	1133.85	1200	13			
Sesame cake				45	1090.0	2
Poultry Feed (layers)	1968	866.6	3			
Mixed concentrate	780	800	2			
Dairy Mix	240	800	1			
Cotton seed cake	672	1250	4	525	680.7	7
Chick pea straw	408	400-450	3			
Teff straw	90.32	250-300	2			
Wheat straw	98	250-300	2			
Wheat and Teff straw	170.4	240-300	2			
Hay (large scale business)	48,000	30-80	2			
Teff straw (large scale)	24,000	20-60	2			
Wheat bran (cereal mills)	10,542	300-460	2			
Cotton seed husk**	25,414.70	360-480	1			
Cotton seed cake**	39,387	400-590	1			
Fattening ration	43,843.84	600-650	1			
Dairy ration	13,153.20	600-650	1			
Layers ration	13,153.20	772.50	1			
Calves ration	657.7	600-650	1			
Heifers ration	657.7	600-650	1			
Pullet ration	1096.1	772.50	1			
Day old chicks ration	219.22	852.0	1			
Broilers ration	219,22	852.0	1			

* By-product traditional cereal mills. ** Mojo oil factory

Demand for purchased feed

A range of customers use purchased feeds, including individual dairy farmers, fatteners, horse/donkey cart owners, cooperatives, and feed retailers. Most of the buyers are farmers. For instance of the total feed businesses surveyed in the seven districts in Tigray, the percentage of businesses who reported farmers, farmers/cart owners/poultry farms, retailers and farmers/retailers as most frequent customers were 43.5%, 39.1%, 8.7% and 8.7%, respectively. In Oromia, 43.9%, 36.8%, 7.5%, 1.8% and 0.0% of the feed businesses surveyed reported selling wheat bran, oil seed cakes, straw/hay, formulated ration, and Bulule (traditional mill by-product) respectively in East Shoa. The corresponding figures

for West Shoa are 23.5%, 35.3%, 0.0%, 41.2% and 0.0%. All businesses in Jimma zone reported selling Bulule only. The average annual quantities of wheat bran and oil seed cakes purchased by a household were 490.3 and 168.7 kg in East Shoa and 332.6 and 199.2 kg in West Shoa. The average quantity (kg/household) of purchased feeds by surveyed households in Amhara and SNNP region is presented in Table 16.

Table 16. Average quantity (kg/household) of purchased feeds by surveyed households in Amhara, SNNP and Oromia regions

Type of feed purchased	N. Gondar	S. Wollo	W. Gojjam	Sidama	Gamogofa	E. Shoa	W. Shoa	Jimma
Barley straw	550							
Naturally pasture - hay	451	447	943	13	26	490	333	
Naturally pasture - green		391	257	4	0.2			
Wheat bran	5	40	23	27	34			
Oil seed cakes	3	2	11			169	199	
Atela	6936		5823					
Brint	120		2917			0.1	2	
Sorghum residue	700	278						
Finger Millet residue	550		438					
Maize residue		5			5			
Maize – green fodder					0.2			
Grass pea straw	126						170	
Tef straw	1450		172				15	
Wheat residue						68	30	
Commercial feed			4					
Mill residue						13	74	26
Sugar cane leaf/top				2				
Banana leaf/stem					0.2			
Improved forage					0.1			

Constraints in feed marketing

The challenges faced by feed suppliers including retailers, oil mills, feed mills, and cereal mills in Oromia are presented in Table 17. The major challenges in feed marketing raised by businesses in Tigray are shortage of finance, inadequate feed supply from producers and lack of technical knowledge in feed formulation.

Table 17: Constraints identified and solutions suggested by feed businesses

Feed business type	Constraints	Suggested solutions
Feed shops/retailers	Lack of storage and marketing shade	Financial provision/credit accessibility
	Limited access to credit	Cooperate on supply (e.g., establishment of common wall shops at visible areas)
	Seasonal price fluctuation	
	Fluctuating supply (e.g., linseed cake)	Improving awareness of farmers on the benefits of concentrate feeds
	Lack of market information	
	Labour shortage	Improving infrastructure to reach high potential areas
	High cost of the feeds affecting demand	Government support to the sector
	Weak support from government office	Strengthening the purchasers
	Weak purchasing power of buyers	Training and awareness about the business
	Inadequate knowledge of the business	Implementing quality control system
	Supply of low quality and spoiled feeds	Increasing the number of suppliers
	Presence of traders in the business who do not pay tax	Market shade provision/establishment
	Transportation problem	Government support to the sector

Feed business type	Constraints	Suggested solutions
Oil, feed and cereal mills	Shortage of raw materials and increased price of ingredients Price fluctuation Light interruption	In the supply of raw materials, better priority given to local factories/market Effort needed in establishing prices Government support to the sector
Large scale hay/ straw traders	Problem related to the acquisition of land for feed production	Identification of sites for feed production Understanding the need of large area for feed production (change of attitude towards land allocation for feed production)

Intervention options

Natural grazing land

Grazing land management and improvement: The intervention is improvement of grazing lands through fertilization and grazing land management practices including cut and carry system. Fertilizers applied were top dressing using commercial fertilizer (urea and DAP) and locally available resources (manure, wood ash, enclosure, and fencing). The approach followed was problem analysis and formulating solutions in district commodity platforms, awareness creation and training of farmers and extension staff, closing communal grazing land by fencing or agreed stock exclusion, and development of bylaws for grazing land closure and use. Interventions were introduced in communal grazing lands and school compounds to increase awareness of the public by focusing on school children. "Grassland Day" and "Pasture Walks" were organized to promote the interventions for farmers, grazing management committees, local leaders, and extension staff. The results are presented in Figure 14 and Figure 15.

Figure 14. Biomass yield (kg/ha) of unfertilized and fertilized grazing lands with ash, manure and chemical fertilizers in Oromia and Tigray states.

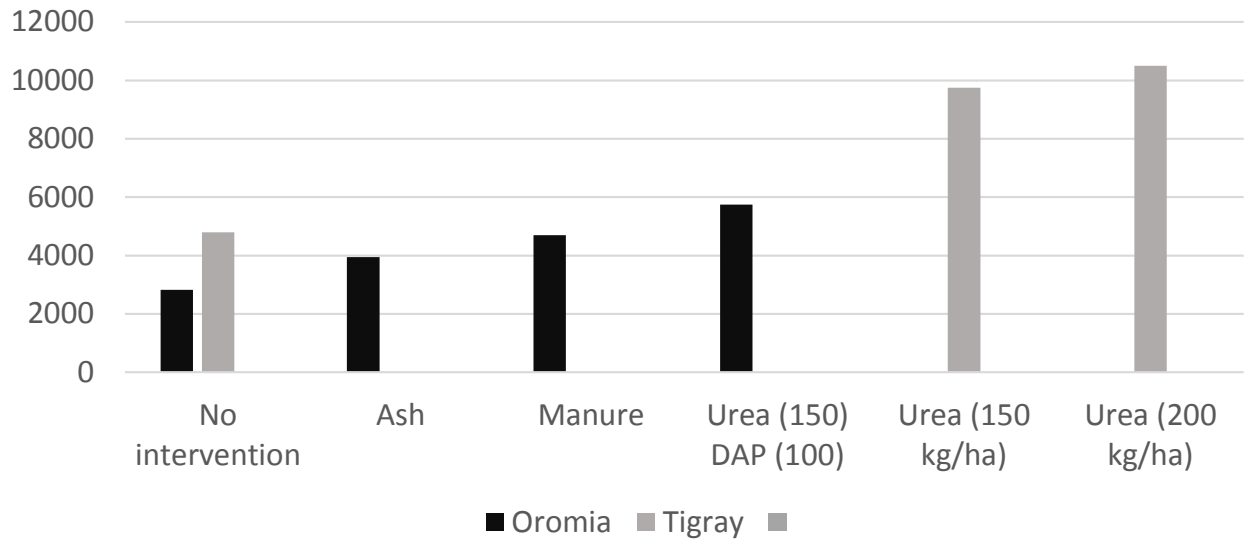


Figure 15. Urea top dressed in communal grazing land (left) and 'Pasture Walk Day' (right) in Adwa district, Tigray.

Feed improvement/utilization

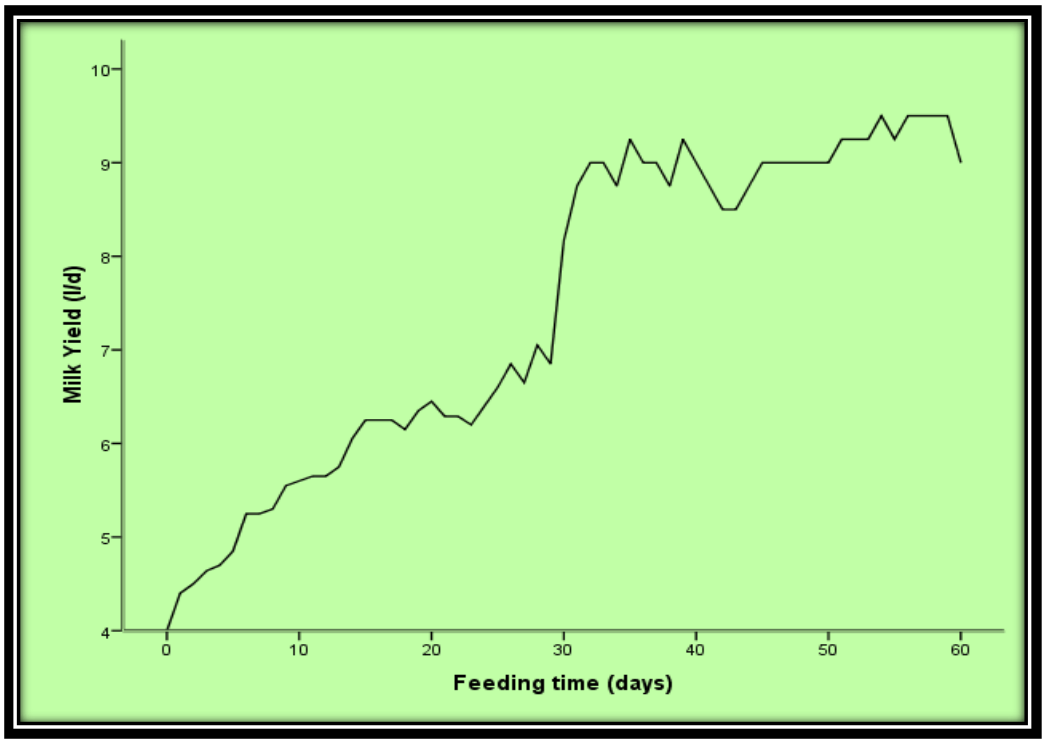
Coarse feed chopping: Feed chopping improved palatability and reduces wastage of coarse feeds such as crop residues. Chopping and chopping machine were introduced by the LIVES project in the four project intervention regions. The machine can be owned by organized groups like dairy cooperatives or individual businesses. A huge demand has been created for the technology. As a result, chopper suppliers have already opened shops at Bahir Dar town. Some dairy cooperatives and private chopping businesses have purchased the machine in Amhara (West Gojjam, North Gondar and South Wollo Zones) and Oromia regions. A chopping businesses have been created at Mecha district. The machine is also used for grinding cereals to formulate concentrate feeds.

Figure 16. Feed chopping and feed chopper machine being demonstrated in West Shoa, Oromia (Left) and a poultry feed processor using chopper/grinder to formulate poultry ration in Bahir Dar, Amhara (Right).

Figure 17. Chopping business using LIVES-introduced chopper was opened in Mecha district (Left) and an ATEVET staff at Dembia district, North Gondar has copied the chopper.

Feed treatment: Four feed improvement and conservation interventions were introduced: Effective micro-organism treatment of crop residues (EM), Urea-molasses treatment of crop residues (UM), and bag silage. EM is used for improving the utilization of low quality roughages and wheat bran (Bokashi) and to reduce farm odor. Urea-molasses treatment of crop residues (UM) improved the feeding quality of crop residues. Bag silage making uses air-tight plastic sheet bags, instead of digging pits as commonly used in pit silage making. This bag technology is also used in urea treatment of feeds instead of pits. Dairy farmers and fatteners who treated teff straw with EM in Lume, Bora, Dugda districts of oromia region have witnessed up to 3 kg improvement in intake/day as a result of improved palatability, increase in water intake by dairy cows which helps to raise milk yield, improved body condition of cows, increased milk yield of 0.5 to 1.5 litres per day, and shorter cattle finishing period. Farmers reported that the technology is relevant for them, simple being ready for use after 24 hours and easily available and cheap. Results from Tigray are presented below in Figure 18 for EM.

Figure 18: Milk production trend in smallholders' dairy cows fed EM treated straw and wheat bran.



Fodder development

Irrigated fodder development: Irrigated fodder development was introduced in high value livestock commodity systems such as dairying and fattening. Alfalfa, Napier grass and other high energy and protein source forages were introduced in SNNP, Tigray, Amhara, and Oromia regions on irrigation plots as well as other fodder development entry points such as farm boundaries. A sample result from Tigray is presented in Table 18.

Figure 19: Backyard farmer managed alfalfa field in Arbegona, SNNP region (Left) and in irrigated plot at Bete Yohanes in Adwa district, Tigray region (Right)

Table 18: Number of farmers growing alfalfa across the seven intervention districts in Tigray

District	No PAs	No. Farmers	Average area (m2)	Yield (kg/m2)	Cutting frequency (days)
Adwa	2	31	292	3.6	20
Ahferom	2	23	205	2.8	17
Laelay Maichew	2	14	167	2.2	20
Atsbi	1	7	57	5.6	15
Ganta Afeshum	2	24	120	0.4	30
Kilte Awlaelo	4	22	1123	0.3	16
Saesi T. Emba	3	30	281	5.1	27
Average	16	151	321	3	21

Farmer based fodder planting material multiplication and farmer to farmer dissemination: Shortage of planting materials is a major constraint for fodder development. A farmer-based planting material multiplication and farmer to farmer distribution was designed and implemented in the four LIVES regions. An example case story from Oromia is presented below. Ijigu Tefera planted Desho and Napier grass on soil and water conservation structure terraces. The zonal LIVES and livestock development office linked the farmer with buyers and he was able to sell Desho grass splits worth ETB 30,000. He also provided 100 elephant grass cuttings, and 100 Dasho grass splits to 11 neighboring farmers. The target distribution was to expand the use of Napier grass in 18 households in Omotucho PA in Kersa district of Oromia.

Strengthening seed/seedling production in public nurseries: The intervention is the production of bee flora planting material and backyard growing of bee flora by farmers. Bee flora seedlings were raised in two farmers' training centers (FTC). The flora chosen were fast growing and pollen and nectar rich plants such as Becium grandiflorum (Tebeb), Leucas abyssinica (Sewa Kerni), Vernonia amygdalina (Grawa) and Hypoestes forskaolii (Gerbia). About 10,000 seedlings of various types were produced in public nursery and distributed to beekeepers (31 male and 4 female bee keepers) and two FTCs. A farmer was able to plant up to 500 seedlings on average. In those farms honey yield increased by 3–5 kg and honey quality/colour improved. Colony strength also improved substantially due to proper feeding of honeybees during the early part of the dearth period.

Figure 20: Seedlings of Becium grandiflorum produced by farmer (left) and at a public nursery (right) in Adwa district, Tigray.

Concentrate Feed delivery system

Access to concentrate feeds is limited for most rural areas. For instance, in LIVES project intervention districts in Sidama and Gamogofa zones, there were no feed shops to supply commercial concentrate feed (formulated feed and ingredients). According to LIVES baseline study in 2014, commercial concentrate and ingredients such as wheat bran and oil seed cakes was used by only 1.6% of the households from the total livestock keepers in the two zones. Cognizant of the situation described above, the LIVES project has introduced interventions to facilitate access to high quality concentrate feeds by smallholder farmers. The intervention has improved access of smallholder farmers to high quality feeds (commercial concentrates) by initiating small-scale feed shop businesses and initiating small-scale feed processing plants to formulate rations in district towns which are far away from centres of commercial feed processing plants. The approach included multi-stakeholder platforms, capacity development, and opening feed shops and linking them to commercial feed suppliers and livestock producers, and enabling small-scale district-level feed processors and suppliers. The results are presented in Table 19.

Table 19. Feed shops opened with the initiation and support of LIVES project in LIVES intervention districts

Region	District/town	Feed Business name	Gender	Structure	Support
	Bona	Chebicho feed trading	Male	Private	LIVES initiated
SNNP	Arbegona	Alemitu feed retailer	Female	Private	LIVES initiated
	Bensa	Adanech	Female	Private	LIVES initiated
	Arbaminch	Feker shemachoch	cooperative	Cooperative	LIVES initiated
	Arbaminch	Musa feed retaining business	Male	Private	LIVES initiated
	Bonke	Mulu feed retailer	Female	Private	LIVES initiated
Oromia	Meki	Abebe Girazmach and Birtukan Dula	Couple	Private	LIVES initiated
	Modjo	Abu Shuku and Bote	Male	Private	LIVES initiated
	Modjo	Abu Shuku and Bote	Male	Private	LIVES initiated
	Alemtena	Kamil Bashir	Male	Private	LIVES initiated
Amhara	Bahir Dar	Ato Andargie		Private	LIVES initiated
	Bahir Dar	Metebaber feed processing		Cooperative	LIVES initiated
	Bahir Dar	Aba Wongelle feed processing		Private	LIVES supported
	North Gondar	Kindu feed processing and supply		Private	LIVES initiated
	North Gondar	Sisay feed processing and supply		Private	LIVES initiated

Locally formulated concentrate feeds: LIVES project provided training and continuous coaching and mentoring on balanced ration formulation to new feed processing businesses in Amhara region. On the top of that linkages were created among formulated feed suppliers and dairy farmers. There have also been study tours to major feed processing centres in the country such as Alema Cudjis Kudijs and mojo feed processing plants. Some of the businesses initiated by LIVES above mentioned intervention approaches include Ato Andargie, Metebabir Feed processing cooperative in West Gojjam and Ato Kindu and Sisay in North Gondar. They are now serving as major suppliers of formulated feed in the region at affordable price.

Figure 21: Andargie's small-scale feed processing unit in Bahir Dar town

Conclusions and recommendations

Conclusion

This study identified diverse feed resources in the various agro-ecological zones and geographic regions in the highlands of Ethiopia. There is a considerable variation in availability of feed resources, utilization and management in the four highland regions studied. The major livestock feed is crop residues in Oromia, Amhara and Tigray and grazing lands and crop residues in SNNP. The contribution of cultivated forage, hay and AIBPs is small in all regions. Although crop residues are abundant, their utilization is low due to wastage, late harvest and lack of feed improvement technologies. Grazing land size is shrinking. Grazing land management is largely poor. Forage genetic material multiplication sites are not supported by proper research and are operating with insufficient budget and manpower, and the overall management does not guarantee production of quality planting materials. The use of AIBPs is limited due to availability and cost. Fodder development is also limited. Feed marketing is constrained by several factors. The available feed resources do not meet the maintenance requirements, let alone for production, of the livestock populations in most of the districts surveyed. Although there is shortage of feed in general, there are feed resources that are available but underutilized due to improper collection, conservation, storage and low adoption of feed quality improvement technologies. The effective interventions in feed development, improvement, utilization and efficient delivery of commercial feeds to smallholders presented in this paper are applicable in the highlands of Ethiopia under smallholder condition and need to be scaled out to fill the gap in the current feed balance.

Recommendation

Grazing land policy: Land policy needs to consider grazing lands. The current policy largely focuses on conservation of hill side grazing lands through stock exclusion closure areas. This need to consider effective fodder development and utilization in closed hillsides. The feed development component of closure areas does not seem well implemented. Conservation should not override people's livelihoods and economic development which should be the centerpiece of conservation. Rational grazing land utilization options need to be considered depending on the livestock production system. For intensive systems, cut-and-carry system with hay production from grazing lands could be a feasible strategy for intensive system. Grazing lands are a major source of animal feed, particularly in extensive systems; cut-and-carry systems may not be appropriate in extensive systems where large breeding flocks and herds are kept. While there are currently a number of livestock development projects operating in the country, almost all are animal commodity oriented although they do have feed component. There seems to be a need for a flagship 'Grazing land program' which would address challenges in extensive mid-highland system. Fertilization of grazing lands has proven to be effective and feasible. This intervention needs to be scaled out, particularly in intensive dairy and fattening systems.

Crop residue management and improvement: The post-harvest period is the most critical period to consider in relation to crop residues and harvested hay management and utilization. There is a need to identify cost effective storage designs and for regular application of best crop residue improving options. In some districts the use of urea is recommended and in others supplementation with AIBPs in the form of mixed total ration is justified. The knowledge and capacity of smallholder farmers should be strengthened by skill training and continual coaching and mentoring

sessions. Demonstrating the importance of on-farm testing of known crop residue improving technologies through research for development is essential.

Fodder development: The challenge in cultivated fodder production is the reluctant of farmers to allocate crop lands for forage production. Various entry points need to be identified and utilized for fodder production. Irrigated fodder development on crop plots has been found feasible in some areas. This need to be scaled up targeting high value livestock development such as dairying and fattening. Another intervention would be introduction of fodder in various entry points such as under fruits trees and dual purpose food-feed production.

Fodder planting material delivery: Strengthening and/or establishing forage multiplication sites/FTCs in potential PAs, and encouraging private businesses to be involved in forage seed development. Mechanisms for forage seed marketing needs to be examined as the absence of proper marketing system is discouraging farmers who are involved in the business. Reliable source of planting materials is important and farmers should be encouraged to produce forage seeds and mechanism need to be devised for farmer-to-farmer seed dissemination. Nursery sites have to be supported by research, budget and capacitated manpower to guarantee production of quality planting materials. Knowledge of farmers about management and utilization of introduced forage crops should be upgraded.

Alleviate feed marketing constraints: AIBPs are not widely used by all livestock farmers, especially those located in the rural production systems. A delivery mechanism need to be created to facilitate access of smallholders to AIBPs. Targeting feed traders in capacity development and knowledge management events can improve the quality and delivery of AIBPs gaps. Interventions in food safety need also to be considered since food safety problems, particularly aflatoxin in animal feeds (Dawit et al. 2016), has become a major issue recently in the dairy industry.

Research on feed utilization: A priority research area in the face of unavailability and high cost of commercial formulated rations from the big feed processors could be development of rations based on locally available resources. Strategic research incorporating crop residue quality in to crop variety research could also be considered.

References

Aklilu, Y., Little, P.D., Mahmoud, H. and McPeak, J. 2013. *Market access and trade issues affecting the dry lands in the Horn of Africa.* Brief prepared by a Technical Consortium hosted by CGIAR in partnership with the FAO Investment Centre. Technical Consortium Brief 2. Nairobi: International Livestock Research Institute.

Behnke, R. 2010. *The Contribution of Livestock to the Economies of IGAD Member States: Study Findings, Application of the Methodology in Ethiopia and Recommendations for Further Work*. IGAD LPI Working Paper 02-10. Odessa Centre, IGAD Livestock Policy Initiative, Great Wolford, UK.

BoANRD (Bureau of Agriculture and Natural Resources Development). 1997. *Tigray livestock development action program*. Executive Summary. BoANRD, Mekelle, Ethiopia.

Chalisia, G., Mekasha, Y. and Urge, M. 2014. Feed resources quality and feeding practices in urban and peri-urban dairy production of southern Ethiopia. *Tropical and Subtropical Agroecosystems* 17:539–546.

De Leeuw, P.N. andTothill, J.C. 1990. *The concept of rangeland carrying capacity in Sub Saharan Africa-myth or reality*. Pastoral Development Network Paper 29b. Overseas Development Institute, London.

Duncan, A., York, L., Lukuyu, B., Samaddar, A. and Stür, W. 2012. *Feed Assessment Tool (FEAST): A systematic method for assessing local feed resource availability and use with a view to designing intervention strategies aimed at optimizing feed utilization*. Questionnaire for Facilitators (Version 5.3); updated: 15 June 2012. Addis Ababa, Ethiopia: ILRI.

Ebro, A. Nsahlai, I.V., Yami, A. and Umunna, N.N. 2004. Effect of supplementing graded levels of Forage Legumes on performance of crossbred calves fed tef (Eragrostis tef) straw. *J. appl. Anim. Res.* 26:107–112.

FAO (Food and Agriculture Organization of the United Nations). 1987. *Master Land Use Plan, Ethiopia: Range/Livestock consultancy report.* Report prepared for the Government of the People's Democratic Republic of Ethiopia. AG/ ETH/82/010 Technical Report. FAO: Rome. Italy.

FAO (Food and Agriculture Organization of the United Nations). 1984. *Master Land use Plan, Ethiopia Range/Livestock Consultancy Report* prepared for the government of the People's Democratic Republic of Ethiopia. Technical Report AG/ETH/82/010. FAO: Rome, Italy. 94p.

Feyisa, F. 2007. *Grazing Land Management, Forage Production and Utilization Methods.* Ethiopian Livestock Production Professionals Association.

Feyissa, F., Assefa, G., Kebede, G., Mengistu, A., and Geleti, D. 2015. Cultivated forage crops research and development in Ethiopia: In: Alemu Yami, Getnet Assefa and Lemma Gizachew (eds). In the *Proceedings of Pasture and rangeland research and development in Ethiopia*. 89–118.

Gebremedhin, B.; Hirpa, A.; Berhe, K. 2009. *Feed marketing in Ethiopia: results of rapid market appraisal.* IPMS Working Paper 15. Addis Ababa (Ethiopia): ILRI.

Gizachew, D., Szonyi, B., Tegegne, A., Hanson, J. and Grace, D. 2016. Aflatoxin contamination of milk and dairy feeds in the Greater Addis Ababa milk shed, Ethiopia. *Food Control*, 59:773–779.

Gizaw, S., Hoekstra, D., Gebremedhin, B. and Tegegne, A. 2015b. *Classification of small ruminant production sub-systems in Ethiopia: Implications for designing development interventions.* LIVES Working Paper 5. Nairobi, Kenya: International Livestock Research Institute (ILRI).

Gizaw, S., Megersa, A., Muluye, M., Hoekstra, D., Gebremedhin, B. and Tegegne, A. 2016. *Smallholder dairy farming systems in the highlands of Ethiopia: System-specific constraints and intervention options*. LIVES Working Paper 23. Nairobi, Kenya: International Livestock Research Institute (ILRI).

Janke, H.E., 1982. *Livestock production systems and livestock development in tropical Africa.* Keil, West Germany: Kieler Wissenchafts Verlaguavk.

Kaitho, R.J., Umunna, N.N., Nsahlai, I.V., Tamminga, S. and Van Bruchem, J. 1998. Utilization of browse supplements with varying tannin levels by Ethiopian Menz sheep 1. Intake, digestibility and live weight changes. *Agroforestry Systems* 39:145–159.

Kossila, V. 1984. Location and potential feed use. In: Sundstøl, F. and Owen, E. (Eds.). *Straw and other fibrous by products as feed*. Amsterdam, the Netherlands: Elsevier Science Publishers B.V. 14:4–24.

Lemma, G. and Smit,G.N. 2005. Crude protein and mineral composition of major crop residues and supplemental feeds produced on Vertisols of the Ethiopian highland. *Animal Feed Science and Technology* 119:143–153.

Mekasha, Y., Biazen, B., Tegegne, A., Shewage, T., Zewdie, T. and Tera, A. 2015a. Spatio-Temporal Dynamics of Natural Grazing Lands and Livestock Holding in Sidama Highlands of Southern Ethiopia: Implications for Sustainable Grazing Land Development. *Journal of Agricultural Engineering and Biotechnology* 3(3):109–119.

Mekasha, Y., Biazen, B., Tegegne, A. and Shewage, T. 2015b. Participatory evaluation of herbage composition, biomass yield and management practices of natural grazing lands in Sidama highlands of Southern Ethiopia. In: Roy, A.K., Kumar, R.V., Agrawal, R.K., Mahanta, S.K., Singh, J.B., Das, M.M., Dwivedi, K.K., Prabhu, G. and Shah, N.K. (eds.) *Sustainable use of Grassland Resources for Forage Production, Biodiversity and Environmental Protection*. Extended abstract, 23rd International Grassland Congress, 20–24 November 2015. New Delhi, India.

Nurfeta, A., Eike, L.O., Tolera, A. and Sundstol, F. 2008. Chemical composition and in-sacco dry matter degradability of different morphological fractions of 10 enset (Enset ventricosum) varieties. *Animal Feed Science and Technology* 146:55–73.

Solomon. M., Peters,K. J.and Tegegne, A. 2004. Effects of supplementation with foliages of selected multipurpose trees, their mixtures or wheat bran on feed intake, plasma enzyme activities, live weight and scrotal circumference gains in Menz sheep. *Livestock Production Science* 89:253–264.

Tadesse, D., Urge, M., Animut, G. and Mekasha, M. 2016. Growth and carcass characteristics of three Ethiopian indigenous goats fed concentrate at different supplementation levels. *Springer Plus* 5:414.

Tegegne, F. and Assefa, G. 2010. F*eed Resource Assessment in Amhara National Regional State, Ethiopia Sanitary and Phytosanitary Standards and Livestock and meat Marketing Program (SPS-LMM)*. Addis Ababa, Ethiopia: USAID.

Tesfaye, A. and Chairatanayuth, P. 2007. *M*anagement and feeding systems of crop residues: the experience of East Shoa zone, Ethiopia*. Livestock Research for Rural Development* 19(3). http://www.lrrd.org/lrrd19/3/tesf19031.htm.

Tesfaye, Y. 2010. *Feed Resources Availability in Tigray Region, northern Ethiopia, for production of export quality meat and livestock.* Ethiopia Sanitary and Phytosanitary Standards and Livestock and Meat Marketing program *(SPS-LMM)*. Addis Ababa, Ethiopia: USAID.

Tolera, A. 2007. *Feed resources for producing export quality meat and livestock in Ethiopia, examples from selected Woredas in Oromia and SNNP regional states*. Ethiopia Sanitary and Phytosanitary Standards and Livestock and Meat Marketing Program (SPS-LMM). Addis Ababa, Ethiopia: USAID.

Tolera, A. and Said, A. N. 1994. Assessment of feed resources in Welayita Sodo. *Ethiop. J. Agric. Sci.* 14:69–87.

Wondatir, Z. 2010. *Livestock production system in relation to feed availability in the highlands and central rift valley of Ethiopia*. M.Sc. Thesis. Haramaya Uninversity. Dire Dawa, Ethiopia.

Yadessa, E. , 2015. *Assessment of feed resources and determination of mineral status of livestock feed in Meta-Robi district, west Shoa zone, Oromia Regional State, Ethiopia*. MSc thesis submitted to the Graduate School of Ambo University, Ambo, Ethiopia.

Yami, A., Sileshi, Z. and Bediye, S 1991. The Potential of Crop Residues and Agro-Industrial By-Products as Animal feed. In: *proceedings of ESAP, 3rd National Improvement Conference*. 24-26 May 1989. IAR, Addis Ababa, Ethiopia. pp. 57–63.

Yeshitila, A., Tessema, Z. and Tegegne, A. 2009. Availability of livestock feed resources in Alaba Woreda, Southern Ethiopia. In: Tamrat Degefa and Fekede Feyissa (Eds). Ethiopian Society of Animal Production (ESAP) 2009. In: *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, 8–10 October 2008. Part II Technical Session. ESAP, Addis Ababa, Ethiopia. pp 21–32.

ISBN 92–9146–501–1

Livestock and irrigation value chains for Ethiopian smallholders project aims to improve the competitiveness, sustainability and equity of value chains for selected high-value livestock and irrigated crop commodities in target areas of four regions of Ethiopia. It identifies, targets and promotes improved technologies and innovations to develop high value livestock and irrigated crop value chains; it improves the capacities of value chain actors; it improves the use of knowledge at different levels; it generates knowledge through action-oriented research; and it promotes and disseminates good practices. Project carried out with the financial support of the Government of Canada provided through Foreign Affairs, Trade and Development Canada (DFATD). lives-ethiopia.org

The International Livestock Research Institute (ILRI) works to improve food security and reduce poverty in developing countries through research for better and more sustainable use of livestock. ILRI is a CGIAR research centre. It works through a network of regional and country offices and projects in East, South and Southeast Asia, and Central, East, Southern and West Africa. ilri.org

The International Water Management Institute (IWMI) is a non-profit, scientific research organization focusing on the sustainable use of water and land resources in developing countries. It is headquartered in Colombo, Sri Lanka, with regional offices across Asia and Africa. IWMI works in partnership with governments, civil society and the private sector to develop scalable agricultural water management solutions that have a real impact on poverty reduction, food security and ecosystem health. IWMI is a member of CGIAR, a global research partnership for a food-secure future. iwmi.org

CGIAR is a global agricultural research partnership for a food-secure future. Its research is carried out by 15 research centres in collaboration with hundreds of partner organizations. cgiar.org

Foreign Affairs, Trade and Development Canada
Affaires étrangères, Commerce et Développement Canada