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Role of Sugarcane Tops as Feed Resource in Two Sugar Estates of Central Ethiopia

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የዚህ ጥናት ዋና ዓላማ ከወንጂና መተሃራ ስኳር ፋብሪካዎች የሚገኘው የሸንኮራ አገዳ ጫፍ ለእንስሳት አርቢዎች ያለውን የመኖ ጠቀሜታ ዳሰሳን መሠረት ያደረገ ነበር፡፡ ጥናቱም በስኳር ፋብሪካዎች አከባቢ ባሉ ከተሞች፤ ካምፖችና ቀበሌ ገ/ማህበራት የሚገኙ 308 እንስሳት አርቢ አባወራዎችን ለቃለ መጠይቅ ያሳተፈና ከፋብሪካዎች የተገኘን መረጃ ያካትታል፡፡ በጥናቱ የሸንኮራ አገዳ ጫፍ የምርት መጠን ፤ የመኖ ጠቀሜታው፤ አያያዝና አመጋገብ ልምድ፣ ግብይት እና የአጠቃቀም ችግሮች ተዳሰዋል፡፡ ከየፋብሪካው ማሳ በዓመት የሚገኘው የሸንኮራ አገዳ ጫፍ መጠን በዓመቱ ለስኳር ምርት ሲባል ታጭዶ ከሚፈጨደው የሸንኮራ አገዳ መጠን ጋር ቀጥተኛ ተዛማጅነት አለው፡፡ በዓመታዊ የምርት መጠን በእሳት የተለበለበው የአገዳ ጫፍ ካልተለበለበው የአገዳ ጫፍ ይበልጣል፡፡ ይህም የሆነበት ምክንያት ለስኳር ምርት የሚውለው ሸንኮራ አገዳ ከመቆረጡ በፊት ማሳው እሳት የምለቀቅበት በመሆኑና ያልተቃጠለው የአገዳ ጫፍ የሚገኘው በአገዳ ተከላ ወቅት ብቻ በመሆኑ ነው፡፡ የሸንኮራ አገዳ ጫፍ በሁሉም አባወራዎች (100%) እንስሳት መኖነት ከመዋሉም በላይ ለማገዶና (50%) ለግንባታ ሥራዎች (37%) ያገለግላል፡፡ በአቅርቦትና በመኖ ተፈላጊነት ረገድ በእሳት የተለበለበ (የተቃጠለ) ሸንኮራ አገዳ ጫፍ በእሳት ካልተለበለበው የአገዳ ጫፍ ብልጫ ያለው ሲሆን ይህም የመኖ እጥረት በሚታይበት ደረቅ ወራት አማራጭ የመኖ ግብዓት ነው፡፡ የሸንኮራ አገዳ ጭፍ በከተማ ለሚገኙ ከብት አርቢዎች በግለሰቦች አመካኝነት በሽያጭ የሚቀርብ ሲሆን ዋጋውም በስኳር ፋብሪካው፤ በአገዳው ዓይነትና በቦታው (ማሳ) ርቀት ይለያያል፡፡ በእሳት ካልተለበለበው አገዳ ይልቅ የተለበለበው አገዳ እንደዚሁም ከወፍራም አገዳ ይልቅ ቀጫጭን አገዳ ያላቸው ዝሪያዎች ለእንስሳት መኖነት የበለጠ ተፈላጊ ናቸው፡፡ የሸንኮራ አገዳ ጫፍ በአብዛኛው ለእንስሳት የሚሰጠው ባለበት ሁኔታ ወይም በመጠኑ በመቀረጣጠፍ ሲሆን የተሰበሰበውም በበቂ ሁኔታ ሳይደርቅ በውጪ ይከማቻል፡፡ የሸንኮራ አገዳን ለእንስሳት መኖነት በይበልጥ ለመጠቀም የማያስችሉ ዋንኛቹ ማነቆዎች የመኖ ይዘቱ ደካማ መሆን (91.2%)፤ የቴክኒክ ድጋፍ እጦት (89%)፤ የማጓጓዣ እጥረት (26%)፤ በተመጋቢ እንስሳት ላይ የአፍ መቁሰል ችግር (16.2%) እና የሰው ጉልበትና ካፒታል እጥረት (11.7%) ናቸው፡፡ በመሆኑም በሸንኮራ አገዳ ጫፍ አጠቃቀም፣ ጥራት ማሻሻል፣አያያዝ፤አመጋገብ ዘዴዎችና ግብይት ላይ ለአርቢዎች በቂ ተግባር-ተኮር ሥልጠና መስጠት አስፈላጊ ነው፡፡ በተጨማሪም የሸንኮራ አገዳ ጫፍን ለመቀርጠፍ የሚያግዝ ማሽን (ቾፐር) በተመጣጣኝ ዋጋ ለአርቢዎች ማቅረብ ያስፈልጋል፡፡

Abstract

This study aimed to assess the production and utilization of sugarcane tops (SCTs) by livestock farms in and around Wonji-Shoa and Metehara sugar estates. A total of 308 households were interviewed using a semi-structured questionnaire, where data on household characteristics, and acquisition, utilization, feeding practices, preserving and marketing of SCTs were collected. Secondary data on sugarcane production were taken from the sugar factories. The estimated production of SCT is proportional to the volume of sugarcane produced or milled and area of sugarcane field harvested, which was higher in Metehara compared to Wonji-Shoa sugar estate. The volume of burnt SCTs surpassed that of green SCTs as the pre-harvest burning practice of sugarcane fields favors the abundant availability of the former. Sugarcane tops were used as feedstuff by the entire surveyed households, primarily for ruminants feeding. Besides, a significant proportion of farmers reported to use SCTs for other purposes viz. fuel source (50%) and construction (37%). Availability and feed use of the burnt SCT surpassed that of green SCT, mainly during the dry season, or dearth period. Sugarcane tops were sold to urban livestock producers, their price being varied with the sugar estate, SCT type and distance from the source (field). Farmers preferred the burnt to green SCTs, and thin-stem to thick-

stem varieties for livestock feeding. Sugarcane tops were usually fed to animals intact or chopped. Farmers practiced preserving intact SCTs by sun-drying and stored in open-air. Limitations in the feed use of SCTs in the study area included its low quality (91.2%), lack of technical supports (89%), lack of transport (26%), mouth injury on animals associated with feeding unprocessed SCTs (16.2%) and lack of family labor and capital (11.7%). In conclusion, SCTs are available year-round and contribute significantly as livestock feed in the study areas. However, it was poorly utilized due to harvesting method employed by the industry, poor handling by farmers and lack of technical supports. Therefore, intervention in areas of SCTs processing, conservation, feeding and marketing is important to enhance its feed use by livestock farms around sugar industries or beyond.

Keywords: Sugarcane tops; feeding; conservation; processing

Introduction

In Ethiopia, feed resources comprise native pasture, crop residues, improved forages, and agro-industrial byproducts (Mengistu *et al*., 2017; Solomon *et al*., 2017; CSA, 2019). However, most available feed resources are low in quantity and quality impairing the livestock productivity (Alemayehu, 2006; Adugna, 2012). The productivity of natural pasture in lowlands has been hampered by frequent drought and poor grazing management. The reliance on crop residues is ever increasing in the mixed crop-livestock farming system in the highlands due to the expansion of cropping lands at the expense of grazing lands. On the other hand, urban and peri-urban livestock production depends mainly on purchased concentrate and low quality roughages. Although various improved forage varieties have been developed, their production and adoption by smallholder producers is hampered by lack of forage seeds, land, awareness (Tesfay *et al*., 2016; Yadessa *et al*., 2016) and poor livestock extension services. Moreover, the limited use of concentrate feeds especially in rural areas is attributed to its shortage and/or poor marketing system (Mesfin *et al*., 2014). As documented in the Ethiopian livestock master plan (Shapiro, 2017), the annual national feed availability varies with season and ranges between 81.3 and 145.2 million tons. A feed deficit as high as 21 to 49 million tons DM per year was reported for the mixed crop-livestock farming system.

Shortage of feed becomes a core problem affecting the long-term development of the Ethiopian livestock industry. The low quality and quantity of forages in the dry season has led to loss of weight and reproductive performances gained by animals in the wet season (Mengistu *et al*., 2017). The limitation in feed availability also escalates feed cost unusually, which in turn raises the market price of animal products. In general, feed cost accounts for 75 to 80 percent of the total cost of livestock production (Demisse, 2017). Despite the shortcomings in feed quantity and quality, many traditional and emerging commercial cattle farms in the country rely on locally available feed resources.

The feed resources available at the sugar industries of Ethiopia are not well exploited, among which sugarcane top is a notable one. Sugarcane tops are unconventional feeds largely available from the government owned or private sugarcane farms at cane harvesting season. It has three major components: leaf, sheath and immature stem rich in simple sugars. However, the adopted burning practices of sugarcane fields before harvesting could partially burn or wilt the leaf and sheath of SCTs that may affect its nutrient composition and biomass yield. Despite the expansion of sugar industries in the country, which in turn increase the by-products, limited research have been done on extent of production, availability and feed use of SCTs around sugar industries. Understanding the role of SCTs around sugar factories would be necessary to enhance its effective use for livestock feeding. Therefore, the objective of this study was to assess the level of SCTs production, and utilization by livestock producers in the vicinity of selected sugar estates in the country.

Materials and Methods

Description of the study areas

The study was conducted in Wonji-Shoa and Metehara sugar estates, located in Rift Valley areas of East Shoa Zone, Oromia Region, Ethiopia (Figure 1). The two sugar estates were purposely selected because they are the oldest industries- with long year of production experience and high capacity of byproduct generation, and are accessible for the study. Wonji-Shoa sugar factory is located between 8˚31′ N and 39˚12′E at an altitude of 1550 m above sea level, while Metehara sugar factory is found between 8˚51′ N and 39˚ 52′ E at an altitude of 950 m above sea level. The average annual rainfall for the respective sugar estates was about 800 mm and 554 mm (Esayas *et al*., 2018). During the study year, the area coverage of Wonji-Shoa's sugarcane plantation was 12800 hectares, while Metehara sugar estate had 10235 hectares of plantation. Mixed crop-livestock production system dominates around Wonji-Shoa sugar estate, while the pastoral and agro-pastoral systems prevail around Metehara sugar estate.

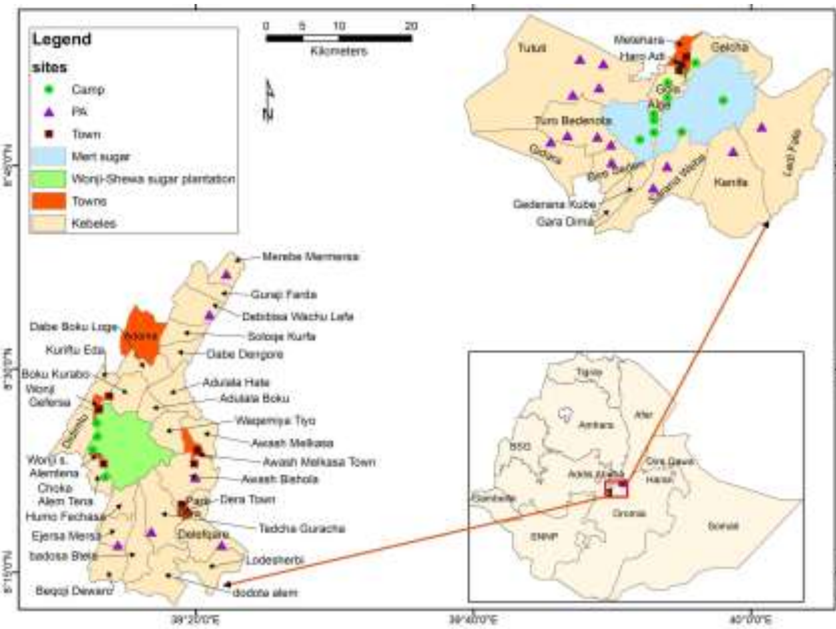

Figure 1. Map of the study areas

Survey sites, participants and data collection

Smallholder livestock farms located in the vicinity of the two sugar estates were the target population for this study. At each sugar estate, rural kebeles (PA) and towns nearby sugarcane plantations, and workers' camps within sugarcane farms were selected and assessed. List of rural households owning livestock was obtained from the agricultural office of three districts (Adama Zuria, Fantale and Dodota) adjoining sugarcane plantation, while households in towns and camps were obtained by enumeration. Residents in camps raise livestock in open barns (zero-grazing) located at marginal areas of sugarcane plantations. A total of 9 PAs (3 in Metehara; 6 in Wonji-Shoa), and the respective 6 towns (2, 4) and 6 camps (3, 3) were selected purposely based on livestock population and accessibility for the study. To simplify data analysis and interpretation, livestock farms located in towns and camps of the respective sugar estates were categorized as "urban" farms as they are governed by the same municipality and the production system and feeding managements are alike. The sample size of participant households was determined as described by Fluid Surveys (2014): Sample Size Calculation: Sample Size = (Distribution of 50%) / ((Margin of Error% / Confidence Level Score)^2), and Finite Population Correction: True Sample = (Sample Size X Population)/(Sample Size + Population – 1). Considering a 50% distribution accounted for respondents' variation on a response, a margin of error of 5% and 95% confidence level score of 1.96, a population of 1546 smallholder livestock farms in the study areas (Metehara, 552; Wonji-Shoa, 994) who have access to the byproducts, the total number of respondents (N) was calculated to be 308. Of the HHs owning livestock in the selected rural and urban kebeles of Metehara and Wonji-Shoa, only the respective (53, 57) and (103, 95)

HHs were selected randomly proportionate to their size, and interviewed. A single-visit-multiple-subjects survey method (ILCA, 1990) was employed and a semi-structured questionnaire was developed and pre-tested by trained enumerators to gather quantitative and qualitative data on household family size, education, occupation, herd size and structure, land holdings and SCTs utilization. Secondary data on annual sugarcane production were taken from the respective sugar estate factory to estimate the volume of SCT generated by dividing the amount of sugarcane milled by 10 (Deshmukh, 1983). In addition, green SCT generated from seedcane production was estimated and incorporated to the total SCT production.

Statistical analysis

Data were subjected to statistical analysis using the Statistical Package for Social Science (SPSS, 2011; version 20). Descriptive statistics (percentage, mean) were used with Pearson Chi-square test (X^2) to compute discrete variables, while the Mean statement was used for continuous variables.

Results and Discussion

Household characteristics

The household characteristics of sample respondents are indicated in Table 1. A larger proportion of male-headed households (87.4 - 90% than female-headed households (10-12.6%) were engaged on livestock farming without a notable difference ($P>0.05$) between the sugar estates. However, there were more female-headed households in urban than in rural Wonji-Shoa. A higher number of male-headed than female-headed households were reported elsewhere in rural areas (Zewdie and Yoseph, 2014; Tesfaye, 2016) and urban areas (Duguma and Janssens, 2016) of the country. The average age of a household head in Wonji-Shoa (42.8 years) and Metehara (39.9 years) sugar estates were within the range of the productive age group (15-64 years). Regardless of location specific, a large proportion of households in the study area were literate (85%), while the average family size in Metehara (5.8) and Wonji-Shoa (5.9 persons/HH) surpassed the national average (5.14 persons/HH; CSA, 2016). The larger family size in the rural than urban households could probably indicate less access to family planning education in the former.

Table 1. Characteristics of respondent households in the study areas

Parameters	Metehara			Wonji-Shoa			*P*-value
	Rural (n=53)	Urban (n=57)	Total (n=110)	Rural (n=103)	Urban (n=95)	Total (n=198)	Sugar estates
Sex of HH head (%)							0.251
Male	86.8	93.0	90.0	92.2	82.1	87.4	
Female	13.2	7.0	10.0	7.8	17.9	12.6	
Age of HH head	41.2	38.7	39.9	41.7	44.0	42.8	0.032
Education of HH head (%):							0.042
Illiterate	39.6	3.5	20.9	8.7	14.7	11.6	
Read and write	24.5	45.6	35.5	37.9	33.7	35.9	
Grade 1-8	13.2	26.3	20.0	23.3	10.5	17.2	
Grade 9-12	17.0	21.0	19.1	25.2	34.8	29.8	
$\geq$Diploma	5.7	3.5	4.5	4.9	6.4	5.5	
Family size	6.2	5.5	5.8	6.2	5.6	5.9	0.720

Rural =peasant associations, n= number of respondents (HH head)

Land and livestock holdings

Except for limited private grazing land holdings, lands owned for other purposes were higher (P<0.001) in Wonji-Shoa than Metehara sugar estate (Table 2). The cultivated landholding in Wonji-Shoa (1.64 ha/HH) was about five-fold higher than in Metehara sugar estate. The average total land holding in Wonji-Shoa and Metehara was 1.82 and 0.40 ha/HH, respectively. Total private land holding in rural areas of Metehara was three-fourth less that of Wonji-Shoa (2.84 ha/HH) probably because land in pastoral areas is mainly owned communally. Except for 2.54 ha of cropping land or 2.83 ha of total land owned by rural households in Wonji-Shoa, land allotted for other purposes and total holdings were exceeded by the national average (1.06 ha; CSA, 2016).

Total livestock holdings among the households varied (P<0.05) between the two sugar estates. Cattle holdings represented the lion share, which was higher (P>0.01) in Wonji-Shoa than Metehara and in rural than urban areas. The total livestock holding (5.7 TLU/HH) of the study area was close to or lower than past reports for central highlands (Zewdie and Yosef, 2014; Fekede *et al*., 2013).

Table 2. Land and livestock holdings of the farm households in the study areas.

Variables	Metehara			Wonji-Shoa			P-value
	Rural	Urban	Total	Rural	Urban	Total	Sugar estate
Land holdings (ha/HH):							
Cropping	0.67	0.04	0.35	2.54	0.67	1.64	<0.001
Grazing	0.00	0.03	0.02	0.10	0.00	0.06	0.127
Residential	0.04	0.02	0.03	0.19	0.05	0.12	<0.001
Total	0.71	0.10	0.40	2.83	0.72	1.82	<0.001
Livestock holdings (TLU/HH):							
Cattle	4.5	3.64	4.06	5.06	4.62	4.85	<0.001
Small rum.	1.43	0.11	0.75	0.8	0.14	0.48	0.030
Equines	0.95	0.13	0.52	0.75	0.23	0.95	<0.001
Chicken	0.03	0.0	0.02	0.07	0.04	0.05	<0.001
Total	6.91	3.88	5.35	6.68	5.03	6.33	<0.001

P-value compares within a row total for the sugar estates; HH= household; TLU (Tropical livestock Unit): Gryseels (1988) and Bekele Shiferaw (1991).

Production of sugarcane tops

Given a production year, the estimated volume of SCT generated from Metehara exceeded that of Wonji-Shoa (Figure 2). Assuming the dry matter content of 23% for SCT, the average annual production of SCT was estimated at 14402.4 and 24312.9 tons of DM in Wonji-Shoa and Metehara sugar estate, respectively. The variation in SCTs production between the two sugar estates was directly proportional to the amount of sugarcane milled or area of field harvested. During the study period, Wonji-Shoa and Metehara sugar factories operated at 85% and 91% of their potential capacity, crushing 4500 and 4800 tons of sugarcane per day, respectively. Suttie (2000) suggested that SCT accounts for about 15 to 25% of sugarcane biomass, which is equivalent to 8-10% of millable sugarcane (Deshmukh, 1983). Except when seedcane from the nursery site was harvested for planting purposes, most of the SCTs were available in the burnt form, leading to certain dry matter loss (Naseeven, 1988). Where no pre-harvest burning of sugarcane fields (i.e., SCTs are harvested green), a range of 6.4-11 tons DM/ha SCTs were obtained varying with sugarcane cultivars (Ripoli *et al*., 2005).

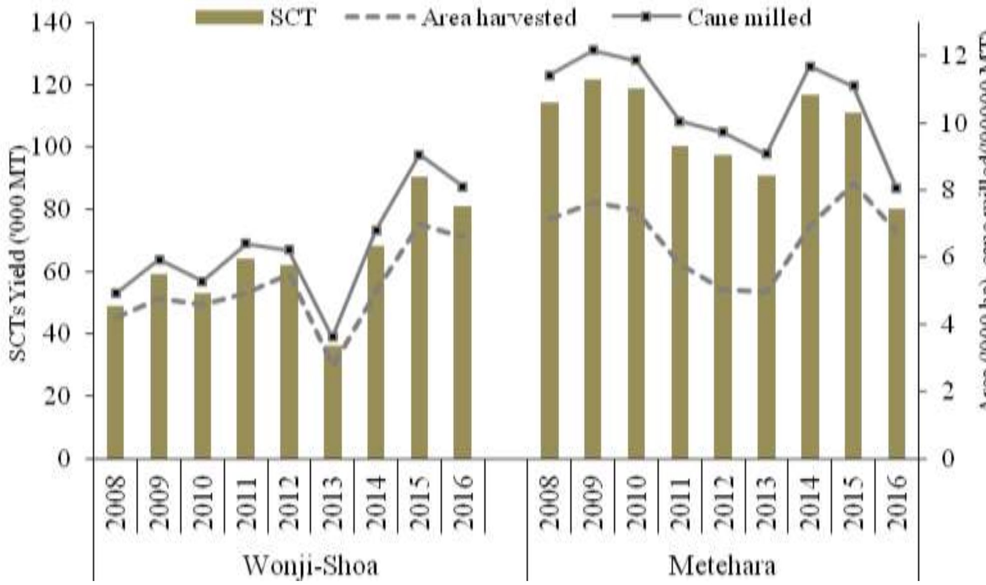

Figure 2. Production of sugarcane tops in the study areas

Accessibility and availability of SCTs

The majority of households in Metehara (98.2%) and Wonji-Shoa (91.9%) sugar estates obtained ($P<0.0001$) SCTs by collecting directly from the fields, while significant proportions of households also purchased it from collectors owning horse Carts (Table 3). A homestead distance from the field and transport availability had an effect ($P>0.01$) on household access to SCTs, where most of the households were found within 15 km radius from the source. Distance to the harvesting field within a wider area of sugarcane plantation fluctuates daily depending on the harvest calendar of the respective sugar factory. About 61.8% of households in Metehara and 52.5% of households in Wonji-Shoa were located within 5 km radius from the state farms. Although most of the households (>50%) using SCTs are situated in the vicinity of the state farms, they often purchased SCTs from collectors. A study conducted by Tesfaye and Chairatanayuth (2007) also revealed that lack of transport and high distance to source fields constrained the collection and utilization of crop-residues by users. Local livestock producers and traders in the study area often competed for collecting SCTs from the fields. The high competition for SCT collection from the field has implications for its abundance, seasonal availability at no cost, and absence of restriction to access sugarcane fields. Up to now, the industries have neither alternative disposal mechanism for SCTs nor a plan for other uses implying that it remains a potential feed resource for livestock producers in the areas.

The type and availability of SCTs were influenced by the season of the year, depending mainly on the harvesting method and purpose of sugarcane production (Figure 3). The pre-harvest burning of sugarcane field has favored the abundant availability of burnt SCTs between November and June, coinciding with feed scarce period (between December and May) when the cost of available feeds is high. As disclosed by the respondents, the availability of SCTs was peaked in March (83.4%) decreasing thereafter and lowest between July and October as the factories cease operation. During this period, farmers utilized SCTs conserved during the harvesting season, but little from their own farms. There was no evidence indicating the surplus SCTs left in field are removed by burning, probably because livestock producers and individuals making business of it are highly competing, wherever harvesting is operated within the estate farms. However, Adugna and Makkar (2018) reported a large proportion of SCTs produced in sugar industries are left in the field and removed by burning. Similarly, Funte *et al* (2010) reported the majority of small-scale sugarcane farms in southern Ethiopia used SCTs and green leaves as feedstuff mostly in the dry season. Green SCTs were available in seedcane planting season, each year between December and March. In Wonji-Shoa, about 7.1% of farm households obtained green SCTs from their own farms often when sugarcane is harvested and sold for chewing.

Table 3. Sources of sugarcane tops (% of respondents) and distance (km) from a homestead

Parameter	Metehara			Wonji-Shoa			*P*-value
	Rural	Urban	Total	Rural	Urban	Total	Sugar estate
Collecting from field	100	96.5	98.2	99.0	84.2	91.9	0.000
Purchase from collectors	81.1	73.7	77.3	29.1	86.3	56.6	0.000
Purchase from market	7.5	0	3.6	0	0	0	na
Own farm	0	0	0	6.8	7.4	7.1	na
Distance from field:							
<5km	39.6	82.5	61.8	54.4	50.5	52.5	
5-15km	45.3	17.5	30.9	43.7	49.5	46.5	0.002
15-30km	15.1	0	7.3	1.9	0	1	

P-value compares within a row total for the two sugar estates ; na=not applicable

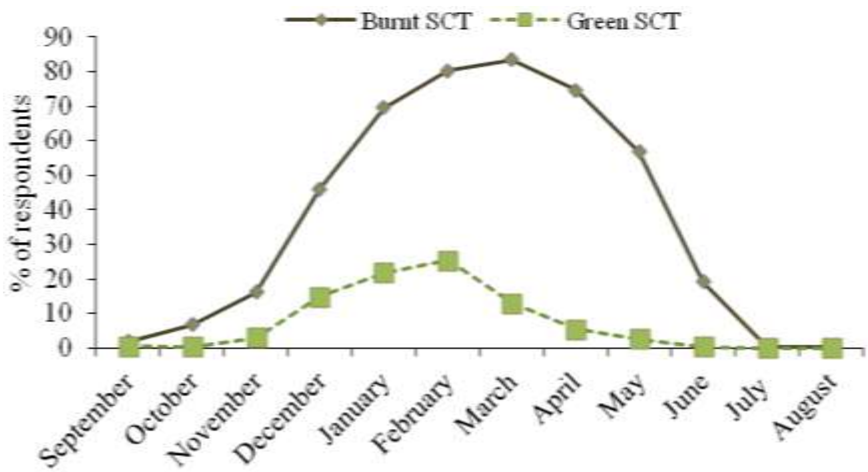

Figure 3. Seasonal availability of burnt and green sugarcane tops

Uses of sugarcane tops

The proportion of households using SCTs as livestock feed, fuel and income source did not differ (P>0.05) between the sugar estates (Table 4). The entire surveyed households used the burnt SCTs as feedstuff, while the use of green SCTs as feedstuff was moderate. About 37% of households in Wonji-Shoa and 24% of households in Metehara sugar estates utilized (P<0.001) SCTs to construct roofs or fences, and over 50% of the households in the study areas used it as a fuel source for cooking. A relatively lower proportion of households used SCTs for stall bedding and income source by selling it.

Feed use of SCTs by smallholder farmers has been favored by its abundant availability and proximity to the sugar industries. Sugarcane tops are potential feed resources in the tropics (Preston and Leng, 1991). Despite the abundant availability of SCTs in feed deficit season (Da Costa et al., 2015), its nutritive value is low (Khanal et al., 1995; Suttie, 2000). It was reported that SCTs contribute about 0.5% of the annual feed DM available in Ethiopia (Adugna et al., 2012), but can be potentially exploited for future livestock development.

Table 4. Uses of sugarcane tops (% respondents) by households in the study areas

Parameter	Metehara			Wonji-Shoa			*P*-value
	Rural	Urban	Total	Rural	Urban	Total	Sugar estate
Livestock feed:							1.000
Burnt SCT	100	100	100	100	100	100	
Green SCT	39.6	43.9	41.7	13.6	58.9	36.25	
Fuel source	62.3	49.1	55.5	44.7	61.1	52.5	0.296
Construction	37.7	36.8	37.3	11.7	37.9	24.2	0.001
Stall bedding	13.2	7	10	0	30.5	14.6	0.000
Income source	9.4	15.8	12.7	2.9	2.1	2.5	0.442

P-value compares within a row total for the two sugar estates

Market prices of sugarcane tops

Sugarcane tops were widely bargained in the study area. Horse cart was used as a unit of exchange in bargaining SCTs, local people being the main suppliers. A horse cart carries a range of 150-300 kg SCTs (wet basis), which varies with type and amount of SCTs. The average bargaining prices of burnt and green SCTs (297.86 *versus* 195.5 birr/cart) in Metehara were three-fold ($P<0.0001$) higher than in Wonji-Shoa (Table 5). Distance from a homestead and the amount of SCTs collected were the major price determinant factors. Other price determinants include transport cost, season, demand, lack of labor, and type/variety of SCT.

Unlike other crop-residues that are marketed on formal markets in the country, SCT was marketed only around the sugar industries. It is obvious that the bulkiness of SCTs made it inconvenient for transportation and marketing to distant areas. However, collectors often brought SCT to individual farm gates for selling. Its selling price is majorly determined by the amount collected and the distance traveled to the source fields. The higher price of SCT noted in Metehara than Wonji-shoa might be due to the difference in distance to the field, and the availability of SCTs transport and alternative roughages. The high price fetched by the burnt compared to green SCTs could be related to its high demand by urban livestock farms. Studies (Funte *et al*., 2010; Jimma *et al*., 2016) have shown that SCTs are also a good source of roughage for livestock where small-scale sugarcane farms prevail.

Table 5. Market price of sugarcane tops in the study areas

SCT type	Metehara			Wonji-Shoa			
	Min	Max	Mean±SE	Min	Max	Mean±SE	*P*-value
SCT (birr/horse cart):							
Burnt SCT	200	375	297.9±5.0	30	180	82.36±3.4	0.000
Green SCT	150	250	195.5±9.0	25	150	52.39±6.0	0.000

P-value compares within a row mean of the two sugar estates

Farmers' preference to SCTs

Farmers in the study area depicted different preferences for SCTs types (Figure 4). A large proportion of households preferred burnt to green SCTs, stating that green SCT is high in moisture and has a spine, causing mouth injures to animals. Tops from thin-stem sugarcane varieties were more preferred by farmers as they are soft, palatable and juicy with minimal risk of mouth injury. Also, less leafy SCTs (36%) were preferred by farmers to the leafier ones as the burnt leaves are hardly chewed, but the stems are juicy and edible to animals. Farmers perceived that SCTs from sugarcane variety- B52298 (Wonji-1), NCo334 and SPY-421 had desirable feed quality, while N-14 (Natal), Barbados and 341-Mexico were less important.

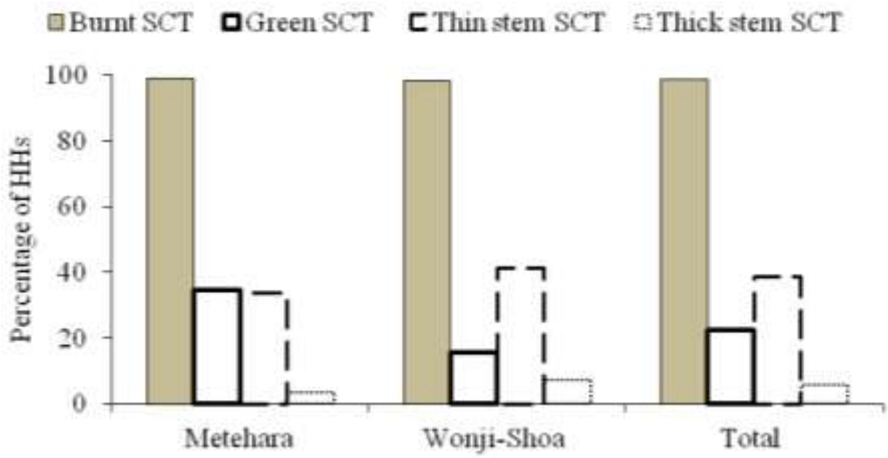

Figure 4. Farmers' preferences to SCT type as livestock feedstuff (% respondents)

Feeding, processing and conservation practices

Sugarcane tops were principally fed to dairy cattle as depicted by the majority of households in Metehara (91%) and Wonji-Shoa (87%) (Table 6). It was also fed to fattening bulls and oxen, draught oxen, equines and camel (in descending order). Green SCTs were mainly fed to calves. In agreement, previous studies (Naseeven, 1988;Suttie, 2000; McKenzie *et al*., 2007) have shown SCTs as an important roughage source for ruminants. The advantages of SCTs feeding to livestock were witnessed by farmers as highly palatable, edible, increased the milk yield of cows, fattening animals gain fast and their coat color appear shiny, and reduces production costs by replacing costly concentrates.

Table 6. Type of livestock feeding sugarcane tops (% respondents)

Parameter	Metehara			Wonji-Shoa			*P*-value
	Rural	Urban	Total	Rural	Urban	Total	Sugar estate
Dairy cows	98.1	84.2	90.9	88.3	86.3	87.4	0.090
Calves	83.0	61.4	71.8	58.3	60.0	59.1	0.263
Fattening bull/oxen	75.5	49.1	61.8	85.4	81.1	83.3	0.008
Draught oxen	54.7	5.3	29.1	66.0	16.8	42.4	0.000
Sheep and goat	34.0	3.5	18.2	20.4	11.6	16.2	0.000
Equines	20.8	1.8	10.9	6.8	3.2	5.1	0.002
Camel	3.8	0.0	1.8	0.0	0.0	0.0	na

P-value compares within a row total for the two sugar estates ; na = not applicable

A large number of surveyed households in Metehara (63.6%) and Wonji-Shoa (98.2%) offered intact SCTs to their animals, while those offering chopped SCTs represented 43 and 85%, respectively (Figure 5). In Wonji-Shoa, chopped SCTs were fed by mixing with other roughages (27.3%), purchased concentrates (20.7%), molasses, salt or brewery and distillery residues (16.2%) and/or water (9.1%). However, these are less important for the households in Metehara sugar estate. Farmers explained that they manually chopped SCTs, to reduce wastage, increase consumption and reduce the risk of mouth injury. Chopping SCTs increases its consumption and reduces wastage and incidence of injury. However, the manual chopping practice is labor intensive and time consuming. In this regard, the lack of a mechanical chopper was a notable constraint for farmers. Chopping makes the storage and transport of bulky roughages economical and improves its utilization by animals (Osafo et al., 1997; Syomiti et al., 2011). The other common practices included blending SCTs with concentrate or other roughages and soaking it with salt, molasses and water. Supplementation is the best strategy to improve feed values of low quality roughage (Syomiti et al., 2011; Preston and Leng, 1991).

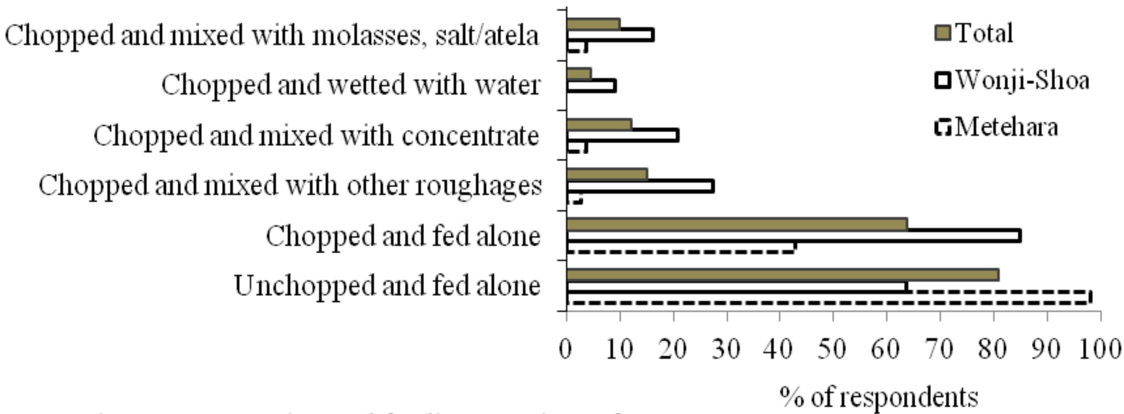

Figure 5. Processing and feeding practices of SCTs

The livestock producers in the study areas conserve SCTs for feed use. About 98% of households in Metehara and 99.5% of households in Wonji-Shoa sugar estates conserved burnt SCT, while 35.5 and 27.5% of households in the respective areas conserved green SCTs (Table 7). Sun drying of SCT before storing was practiced by a large number of households (Metehara- 98.2%; Wonji-Shoa- 80.8%) as compared to under shed drying (31.8%, 40.4%). About 91.8% of households in Metehara and 85.9% of households in Wonji-Shoa stacked SCTs in an open-air or along the fence, while the proportions of households storing SCTs under shed were 49.1% and 38.4%, respectively. Drying intact SCTs only by turning delay moisture removal. Leaf tissue has a high surface-to-volume ratio and numerous stomata that favor rapid drying (Digman *et al*., 2011). However, with an increase in stem-thickness, the radial distance of stem core to the surface increases making the drying process difficult (Romero *et al*., 2015). Chopped thick-stem forages lose moisture at a higher rate and hence dry fast. However, farmers chopped SCT only at feeding times, but not for preserving purposes.

The storage duration of SCTs varied (P>0.01) among the surveyed households, in which about 87% of households in Metehara and 70% of households in Wonji-Shoa stored SCTs before use for a week to 4 months period. Other farms stored it even for 8 months or beyond. Most of the respondents in Metehara (94.5%) and Wonji-Shoa (89.4%) noted quality loss upon drying and storing of SCTs for a longer period. An open-air storage of SCTs predisposes it to rain and sunlight, leading to quality losses. Hence, the poor preserving practices of SCTs coupled with its low quality affect the feed value. Farmers perceived the spoilage of SCTs by their bad smell, color change to dark brown, mold appearance, hard texture of leaves and loss of palatability by animals.

Table 7. Preserving practices of sugarcane tops and quality loss at storage (% respondents)

Parameter	Metehara			Wonji-Shoa			*P*-value
	Rural	Urban	Total	Rural	Urban	Total	Sugar estate
Type of SCT:							
Green SCT	32.1	38.6	35.5	11.7	45.3	27.8	0.000
Burnt SCT	98.1	98.2	98.2	99	100	99.5	0.577
Drying method							
Sun drying	100	96.5	98.2	69.9	92.6	80.8	0.000
Shed drying	34.0	29.8	31.8	62.1	16.8	40.4	0.000
Storage condition:							
Stacked in an open air	86.8	96.5	91.8	75.7	96.8	85.9	0.000
Stacked under shed	35.8	61.4	49.1	46.6	29.5	38.4	0.790
Stacked along fence	58.5	0	28.2	51.5	56.8	54.0	0.001
Storage duration							
1week-1 month	24.5	47.4	36.4	28.2	24.2	26.3	
1-≤ 4 month	54.7	47.4	50.9	54.4	31.6	43.4	0.006
4 -≤8 month	18.9	5.3	11.8	14.6	29.5	21.7	
>8 month	1.9	0.0	0.9	2.9	14.7	8.6	
Quality loss characteristics:							
No quality loss	9.4	1.8	5.5	17.5	3.2	10.6	0.000
Bad smell	88.7	53.6	70.6	66.0	92.6	78.8	0.365
Color change	69.8	66.1	67.9	74.8	87.4	80.8	0.188
Mold appearance	81.1	73.2	77.1	68.0	58.9	63.6	0.122
Rough in texture	34.0	0.0	16.5	39.8	42.1	40.9	0.034

P-value compares within a row total for the two sugar estates

Challenges in using SCTs as livestock feed

Constraints facing farmers in using SCTs as feed resource is indicated in Figure 6. Low nutritive value of SCTs (91.2%) especially with extended storage time and lack of means of transportation (26%) were principal challenges reported by respondents. Less important problems were health risks (mouth injuries) resulting from feeding unchopped dried SCTs (16.2%) and lack of labor and capital (11.7%). Although some farmers had interest to purchase electrically operating choppers, they had no information and support from the supply side. About 89% of the households did not receive any technical support on SCTs processing, conservation and feeding management.

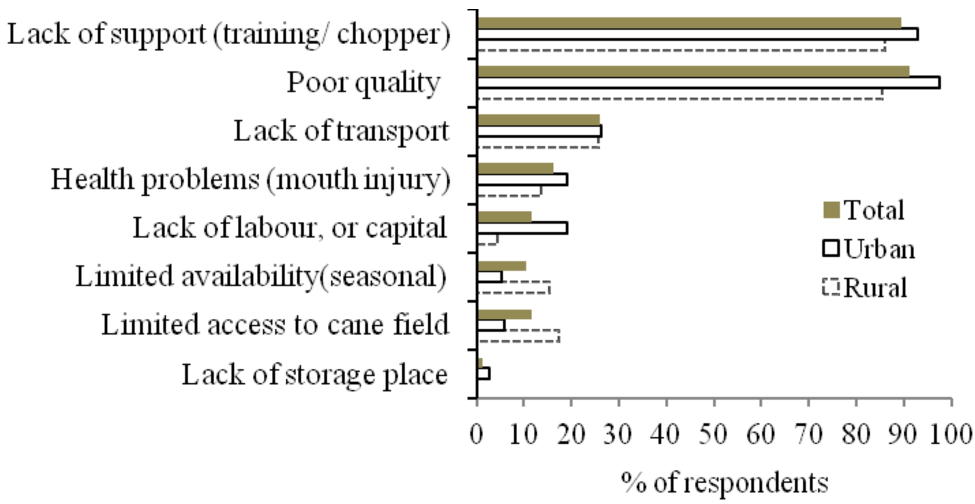

Figure 6. Major constraints faced farmers in using SCT and molasses

Conclusion and Recommendations

This study has revealed that SCTs are important feed resource for smallholder livestock farms close to Wonji-Shoa and Metehara sugar estates. It was mainly used to feed ruminants and abundantly available in the dry season when the common feedstuffs are in scarce and/or their prices escalate. Farm households adopted different processing and conservation practices of SCTs. However, it has been poorly utilized due to harvesting method employed by the industry, poor handling by farmers and lack of technical supports. This demands technology intervention in areas of processing and conservation. Therefore, technical supports including chopping, proper drying, baling, ensiling, supplementation, and availing a chopper for farmers at a reasonable price are vital. Further research is imperative on SCTs quantification (production/availability) in fields and manipulation for improved livestock feeding.

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