

# Feed resources availability, utilization and marketing in central and eastern Tigray, northern Ethiopia



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# Acronyms

AIBP	Agro-industrial by-products
CSA	Central Statistical Authority
FTC	Farmers' training centre
FEAST	Feed Assessment Tool
LIVES	Livestock and irrigation value chains for Ethiopian smallholders
PA	Peasant association
TLU	Tropical livestock units

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## Summary

This survey explored the situation of different feed resources for ruminant livestock in two zones (central and eastern) in Tigray region of northern Ethiopia. These two zones account for the region's 12% of the total land mass, 23% of the human population, 28% of the cattle population, and 56% of the small ruminant population. Farmers feed their livestock a variety of feed resources that range from crop residues to non-conventional feeds.

The overall contribution of crop residues exceeds 50% of the livestock feeds currently used by smallholder farmers, and this reflects the level of integration between crop and livestock farming. About 63% (2,038,046 qt) is contributed from the eastern zone and the remaining 37% (1,199,947 qt) from the central zone districts. Wheat residue is by far the most dominant and accounted for about 41% of the total residue. About 66% of the 146,890 qts pulse residue produced in the two zones is from the eastern zone districts, with faba bean dominating all pulses across the seven districts.

The total harvested hay is 666,925 of which 331,339 tonne is collected from the eastern zone. Storage condition for hay is generally poor. Most farmers store it in open fields which leads to rapid deterioration in the feeding quality.

Cultivated forage crops growing in the study districts are sesbania, leucaena, Napier grass, alfalfa, tree lucerne, vetch, cowpea, lablab and pigeon pea. Of these species sesbania, leucaena, and Napier grass are frequently used for feeding livestock. Forage productivity is generally low, on average about 430 kg/ha, and this contribution is less than 25%. About 39% of the surveyed peasant associations (PAs), 11 out of 28, 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.

The availability of agro-industrial by-products (AIBP) as feed supplement varies across districts. According to the response from the participants involved in the discussions, AIBPs were more available in the eastern zone than in the central zone. The most pervasive AIBP is wheat bran. About 63% of the discussants in the eastern zone rated it as medium. Non-conventional feed resources used in both zones include *atella*, vegetable leftovers and cactus. *Atella* and vegetable rejects are reported to be more available in the central zone while cactus is an important livestock feed abundantly available in the eastern zone. Urea treatment of crop residues, silage making, and UMMNB as a source of protein and energy supplements are not usually used by farmers. Lack of finance, limited knowledge and stable supply of molasses were mentioned as reasons for not widely using such technologies.

In conclusion, the management and utilization of crop residues with particular attention to collection and transportation is constrained by factors such as labour shortage, distance from harvesting field to animals and delayed harvest in the project districts. Grazing land management and improvement is seldom considered by farmers or the extension system. Acute shortages of AIBPs supply from the sources and high price fluctuation in the main towns of the districts are discouraging smallholder dairy and small ruminant farmers from using them on a regular basis. The contribution of improved forage plants is not to one's expectation and forage genetic material multiplication sites are operating with insufficient budget and manpower, and not supported by proper research. The overall feed supply to demand ratio in four districts in the eastern zone is not enough to cover the annual maintenance requirements of the present stock.

# I. Introduction

## I.1 Background

Feed is the single most important factor determining the productivity and marketability of livestock products. Smallholder livestock production in Tigray region is dependent on a variety of crop residues, grass hay, grazing/browsing, agro-industrial by-products, and improved forage species.

Within the limits of agro-ecology, the availability of crop residues is associated with the farming system, one's favourite crops, and intensity of agronomic practices. In 2013/2014 harvest season, about 2.9 million tonnes cereal (teff, barley, wheat, maize, sorghum and finger millet) and 59,000 tonnes pulse (faba bean, field peas, chick peas, lentils and fenugreek) residues are harvested (CSA 2013/2014). In Tigray region, the contribution of crop residues to livestock feeding is about 45% (BoANRD 1997). Stubble grazing is an important source of feed common in Tigray and can yield up to 0.5 tonne DM/ha (FAO 1987), although this too is largely determined by the inherent productivity of the land, crop type, and other environmental variables.

Grazing lands are steadily shrinking in size due to the conversion of prime grazing lands to crop lands. In areas where their relative abundance is still significant, grazing lands are restricted to marginal areas with low farming potential such as hill tops, swampy areas and roadsides. The progressively smaller agricultural holdings are particularly evident in the mixed farming highlands where the bioclimatic conditions are relatively favourable for crop farming. Due to the lack of a coherent land use policy, vast grazing lands in the central zone are already converted to crop fields. The size of grazing lands in most districts in the eastern zone is by far better than is the case in the central zone. The individualization of grazing lands in combination with prevalence of drier environment in the eastern zone might have contributed to valuing and maintaining grazing lands.

In Tigray region, several introduced forages are tested on-station in different ecological zones and considerable efforts were made to test the adaptability of different species of pasture and forage crops under varying agro-ecological conditions. A number of useful forages have been selected for different zones, although the adoption rate is extremely low. Introduced forages have been grown in farmers' training centres (FTCs), farmers' arable lands, and in wastelands. The overall success rate, measured in terms of improved animal production and income, is below expectation.

Despite the fact that smallholder mixed crop-livestock farmers use diverse feed resources, inadequate and poor quality feed supplies continue to be major challenges. 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. This survey seeks to contribute towards filling in this gap in selected Livestock and irrigation value chains for Ethiopian Smallholders (LIVES) action districts in central and eastern Tigray in northern Ethiopia. The survey tries to concisely articulate and quantify the current feed resources, potentials for improvement and constraints hindering efficient utilization of feed resources for market oriented livestock development.

## 1.2 Objectives

The objectives of this feed assessment survey were to:

1. Assess available livestock feed resources in the project districts/zones
2. Identify and document improved forage genetic resources in the project districts/zones
3. Assess livestock feed agri-business
4. Estimate the total livestock feed requirements and determine the deficit/surplus in the project districts/zones
5. Identify research and/or development potential interventions and action research on those interventions

## 2. Methodology

### 2.1 Survey districts and peasant associations

The survey was carried out across the seven action districts located in the central (Ahferom, Adwa and Laelay-Maichew) and eastern (Atsbi-Womberta, Ganta-Afeshum, Kilte-Awlaelo and Saese-Tsaeda-Emba) zones. In each district, four potential peasant associations (PAs) with potential for feed production were included. Table 1: show the names of PAs and land use/cover for each district.

Table 1: District level land use/cover and a list of selected study PAs

District	Land use/cover (ha)					Selected PAs
	Forest	Arable	Grazing	Residential	Other	
Adwa	43,651	13,714	5085	1481	4600	Mariam Shewito, Debregenet, Gendebta and Betehanes
Ahferom	47,216	24,458	29,738	8950	23,617	Sero, Endamariam Agamo, and Laelay Migaria Tsemri
Laelay Maichew	13,761	14,552	4405.5	1231.75	8397.5	Dura, Medego, Dereka and Adi Tsehafi
Atsbi-Womberta	112,845	13,059.3	7588		13,604	Barka Adisebha, Adi Mesanu, Golgol Naele and Habes
Ganta Afeshum	11,949	10,559	4106		5288	Hadnet, Wuhdet, Golagenahiti and Sasun
Kilte Awlaelo	53,634	19,809.5	7930.9		42,148.5	Genfel, Aynalem, Negash and Mesanu
Saese Tsaeda Emba	7500	20,127	12,791	4509.4	118,886.9	Guila Abenea, Hadinet Maimegelta and Tseqanet

### 2.2 Data collection and analysis

Data on various feeds were collected using PA group discussion, individual interviews and discussion with district experts. Individual interviews were organized for 63 smallholder farmers who represented small, medium and large land holdings as perceived by each district (Table 1). Cultivated land holdings of less than 0.5 ha was considered as small, 0.5–1 ha as medium and >1 ha as large. Information collected was analysed using the spreadsheet program Feed Assessment Tool (FEAST) (Duncan et al. 2012). Details of the FEAST questionnaire is presented in Annex 1.

Data on amount of feed, land used for feed production, feed management and utilization, and feed prices were collected using group discussion, individual interviews and discussion with district experts. In total 28 group discussion sessions with 140 smallholder farmers were held. The discussion with district livestock experts (21) was used to

triangulate information obtained from the group discussion, and get an understanding of the feed situation at district level. For the feed agribusiness interview, 23 feed traders and flour mill operators were interviewed.

An estimation of crop residues was obtained by considering the average crop production of two recent harvest seasons (2013/2014 and 2014/2015) and applying appropriate conversion factors (FAO 1987). Based on FAO (1987), the following assumptions were made: The contribution of stubble grazing was estimated by assuming a yield of 0.5 tonne/ha; browses species 1.2 tonne/ha; and the productivity of natural grazing lands was assumed to be 2 tonne DM/ha, irrespective of ownership type.

The current feed demand was estimated by considering all ruminant livestock species reported by the district office of agriculture and converting to tropical livestock units (TLU).

The following assumptions were made when computing the feed balance:

- One TLU requires 2.5%/day feed~23 qt/year
- As suggested by Abegaz et al. (2007), efficiency of utilization of feeds is estimated at 70% and full (100%)
- Based on empirical evidences in the field, the number of Napier grass cuttings that can cover 1 ha land is 10,000, and the number of tree legumes that can be supported in 1 ha land is 2500
- Secondary information available in the district and regional agricultural and rural development bureau was extensively used. Data available in the Central Statistical Authority (CSA) was also used.



## 3. Results

### 3.1 Crop residues and aftermaths

Crop residues are by far the most common feeds found in all surveyed districts, and the overall contribution exceeded 50% of the livestock feeds currently used by smallholder farmers.

#### Availability of cereal and pulse residues

In the central and eastern zones, the average cereal crop residues produced was 1,199,947 and 2,038,046 quintals, respectively (63% contributed from eastern zone districts). 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. Table 2 shows estimated crop residue yields for each district. A less common crop in other parts of Ethiopia but widely farmed in the central and eastern zones of Tigray is *hanfets*. This crop inherits the characteristics of wheat and barley, and its contribution to livestock feeding is almost 15%.

Table 2: Estimated cereal residue production (qt) in the central and eastern zones in Tigray

District	Type of residue*							Total
	<i>Teff</i>	Barley	Wheat	Maize	Sorghum	Finger Millet	<i>Hanfets</i> <sup>+</sup>	
Adwa	6208	645	5438	2012	1992	1949	1395	19,639
Ahferom	91,719	14,856	196,209	23,232	46,279	20,948	37,704	430,947
Laelay Maichew	223,303	38,163	172,622	103,727	16,5994	45,552	0	749,361
Atsbi-Womberta	6149	164,400	293,923.5	30,008	0	2099	229,310	725,888
Ganta Afeshum	7980	75,638	206,827	25,320	23,748	11,428	41,162	392,103
Kilte Awlalo	17,624	64,600	211,175	25,952	0	27,218	91,295	437,864
Saesie Tsaeda Emba	14,157	120,353	234,750	36,632	0	8662	67,641	482195

\*Based on average of recent two years crop yield data; +A mixture of wheat and barley

The total pulse residue is estimated at 146,890 quintals, about 66% of it contributed by the eastern zone districts (Table 3). Faba bean is the most dominant crop (contributed about 61%) across the seven districts.

Table 3: Estimated pulse residue production (qt) in the central and eastern zones in Tigray

District	Faba bean	Field peas	Chick peas	Lentil	Fenugreek	Total
Adwa	495	22	11	27	--	555
Ahferom	12,485	1552	270	2369	124	16,800
Laelay Maichew	25,139	1267	3787	1952	673	32,818
Atsbi-Womberta	24,252	14,334.6	--	4723.2	--	43,309.8
Ganta Afeshum	16,787	5280	--	7206	--	29,273
Kilte Awlalo	2769	602	1547	860	306	6084
Saesie Tsaeda Emba	8062	7519	1208	1263	--	18,052

## Management, utilization and improvement

The way smallholder farmers manage and use their crop residues is summarized in Tables 4 and 5. The management of crop residue reflects the way smallholder farmers collect, transport, store, and feed to their livestock, and attempt to improve its nutritional quality using proven practices. Invariably a common crop residue storage practice observed across the seven districts is that farmers are insensitive to a progressive decline in the feeding value of crop residues stored outside without any protection. In some districts (Atsbi, Laelay Maichew and Saesie Tsaeda Emba), improper stacking that exposed crop residues to termite damage was significant. Late storage that sometimes extends up to 3–5 months after the harvest of the main crop was also observed in some districts. This inevitably leads to a large amount of wastage due to hoof trampling and loss to wind, notwithstanding the rapid loss of nutrients due to rain and curing process (Picture 1).

Picture 1: Poor storage of crop residues in an open field in Ahferom (left) and top of mud house in Atsbi (right).



Farmers' current practices used to improve crop residues include mixing with other feeds and serving a mixed feed to livestock. In the eastern zone where cactus is a common backyard crop, cladodes are manually chopped and mixed with wheat straw. In the central zone and to some extent in Atsbi, supplementing low quality residues with green feed and providing water/*atella* soaked wheat bran and oilseed cakes is a common strategy of improving the edibility of crop residues.

Table 4: Management of crop residues in the central and eastern zones

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 <i>atella</i> 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 <i>atella</i> , 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 5 summarizes the contribution and major constraints to use technologies to improve crop residues. Crop residues in the central and eastern zones sustain livestock for 7–12 months, and contribute to 50–75% of the livestock demand of an average household. The major limitation to the use of crop residues appears to be the absence of interest to use proven technologies, such as chemical treatment and supplementation, that improve their feeding values. Decreasing particle size using chopping devices is widely recognized and used by farmers, and the major reason explained by the respondents is lack of commitment on the part of users, absence of suitable technologies and labour shortage during the period when cropping activities at their peak.

Table 5: Crop residue utilization and improvement in the central and eastern zones

District	Maximum 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

## 3.2 Stubble and fallow grazing

Stubble grazing occurs 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 the first few days of stubble grazing, farmers are reluctant to open grazing of their stubbles for other people's livestock. The rule of thumb is that land owners and possessors exhibit flexibility in permitting others to use the stubble only after the remaining aftermath is apparently of low quantity and quality. Although the absence of alternative feed resources is increasingly compelling smallholder farmers to make use of their stubbles, 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. Some districts are still making use of aftermath grazing in areas not included in 'zero grazing' policy. It should be noted that if the disadvantages of aftermath grazing outweigh the potential benefits, the complete abandoning of this practice may positively contribute to the region's determination to conserve natural resources (Picture 2).

Picture 2: A scene of sites where aftermath grazing is completely abandoned in Adwa (left) and Laelay Maichew (right).



### 3.3 Grazing lands

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, and are restricted to marginal areas with low farming potential such as hill tops, swampy areas and roadsides. The progressive conversion of grazing lands into crop fields is particularly evident in the central zone where the bioclimatic conditions are relatively favourable for crop farming. Grazing lands in the eastern zone appear to have been maintained and managed better than those located in the central zone where free grazing is still the norm (Picture 3).

Picture 3: A sharp contrast in productivity of grazing lands in Adwa (left) and Atsbi (right) due to presence/absence of free grazing.



#### Size of grazing lands

Size is one of the indicators of the sustainability of grazing systems management. Table 6 shows the size of grazing lands currently available in the surveyed districts in the central and eastern zones. The total size of grazing lands available in the central zone is 1228 ha, half of which is found in Ahferom district. The four districts in the eastern zone have 16,068 ha grazing land. The largest grazing land is found in Atsbi district (7588 ha) while the smallest is in Laelay Maichew district (215 ha). The number of PAs with grazing land varied from district to 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 Awlalo districts five PAs have no such designated grazing lands.

Table 6: Size of grazing lands in the central and eastern zones (ha/PA)

District	N	Average	StDev	Median	Minimum	Maximum	Total (district)
Adwa	13	23.4	23.3	10.5	2.5	75	303.8
Ahferom	25	28.4	47	11	1	214	709.0
Laelay Maichew	13	16.5	16.1	9	1	50	215.0
Atsbi	15	505.9	237.1	540	120	909	7588.0
Ganta Afeshum	13	117.6	108.5	98	8	350	1529.0
Kilte Awlalo	13	108.3	94	65	5	308.5	1407.8
Saesie Tsaeda Emba	21	264	210.6	260	5	750	5543.0

## Utilization and condition

Table 7 shows ownership, contribution, utilization and condition of grazing lands. 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.

Across the 7 surveyed districts, the condition of grazing lands, evaluated on four ordinal scales (excellent, good, fair, and poor) using aboveground biomass as a proxy indicator of the health of the grazing lands, is generally far from being a perfect excellent. 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. In this regard, grazing lands in Atsbi-Womberta had higher scores than grazing lands in the other districts.

The contribution of grazing lands to livestock feeding ranges from less than 25 to 50%, which reflects the condition as well as the ownership pattern of the grazing lands. Where the condition score of a grazing land is good and is privately owned, the contributions tends to increase. The dependency of smallholder farmers on feeds derived from grazing lands varies from five–eight 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. It is difficult to distinguish between the two forms of utilization on the basis of ownership. Despite the presence of large swaths of privatized grazing lands in Saesie Tsaeda Emba and to some degree in Ganta Afeshume districts, direct grazing is still a persistent problem. Frequency of utilization varied from one–three/year, and privatized grazing lands tended to have low frequency of utilization compared to the communal grazing systems.

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 8). 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.

Table 7: Contribution, utilization and status of grazing lands in central and eastern zones

District	Ownership (%)		Condition		Contribution	Dependency (months)	Form of utilization		Frequency of utilization	
	Communal	Private	Communal	Private			Communal	Private	Communal	Private
	75	25								
Adwa			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
	--	100						Cut-and-carry and direct grazing	1	1
Ganta Afeshum				Good	25–50%	4				
Kilte Awlaelo	65	35	Fair		<25%	7	Free grazing		1	
	--	100						Cut-and-carry and direct grazing		3
Saesie Tsaeda Emba				Good	25–50%	7				

Table 8: Common grazing interventions in the central and eastern zones

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 and acute forage seed supply	-----	Enclosing, weeding, (re)seeding

### 3.4 Hay making and the use of standing hay

In the central zone, the minimum and maximum sizes are 0.5 and 112.5 ha, respectively (Table 9). The largest median grazing land size (293 ha) is located in Atsbi with the largest inter PA variation (153). Of the total grazing lands available in each district, the proportion of land allocated for hay making ranges from 0.1 to 0.9.

Table 9: Grazing land sizes for hay making in the central and eastern zones (ha/PA).

District	N	Average	StDev	Median	Minimum	Maximum
Adwa	12	14.0	31.3	4.5	0.5	112.5
Ahferom	16	14.3	13.9	10.75	1.3	42.8
Laelay Maichew	8	5.2	4.4	3.9	0.5	12.5
Atsbi	15	300.3	153.4	292.5	36	599.9
Ganta Afeshum	13	117.6	108.5	98	8	350
Kilte Awlaelo	13	90.1	78.3	65	5	277.7
Saesie Tsaeda Emba	19	111.6	105.9	79.2	1.6	416

Table 10 presents data on the number of households involved in hay making, land allocated for hay making, its contribution and standing hay practices. Estimated 120–700 households/district are involved in hay making, the largest being in Saesie Tsaeda Emba and the smallest in Laelay Maichew. 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 able to harvest 350–1200 kg of grass hay annually. This is barely sufficient for one–two months of continuous feeding of selected classes of livestock. The right time to 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 litre water) after each layer. Farmers believe that this, apart from its preservative effects, it also improves the palatability of hay. The attention given to plant stage of maturing for hay making is unanimously low as there is no optimum time set for cutting grass hay. Each district also allows the harvesting of additional hay from rehabilitated/ reforested areas and arable lands. Preserving part of a grazing land to be as standing hay is an important strategy where feed supply fluctuates unpredictably. Only three of the seven districts still practice this tradition (Table 10).

Table 10: Hay making and the use of standing hay in central and eastern zones

District	Total household heads engaged in hay making	Area allocated for hay making (ha/hh)	Hay making			Standing hay		
			Months of hay making	Quantity of hay produced (kg/hh)	Months of hay feeding	Area for standing hay (ha)	Season of use of standing hay	Contribution of standing hay to livestock feed
Adwa	350	0.25	September–November	750	January–May	18	September–October	<25%
Ahferom	400	0.25	September and October November and December	350	February–May	0		
Laelay Maichew	120	0.25		600	March–May	0		
Atsbi Wemberta		0.5	September and October	1200	February–June	32	September–October March–April	<25%
Ganta Afeshum	930	0.25	September and October	900	February–June	80	October–November	25–50
Kilte Awlaelo	1700	0.25	September and October	700	February–May	0		
Saesie Tsaeda Emba	7200	0.25	September	800	December–March	0		

### 3.5 Agro-industrial by-products

Agro-industrial by-products (AIBPs) have special value in the feeding of livestock mainly in urban and peri-urban livestock systems. In the central and eastern zones of Tigray region, limited oil crops, mainly noug and sesame seed cakes are used as important supplements to the poor quality crop residues during the dry season feed supply.

#### Availability and prices

The availability of AIBPs, scored as being low, medium and high, varied across the districts. In the central zone, there is no consistent and stable supply of AIBPs. Respondents from Adwa (one PA) and Ahferom (two PAs) scored it as low. Similarly, respondents from two PAs in Adwa and one PA in Ahferom claimed that the AIBPs are not available. Most respondents (10 out of 16 PAs) from the eastern zone rated AIBPs availability as being medium. Surprisingly, only four types of AIBPs from flour milling (wheat bran) and edible oil extracting plants (cotton, noug and sesame cakes) are reported to be widely available in the market. The largest variation in price is for sesame cake and wheat bran showed small variation (Table 11).

Table 11: Prices paid for AIBPs in the central and eastern zones

AIBP	N	Mean	Median	Std. Deviation	Minimum	Maximum
Wheat bran	25	391	375	52.6	340	560
Sesame cake	5	1130	1050	323.3	700	1500
Noug cake	6	733	700	140.2	600	1000
Cotton cake	10	533	430	173.7	360	800

The pattern of price variation by district is given in Table 12. Wheat bran is a common AIBP sold across the 7 districts with a price range from ETB 363 to ETB 480/qt.

Table 12: District level price variations for AIBPs

AIBP	Districts						
	Adwa	Ahferom	Laelay Maichew	Atsbi Womerta	Kilte Awlaelo	Ganta Afeshum	Saesie Tsaeda Emba
Wheat bran							
Mean	363	453	383	368	370	421	380
Std dev	17.7	64.3	41.5	9.6	25.8	94.7	24.5
Sesame seed cake							
Mean			1300				
Std dev			264.6				
Noug seed cake							
Mean			763	387			
Std dev			170.2	23.1			
Cotton seed cake							
Mean						550	656
Std dev						212.1	174.4

#### Utilization

AIBPs are available mainly in the urban and peri-urban dairy and fattening systems, and the overall contribution to livestock feeding is much less than 25%. In the central zone, livestock species targeted for the feeding of AIBPs favoured dairy while in the eastern zone the use of AIBPs for the fattening of cattle and sheep is also popular. The



overall response shows 22 respondents stated that most AIBPs are used for both dairy and short term fattening of oxen and sheep (Table 13).

Table 13: Livestock species given priority for feeding AIBPs

District	Livestock given priority*		
	Dairy	Dairy and fattening	Total
Adwa	2	2	4
Ahferom	3	1	4
Laelay Maichew	0	4	4
Atsbi Wemberta	0	4	4
Ganta Afeshum	1	3	4
Kilte Awlaelo	0	4	4
Saesie Tsaeda Emba	0	4	4
Total	6	22	28

\*Numbers refer to counts of respondents from 4 PAs/district

### 3.6 Improved forage genetic materials

Introduced multi-purpose woody and herb species have been in farmers' fields and agricultural extension training centers for at least three decades in Tigray region. A variety of exotic grasses and legumes have been tried in farmers' training centres, farmers' private fields, and along major watershed areas and gullies. Until now, broad use of such improved forage species in the region 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. 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.

Eleven public forage genetic material multiplication sites with an average size of 0.56 ha, serve more than 130,000 households living in the seven districts (Table 14). 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.

Table 14: Public and private forage multiplication sites

District	Number of sites	Public (ha)	Group	Farmers
Adwa	1		0.75	
Ahferom	2			
Laelay Maichew	2	2		20
Atsbi Wemberta	1	0.75		6
Ganta Afeshum	1	0.5		
Kilte Awlaelo	1			2
Saesie Tsaeda Emba	3	3		7
Total	11	6.25	0.75	35

## Major forage species

Quite a narrow range of forage species have been indiscriminately introduced into the districts without considering the needs and capabilities of the farming communities. 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 (*Leucaena leucocephala*), and alfalfa (*Medicago sativa*) (Table 15).

Table 15: Forage species distributed by regular extension to farming communities in the central and eastern zones

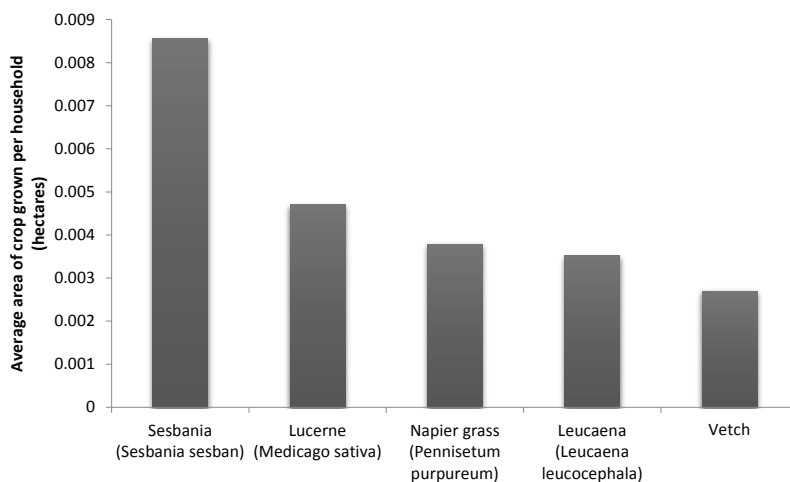
Name of district	Forage types according to their order of dominance								
	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	7 <sup>th</sup>	8 <sup>th</sup>	9 <sup>th</sup>
Adwa	Leucaena	Sesbania	Napier	Alfalfa	Cowpea	Pigeon pea			
Ahferom	Leucaena	Sesbania	Napier	Alfalfa	Cowpea		Rhodes		
Laelay Maichew	Leucaena	Sesbania	Napier	Alfalfa	Cowpea		Rhodes		
Atsbi Wemberta	Leucaena	Sesbania	Napier	Alfalfa				Tagassaste	Vetch
Ganta Afeshum	Leucaena	Sesbania	Napier	Alfalfa				Tagassaste	
Kilte Awlalo	Leucaena	Sesbania	Napier	Alfalfa	Cowpea				
Saesie Tsaeda Emba	Leucaena	Sesbania	Napier	Alfalfa	Cowpea	Pigeon pea		Tagasaste	Vetch

The average area allocated for each major forage crop is depicted in Figure 1.

Picture 4: Benefits of using N fertilizer in grazing areas in Adwa (left) and Atsbi (right).



Figure 1: Average area allocated for major fodder crops.



Other less common grass species include *Phalaris (Phalaris aquaticum)*, *Columbus (Sorghum almum)*, and *Setaria (Setaria encephalata)*. The common herbaceous and woody leguminous species widely introduced in Tigray region include common vetch (*Vicia dasycarpa*), cowpea (*Vigna unguiculata*), green leaf desmodium (*Desmodium intortum*), silver leaf desmodium (*D. uncinatum*), siratro (*Macroptilium atropurpureum*), lablab (*Lablab purpureus*), and tagassate (*Chamaecytisus prolifer var palmensis*).

Forage development strategies include alley cropping, backyard, and along watersheds. Backyard and alley cropping are the commonest strategies across the seven districts (Table 16).

Table 16: Common forage development strategies\*

District	Strategies+								
	A	B	C	D	C	F	G	H	I
Adwa	0	0	0	0	0	0	2	1	1
Ahferom	0	0	0	0	0	0	4	0	0
Atsbi Wemberta	3	0	0	0	0	0	1	0	0
Ganta Afeshum	1	0	0	0	1	1	1	0	0
Kilte Awlaelo	0	1	0	2	0	0	1	0	0
Laelay Maichew	0	0	0	0	0	3	1	0	0
Saesie Tsaeda Emba	0	0	1	2	1	0	0	0	0
Total	4	1	1	4	2	4	10	1	1

\*Forage development strategies: A=Backyard; B=Alley cropping and gullies; C=Alley cropping and intercropping; D=Alley cropping; E=Gullies; F=Backyard and gullies; G=Backyard, alley cropping and gullies; H=Backyard, alley cropping, intercropping and gullies; I=Gullies and integrated development.+Numbers refer to counts of respondents from 4 PAs/district

Farmers are attracted by the multipurpose nature of improved forage development in sites exposed to erosion. It is common to see farmers planting Napier grass as well as alfalfa along eroded areas and waterways (Picture 4).

Picture 5: Farmers using improved forage to reduce erosion risks in Laelay Maichew (left) and Atsbi (right) districts.



## Management and utilization

As improved forage production is not well integrated into the farming system, the level of management applied is expectedly low. Existing stands receive little attention in terms of water management, harvest schedules and soil nutriment management requirements. Apart from sporadic harvesting of what is available, farmers are not in a position to provide what is required for a typical introduced forage species. A reflection of the current low improved forage management efforts of smallholder farmers is the low productivity yield of forage species, which does not exceed 500 kg DM/household. The number of farmers who actively took part in designed forage development is also on average 259/PA (Table 17). Although not significant, the average yield obtained tended to negatively correlate with number of

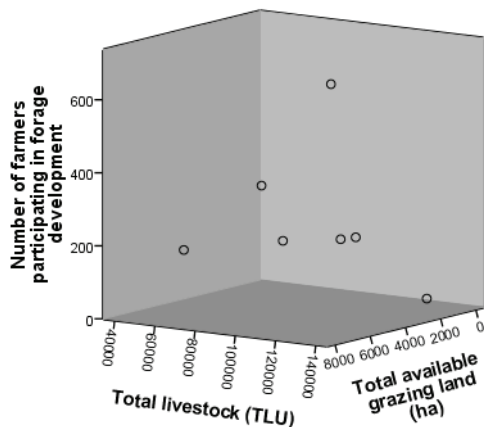
participating households (Pearson correlation  $-0.215$ ,  $P=0.643$ ). This has an important implication on extension, as the number of participating households increases, the extension advice may tend to be weak.

Table 17: Number of households participating in improved forage development and estimated yield

District	Improved forage yield (kg/hh)			Number of households participating//PA		
	Mean	Std. Dev	Median	Mean	Std. Dev	Median
Adwa	500	360.6	400	162	120	100
Ahferom	360	456.6	360	25	21.2	25
Laelay Maichew	631.3	374.9	700	150	70.7	150
Atsbi	213.3	250.1	589	200	27.6	200
Ganta Afeshum	287.5	159.1	287	150	86.6	200
Kilte Awlalo	683.3	376.4	700	292	270.9	225
Saesie Tsaeda Emba	252.5	207.7	225	667	416.3	800
District	429.5	312.2	400	259	278.6	200

The number of farmers participating in forage development increases with an increase in the number of TLU and reduced availability of grazing lands (Fig. 2).

Figure 2: Relationship between total TLU, available grazing land and number of farmers participating in improved forage development.



A recent development observed in some of the districts is that farmers are willing and ready to allocate a small portion (up to 25%) of their irrigated land for fodder development. This has resulted in the adoption of alfalfa for dairy feeding (Picture 5).

Picture 6: Irrigated alfalfa fields in Adwa (left) and Saesie Tsaeda Emba (right) districts.



Smallholder farmers use improved forage on the basis of cut-and-carry, and the overall contribution is <25%. Smallholder farmers use improved forage not just to feed their livestock without discriminating between livestock species and classes. They consider potential production returns and hence target dairy (improved and local) and fattening of cattle and small ruminants (Table 18).

Table 18: Target livestock species for feeding improved forage

District	Target livestock enterprises+					
	1	2	3	4	5	6
Adwa	0	3	1	0	0	0
Ahferom	1	2	1	0	0	0
Atsbi Wemberta	0	1	0	1	0	2
Ganta Afeshum	1	3	0	0	0	0
Kilte Awlalo	0	3	0	0	0	1
Laelay Maichew	2	1	0	0	1	0
Saesie Tsaeda Emba	0	4	0	0	0	0
Total	4	17	2	1	1	3

Numbers refer to counts of respondents from 4 PAs/district.

+Livestock enterprises: 1=Local and improved dairy; 2=Local and improved dairy and cattle fattening; 3=Local and improved dairy and small ruminant breeding; 4=Small ruminant fattening; 5=cattle fattening; 6=Local and improved dairy and small ruminant fattening; local and improved dairy and cattle fattening

### 3.7 Non-conventional feed resources

The three important non-conventional feeds that contribute to the feeding of dairy cattle and fattening are *Atella*, vegetable leftovers, and cactus (*Opuntia ficus indica*) cladodes. *Atella* is more common in the central zone districts while cactus cladodes feeding is a traditional feed in the eastern zone districts (Table 19). Cladodes/pods of cactus pear are traditionally used as livestock feed during normal dry season and drought periods. Vegetable leftovers are used as supplements during the irrigation season and include cabbage, tomatoes, salads, and potato vines.

Table 19: Non-conventional feed resources used in the central and eastern zones

Name of district	<i>Atella</i>	Vegetable leftover	Cactus cladodes
Adwa	January–December	February–June	April and May
Ahferom	January and April	November–February	May–July
Laelay Maichew	January		
Atsbi Wemberta			March–May
Ganta Afeshum			January–March
Kilte Awlalo	January–December	December–March	January–May
Saesie Tsaeda Emba	January–December	September– December	February–May

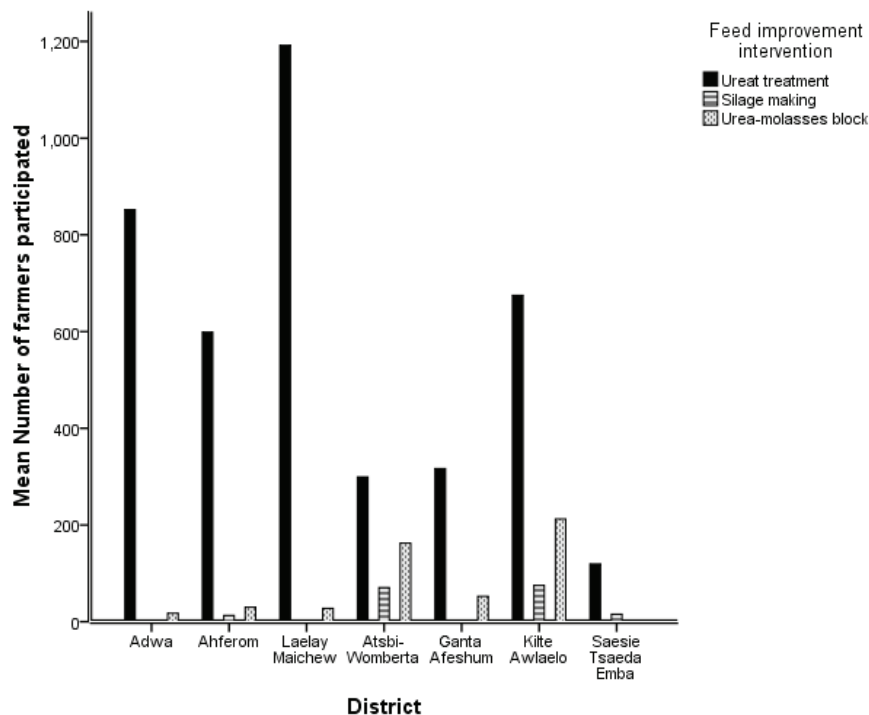
### 3.8 Urea treatment, silage and feed blocks

Apart from hay and straw/stover, the conservation and preservation of green feeds in the form of silage is not widely practiced in the central and eastern zones. Treating crop residues with fertilizer grade urea improves the feeding quality but insignificant numbers of farmers have adopted this technology. Silage making is demonstrated to farmers on many training occasions, but the rate of adoption is disproportionately low. With the expansion of irrigated agriculture, the prospect for making silage using simple plastic tubes as demonstrated by LIVES may attract the attention of dairy farmers.

The provision of energy and protein rich supplements in the form of urea-molasses block has been initiated during training sessions but never implemented as a regular livestock feeding task. The ingredients used for block formulation are wheat bran (25%); molasses (40%); poultry litter/noug cake (10%); cement (10%); urea (10%), salt (5%). The absence of continuous molasses supply is hindering the uptake of block feed technology in the districts.

As indicated in Figure 3 small number of farmers are involved in these feed improving technologies.

Figure 3: Number of farmers participated in feed improvement technologies (Average of two years 2005–06, Ethiopian calendar).



An increasingly large number of farmers in the central zone participate in urea treatment of crop residues and more farmers from the eastern zone districts participate in silage making.

### 3.9 Feed marketing

Feed marketing is one of the means by which smallholder livestock keepers address deficit feeds and get access to better quality feeds. Feed marketing is normally carried out by licensed traders and largely involves the marketing of flour mill and oilseed by-products. The following section presents an overview of the characteristics of feed traders, services rendered by them and quantity and price of traded feeds.

#### Characteristics of respondents

From agro-industrial by-products, wheat bran is widely marketed in Tigray and most discussions included under this section will make use of data on wheat bran. Twenty-three feed traders responded to the survey questionnaire on feed agribusiness. Most feed traders are males with primary education, and their business is licensed with a private business proprietary structure (Table 20).

Table 20: Characteristics of business owners for feed market in the central and eastern zones

Town	Gender		Education*				Type of feed business**			Business structure***			Licensed business	
	M	F	1	2	3	4	1	2	3	1	2	3	Yes	No
Axum	3	0	0	1	1		2	1	0	3	0	0	3	0
Adwa	2	0	1	0	1		2	0	0	2	0	0	2	0
Enticho	2	0	2	0	0		2	0	0	2	0	0	1	1
Adigrat	5	1	3	1	3		4	2	1	5	1	1	6	0
Frewoini	2	1	1	2	0		3	0	0	3	0	0	3	0
Atsbi	2	1	2	0	0	1	3	0	0	3	0	0	3	0
Wukro	3	0	3	0	0		3	0	0	3	0	0	3	0
Total	19	3	12	4	5	1	19	3	1	21	1	1	21	1

\*Education: 1=primary; 2=secondary; 3=tertiary; 4=illiterate. \*\*Type of feed business: 1= feed trader; 2=cereal mill owner; 3=feed mill owner. \*\*\*Business structure: 1=private proprietorship; 2=partnership; 3= Cooperative

Feed traders are expected to provide services on the basis of good faith. Most feed traders proclaim that regular quality checks are made for feeds traded to their customers, but lack proper labelling (Table 21).

Table 21: Services rendered by feed traders

Town	Regular feed quality checks		Packing		Labelling		Feeding advice to customers	
	Yes	No	Yes	No	Yes	No	Yes	No
Axum	3	0	2	1	0	3	2	1
Adwa	1	1	2	0	0	2	2	0
Enticho	2	0	1	1	0	2	2	0
Adigrat	6	0	5	1	0	6	4	2
Frewoini	3	0	0	3	0	3	3	0
Atsbi	3	0	0	3	0	3	2	1
Wukro	3	0	0	3	0	3	3	0
Total	21	1	10	12	0	23	19	4

Services rendered by feed trades also include advising customers on the proper feeding of livestock. The median number of farmers who received such advice ranges from 10 to 300 (Table 22).

Table 22: Number of farmers advised by feed traders

District	N	Mean	Std. deviation
Adigrat	5	109	86.5
Adwa	2	58	60.1
Atsbi	2	152	209.3
Axum	2	70	28.3
Enticho	2	19	15.6
Firewoini	3	63	35.1
Wukro	3	22	24.7

Despite the provision of such advice to farmers, feed traders seldom receive reciprocal training in the processing, handling, labelling and storage of feeds (Table 23). Three feed manufacturers were included in the survey in the central (1) and eastern (2) zones, and neither of them has received any formal training in processing/formulating commercial rations for livestock keepers.

## 23: Capacity development training provided for feed traders

Town	Training in processing		Training in packing and labelling		Training in storing	
	Yes	No	Yes	No	Yes	No
Axum	0	1	0	3	1	2
Adwa			1	1	1	1
Enticho			0	2	0	2
Adigrat	0	2	1	6	1	6
Frewoini			0	3	0	3
Atsbi			0	3	0	3
Wukro			0	3	2	1
Total	0	3	2	21	5	18

## Quantity and price of traded feeds

Table 24 shows the total quantities of the six AIBPs sold over 12 months across the 7 districts. The highest quantity of AIBP sold is wheat bran (3596 qt) and selling price is ETB 357/qt. This is also traded by the largest number of business (16).

Table 24: Total quantities of AIBP sold over a 12-month period.

Product	Quantity sold qt	Selling price (ETB/qt)	No. businesses involved
Wheat bran	4706	356.9	21
Wheat short	559	371	5
Pulse bran	140	425.0	2
Cottonseed cake	525	680.7	7
Noug cake	240	810.0	3
Sesame cake	45	1090.0	2

When the data are disaggregated by district, the largest quantity of wheat bran is traded in Adigrat and the lowest is traded in Enticho (Figure. 2). Similarly, the largest price was paid in Adigrat while the lowest was in Axum town. Two important factors that influence price of wheat bran are availability and demand. There are two flour milling factories in Adigrat and for various reasons the demand for wheat bran is generally high. The dairy system in Adigrat is relatively large and well developed, and the tradition of using agro-industrial by-products is rooted, and these might probably have contributed to the inflated price of wheat bran in the district.



Figure 4: Price of wheat bran across the major district towns in the central and eastern zones.

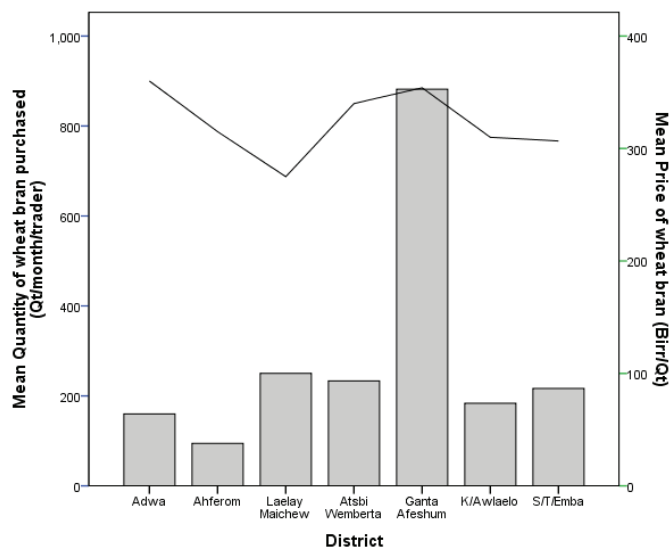


Table 25 shows the type of buyers of traded feeds. Typically this is for wheat bran which covers the major part of supplementary livestock feeds. The customers, who buy wheat bran are not only large ruminant livestock keepers, but include poultry keepers, cart owners, and retailers. The largest share goes to farmers around Adigrat.

Table 25: Nature of buyers of traded feeds

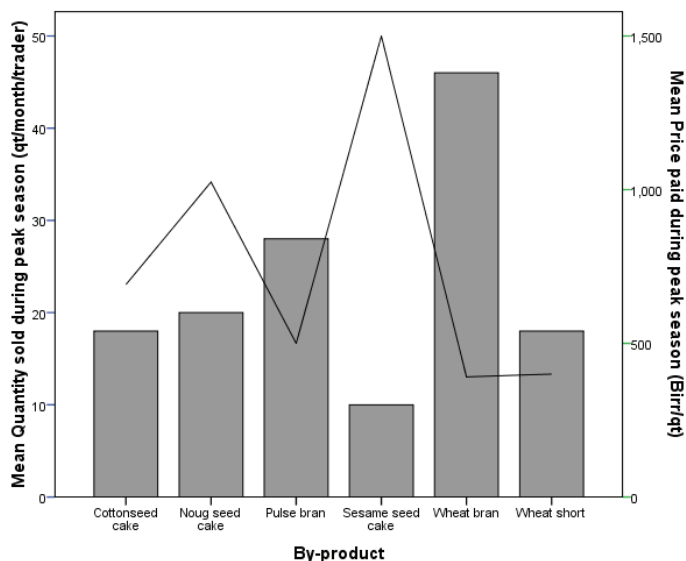
Town	Categories				Total
	1	2	3	4	
Adigrat	3	2	1	1	7
Adwa	0	2	0	0	2
Atsbi	2	1	0	0	3
Axum	1	0	1	1	3
Enticho	1	1	0	0	2
Frewoini	1	2	0	0	3
Wukro	2	1	0	0	3
Total	10	9	2	2	23

+Numbers refer to the frequency of feed traders who mentioned a particular customer.

Categories of buyers of feeds: 1=Farmers; 2= Farmers, cart owners, poultry farms; 3=Retailers; 4=Farmers and retailers.

A typical pattern observed in relation to the sale of AIBPs within a year is that there are peak season months (January–May) and low season months (July–November) during which time quantities sold and prices paid show marked fluctuations. During the peak season, the average quantities of wheat bran sold increases from just 13 to 46 qt/trader per month and the average prices shoot from ETB 311/qt to 391/qt (Figure. 5).

Figure 5: Quantity of by-products sold and price paid during peak season.



### Feed storage capacities and information communication means

Table 26 shows storage capacity of feed traders. The largest (up to 15,000 qt) storage capacity is owned by flour factory operators and feed traders have 50–500 qt capacity storage most of which is rented.

Table 26: Storage capacity and information flow among feed traders

Feed business	Capacity (qt)	Adigrat	Adwa	Atsbi	Axum	Enticho	Frewoini	Wukro	Total
Feed trader	50	2	0	1	0	0	0	0	3
	100	1	1	0	0	0	0	0	2
	200	1	1	2	1	1	0	2	8
	250	0	0	0	1	0	0	0	1
	300	0	0	0	0	1	2	0	3
	500	0	0	0	0	0	1	1	2
	Total		3	2	1	2	2	3	1
Cereal mill	300	1			0				1
	1000	1			0				1
	15000	0			1				1
	Total		2			1			3
Feed mill	200	1							1
	Total		1						1

Feed traders rely on their mobile to get vital trade information about the feeds they sell (Table 27). There is little use of other information communication means to find vital market prices of feeds.

Table 27: Information communication means used by feed traders

Feed business	Communication tool	Adigrat	Adwa	Atsbi	Axum	Enticho	Frewoini	Wukro	Total
Feed trader	Mobile	4	1	3	2	2	3	3	18
	Mobile and radio/TV	0	1	0	0	0	0	0	1
	Total	4	2	3	2	2	3	3	19
Cereal mill	Mobile	2			1				3
	Total	2			1				3
Feed mill	Mobile	1							1
	Total	1							1

Feed traders get updates on prices and demanded products using different means. Competitors are the most dominant means of getting updates on prices and products (Table 28).

Table 28: Information sources for feed traders

Feed business	Sources	Adigrat	Adwa	Atsbi	Axum	Enticho	Frewoini	Wukro	Total
Feed trader	Competitors	0	1	1	2	2	3	1	10
	Customers	1	1	2	0	0	0	2	6
	Newspaper	3	0	0	0	0	0	0	3
	Total	4	2	3	2	2	3	3	19
Cereal mill	Competitors	2			1				3
	Total	2			1				3
Feed mill	Competitors	1							1
	Total	1							1

Table 29 shows the means for feed price determination. Feed traders make use of prevailing market prices and consider their costs and a marginal profit when fixing a price for a particular feed product. The majority of the feed traders sold feeds based on the prevailing market prices in their respective towns.

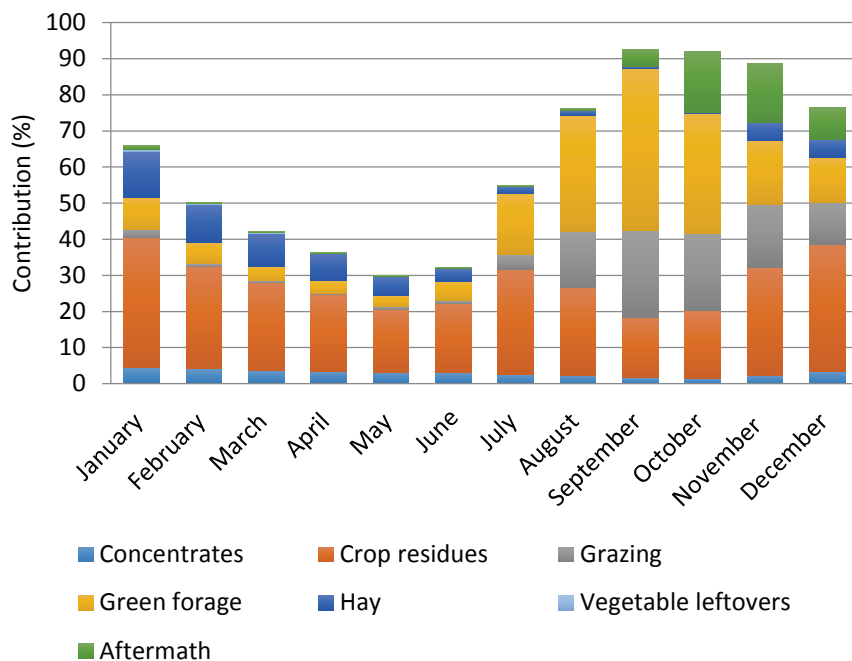
Table 29: Means of price determination

Feed business	Means	Adigrat	Adwa	Atsbi	Axum	Enticho	Frewoini	Wukro	Total
Feed trader	Market price	1	0	2	2	1	2	3	11
	Cost price	0	1	0	0	0	0	0	1
	Cost price and Margin	3	1	1	0	1	1	0	7
	Total	4	2	3	2	2	3	3	19
Cereal mill	Market price	1			1				2
	Cost price and Margin	1			0				1
	Total	2			1				3
Feed mill	Cost price v Margin	1							1
	Total	1							1

### 3.10 Feed supply and demand balance

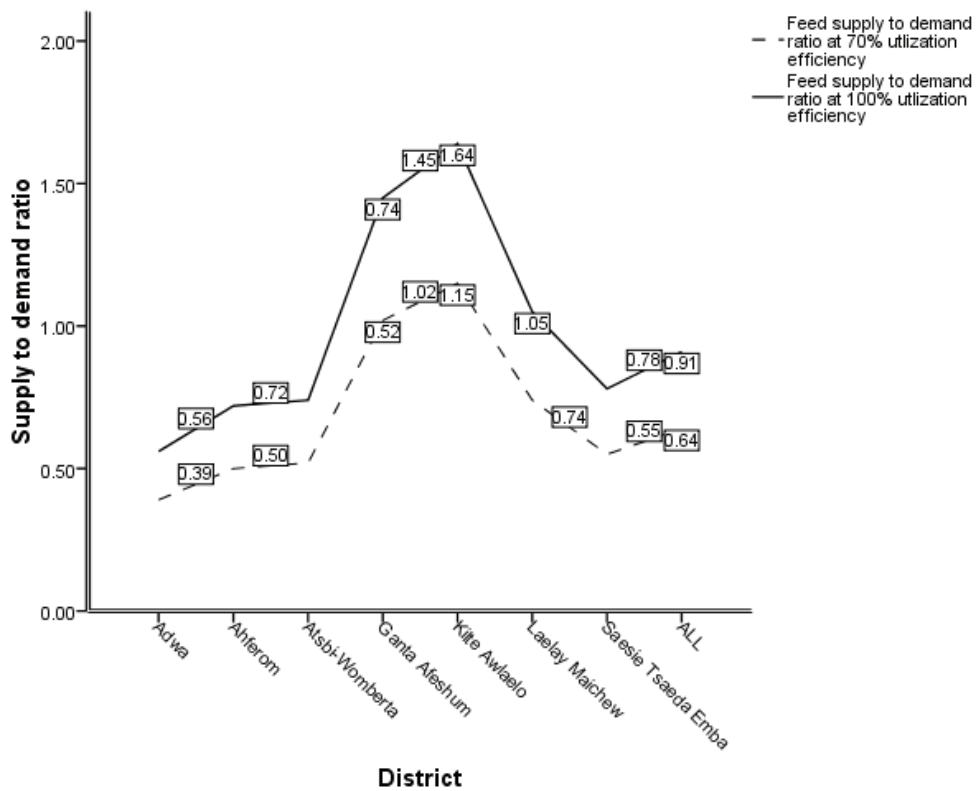
The availability of different feeds varies across the different months of a year (Figure. 6). Major use of crop residues and to extent hay is a uniform scenario across the districts. Grazing is limited to August–December months and the use of AIBPs increases during the dry months.

Figure 6: A summary of the availability of different feeds across months.



Based on the assumptions given in the methodology section, the following indicative feed balance is calculated for four districts in eastern zone (Figure. 7). The total feed demand for an estimated 293,209 TLU is 698,107 t, and the available total feed supply at 70% and 100% utilization is 447,155 t and 638,792 t, respectively. Only two districts (Ganta Afeshum and Kilde Awlalo) are able to produce feeds that just meet the maintenance needs of existing TLU. The overall feed supply to demand ratio in the four districts in the eastern zone is 0.64 and 0.92 at 70% and 100% utilization efficiency, respectively. This amount of feed is sufficient to support the existing stocks only for 8 and 11 months at 70% and 100% utilization efficiency, respectively.

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



## 4. Discussion

This survey attempted to explore the situation of different feed resources of seven districts in the central and eastern zones of Tigray region in northern Ethiopia. It should be noted that the survey is far from providing a complete picture of the entire region's potential for all kinds of feeds used by livestock. These two zones account for 12% of the region's total area, 23% of the human population, 28% of the cattle population, and 56% of the small ruminant population. Given such coverage, the selected districts may clearly show the opportunities for the effective use of different feeds. The sample size used in the analysis of feed marketing may not fully reflect the actual number of feed traders operating in a district and the range of feeds they trade. This is caused by the reluctance of many traders who sale livestock feeds under the camouflage of food grains.

The overall contribution of crop residues exceeds 50% of the livestock feeds currently used by smallholder farmers and this reflects the level of integration between crop and livestock farming. 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.

The time of harvesting of crop residues normally coincides with the dry season when other alternative feed resources are either not available or expensive. This calls for increasing attention to improving their feeding value using physical, chemical and supplementary options. Crop residues are characterized by low digestibility (<50%), low ME (<7.5MJ/g DM), low crude protein (<6%) and low intake (<15 g/kg live weight) (Owen and Jayasuriya 1989). Due to poor quality, 85% of the feed consumed is used for maintenance, while only 15% is used for production. Except a few cattle fatteners who are making effective use of urea treated straw mixed with wheat bran/cotton/noug seed cakes, the current practice in relation to using crop residues appears to undermine the role of crop residue improvement technologies. As a result of urea treatment, the CP content of *teff* and barley straws can be increased by 134% and 85% respectively, and IVOMD by 7.4% and 28%, respectively (Mesfin and Ledin 2004). Supplementation with foliage increased digestibility of *teff* straw by 50 to 142% (Nsahlai et al. 1998).

More than 90% of grazing lands in the eastern zone are owned privately, while in the central zone communal use is still common and privatized use of grazing land is less than 25% of the total grazing land area. However, the dominant form of utilization in both zones is same-cut-and-carry, and direct grazing of protected grazing lands is observed as an isolated case in both zones. The tradition of hay harvest in the central and eastern zones is well established, but the storage condition is generally poor. Most farmers store it in open fields and this leads to rapid deterioration. Yayneshet et al. (2009) estimated that due poor storage of grass hay, the crude protein content decreases by almost 70% between September and March.

Cultivated forage crops growing in the study districts are sesbania, leucaena, Napier grass, alfalfa, tree lucerne, vetch, cowpea, lablab and pigeon pea. 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, on average about 430 kg/ha, and contribution to livestock feeding is less than 25%. This is despite the presence of evidence on the beneficial effects of multi-purpose trees on dry matter intake and body weight gains (Kaitho et al. 1998; Solomon et al. 2004).

AIBPs are able to provide nutrients deficient in crop residues and hay, and improve digestibility (Zinash and Seyoum 1991; Yami et al. 1991; Lemma and Smit 2005). AIBPs were more available in the eastern zone than in the central zone. The presence of limited distribution networks for AIBPs has forced smallholder farmers to depend on wheat bran and noug cake, and other by-products are unknown to most.

Non-conventional feed resources used in both zones include *atella*, vegetable leftovers and cactus. *Atella* and vegetable rejects are reported to be more available in the central zone while cactus is more abundant and an important livestock feed in the eastern zone. Of the total sample PAs that use *atella* and vegetable rejects, nearly 75% of are from the central zone. The chemical composition of *atella* varies according to the ingredients used to make tella. The highest crude protein (24%) is obtained from tella made from sorghum grains (Alemayehu and Yayneshet 2011). More than 83% of the sample PAs that reported cactus as an important feed supplement are from the eastern zone of Tigray. Cactus (*Opuntia ficus indica*) is an important feed resource yielding about 35 t/ha dry matter and covers more than 130 ha land in four districts in the eastern zone (UNECA 1997). The cladodes/pods of cactus pear are traditionally used as livestock feed during normal dry season and drought periods, and can be included up to 60% level (Firew et al. 2007).

The feed business is more relevant for AIBPs that include wheat bran, wheat shorts and oil seed cakes than hay and forage. The traded quantity and the price depend on the season of demand and supply. Wheat bran is the most important by-product traded by all feed traders. Wheat bran is highly demanded in the months of February to June during which main feed are scarce. And it is at its slack demand period usually from August to December. Shortage of finance, inadequate feed supply from producers and lack of technical knowledge in feed formulation are the major constraints pointed out by the feed traders.

Most smallholder mixed crop-livestock farming systems are characterized by periods of feed deficiency (Yeshitella et al. 2009; Yayneshet, 2010). In the eastern zone the available feed is able to cover 92% of the current stock feed demand. Only two districts (Ganta Afeshum and Kilte Awlaleo) are able to produce feeds that just meet the maintenance needs of the existing TLU. The expansion of irrigation in Kilte Awlaleo and the tradition of using AIBPs and a shift to crossbred cattle in Ganta Afeshum might have contributed to narrowing the gap between demand and supply.

## 5. Conclusions and recommendations

### Conclusion

Crop residues are the common source of feeds in the eastern and central zones of Tigray region. The management and utilization of crop residues with particular attention to collection and transportation is constrained by factors such as labour shortage, distance from the harvesting field to animals, and delayed harvest in the project districts. Grazing land is the second most important feeds for livestock after crop residues. Interventions such as fertilizing the grazing land for more biomass production are seldom considered either by farmers or the extension system. Hay as a reserve livestock feed for the dry seasons is made from pasture lands, enclosure range lands, borderlines, arable lands and rehabilitated areas. Preserving part of a grazing land to be used as standing hay is an important strategy where feed supply fluctuates unpredictably. But only three of the seven districts still practice this tradition.

Acute shortages in the supply of AIBPs and high price fluctuation in the main towns of the districts are discouraging smallholder dairy and small ruminant farmers from using them on a regular basis. Improved forage crops such as leucaena, sesbania, Napier grass and alfalfa grow in most PAs of the project districts. The contribution of improved forage plants is low for various reasons. 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. Farmers' knowledge of managing and using improved forage stands is poor. The overall feed supply to demand ratio in four districts in the eastern zone is 0.64 and 0.92 when utilization efficiency is set at 70% and 100%, respectively.

### Recommendations

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. In this regard, the extension system has to play the leading role in this area of innovative intervention. The knowledge and capacity of smallholder farmers should be strengthened using short practical training sessions and coaching. Demonstrating the importance of on-farm testing of known crop residue improving technologies through research for development is essential.

Grazing lands as sources of livestock feed stand second to crop residues, and there is a need to maintain the size and improve productivity using soil nutrient management. Application of nutrient needed for plant growth should be widely carried out together with community members and local administration.

AIBPs are not widely used by all livestock farmers, especially those located in the rural production systems. There is a need to popularize the usefulness to larger areas by making use of FTCs and targeting farms that regularly buy bulky feeds as crop residues and hay. Feed traders are providing services to their customers without having the required



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knowledge and skills. Targeting feed traders in capacity development and knowledge management events can improve their gaps.

Forage legumes are important feed supplements in terms of high livestock yield and nutrition. But the smallholder farmers are not in a position to satisfy their needs for planting materials (seed and/or seedlings). 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.

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