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Mulberry (*Morus alba*) as Emerging Potential Opportunity For Livestock Feed Development In Northern Ethiopia

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ABSTRACT

This study was conducted in five districts of Tigray region, Northern Ethiopia to explore the current status of mulberry (*Morus alba*) plant cultivation and utilization. From each study district, fifteen households who own mulberry plant were selected and pre-tested structured questionnaire was used to elicit information from the respondents. Collected data were complimented with information obtained from field checks and secondary data from development agents of the respective districts. Respondents noted that February to June are the critical feed shortage times across the study districts. Respondents mentioned use of conserved feeds, purchased feeds, feeding cactus pear (*Opuntia ficus indica*), sharing feeds with other farmers and reducing the number of animals as the most important strategies to tackle feed shortage, in that order. The overall average mulberry plant per household was 9.1 and respondents' experience in cultivating mulberry was 5.2 years. The majority (76.7%) of respondents grew mulberry around their homestead followed by boarders of irrigation fields. The purpose of growing mulberry was to use it as feed for silkworm. Only 20% of the respondents have awareness and appreciation of the potential of mulberry as feed for livestock. However, the majority (93%) of interviewed households showed their interest in increasing the number of the plant, if convinced about its importance as livestock feed. Therefore, there is a need to evaluate the chemical composition, nutritive value and supplementary effect of mulberry leaf on the performance of ruminant animals for awareness creation and its wide scale planting and utilization as alternative feed for livestock.

Key words: Feed, Forage, Livestock, Mulberry, Roughage, Shrubs and Survey.

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INTRODUCTION

It is a widely known fact that Ethiopia has the largest livestock population in Africa (CSA, 2013). However, the country is not fully benefitting from the sector due to, among others, shortage of feed both in quality and availability (Adugna, 2007; Legesse, 2008). The major feed resources in Ethiopia are crop residues and natural pasture (Negesse et al., 2009), which are generally characterized by relatively low nutrient content, high fiber content, low digestibility and low voluntary intake (Adugna, 2008). Consequently, these feed resources usually fail to provide sufficient nutrients for reasonable livestock productivity (Shayo, 2002). This implies that such diets require supplementation to enhance animal performance. One potential way for increasing the availability of feeds for smallholder farmers could be through the use of fodder trees and shrubs (Ajebu et al.,

Table 1. Altitude, rainfall and temperature ranges of the surveyed districts.

Districts	Altitude (masl)	Rainfall (mm)	Temperature(^{o}C)
Kilte-Awlalo	1760-2720	500- 1000	16-20
Hawzein	1500-2400	580-750	14-27
Ganta-Afeshum	1500-3500	580-750	2- 24
Ahferom	1400-3200	450-650	25-34
Medebay-Zana	1700-1900	650-950	15-30

masl= meter above sea level.

2013).

The use of tree forages as components of diets is a widespread practice in many tropical countries (Singh and Makkar, 2002). These feed resources have good nutritive value, and positively impact rumen function and microbial yield (Leng, 1997). The use of such forages is also the most practical method that can be adopted locally by small-scale farmers (PANESA, 1988). As a result, fodder trees and shrubs gained great attention for improving livestock productivity in developing countries, including Ethiopia (Franzel et al., 2014). One of the forage plants that can contribute significantly as feed resources to supplement low quality roughages is white mulberry (*Morus alba*). It is a shrub or a tree, which belongs to Moraceae family (FAO, 1990). It is found from temperate to subtropical regions of the Northern hemisphere to the tropics of the Southern hemisphere and can grow in a wide range of climatic, topographical and edaphic conditions (Ercisli and Orhan, 2007). Mulberry has been used traditionally as a major feed for silkworms in different parts of the world (Vu et al., 2011).

There is also evidence that indicates the potential of mulberry plant to be used as sources of high quality forage or protein banks when feed is scarce or when natural forages are of very low quality (Doran et al., 2007). Studies have found that mulberry is well comparable with leguminous multipurpose trees as a feed for ruminants (Sánchez, 2002; Kabi and Bareeba, 2008).

Available literatures indicate the positive effects of feeding mulberry on milk yield (Benavídes et al., 2002; Singh and Makkar, 2002), growth rate of sheep (Liu et al., 2001) and goats (Omar et al., 1999; González and Milera, 2000). Mulberry is introduced in different parts of Ethiopia, including Tigray region. Nevertheless, data regarding area with mulberry plantation is not available in the country. Despite the availability of this versatile plant in different parts of Ethiopia largely for silkworm farming (Sanchez, 2002), hardly any research has been conducted regarding its role as feed for livestock in the country. Therefore, this study explores the current practice of mulberry cultivation and utilization in Tigray Regional State, Northern Ethiopia.

MATERIALS AND METHODS

Description of Study Areas

The survey was conducted in Tigray Regional State, Northern Ethiopia, situated between latitudes 12°15' N and 14°57' N and longitudes 36°27' E and 39°59' E (Aklilu, 2007). Five districts namely, Kilte-Awlalo, Hawzein, Ganta-Afeshum, Ahferom and Medebay-Zana were selected purposively based on availability of mulberry plantation. Mixed crop-livestock is the major production system in all the study districts. The major livestock species of the area that play role in the livelihood of the smallholder farmers include cattle, sheep, goat, chicken and equines. The surveyed districts vary in altitude, rainfall and temperature (Table 1).

Data Collection and Statistical Analysis

From each study district, fifteen households who own mulberry plant were identified and selected purposely for data collection. A structured questionnaire was designed, pretested and used to acquire information to understand status of feed shortages and associated coping mechanisms, to profile mulberry grower households in terms of trees per household, years of experience, purposes and methods of establishment and explore awareness of the feed value of the plant. The interview was conducted by the help of trained enumerators under close supervision of the principal researcher. Field observations were made and secondary data were obtained in collaboration with the development agents in the respective districts to verify and complement information acquired via the questionnaire survey in those locations. Data collected were systematically coded and analyzed using descriptive statistics by employing Statistical Package for Social Sciences (SPSS, 2011). For data involving frequencies, descriptive statistics were used and Pearson Chi-square (χ^2) was used to compare categorical variables between surveyed districts. Quantitative variables were analyzed using analysis of variance procedure (SAS, 2002).

Table 2. Household characteristics in the five study districts of Tigray Regional State (values are mean (SD).

	Districts							
Variables	**KA**	**Hawzein**	**GA**	**Ahferom**	**MZ**	**Overall**	**X^2**	**P-value**
Age (years)	47.5 (6.02)	48.5 (5.18)	46.9 (6.99)	46.7 (5.87)	47.5 (7.87)	47.5 (6.31)	-	0.95
Family size	5.1 (1.36)	4.9 (1.19)	5.2 (1.57)	4.9 (1.1)	5.20 (1.52)	5.1 (1.33)	-	0.94
Landholding (ha)	0.9 (0.24)	0.8 (0.19)	0.86 (0.39)	0.87 (0.25)	0.87 (0.31)	0.87 (0.28)	-	0.97
Education level (%)								
Read and write	73.3	66.7	76.9	60.0	73.3	69.9	1.25	0.87
Illiterate	26.7	33.3	23.1	40.0	26.7	30.1		

KA=Kilte-Awlalo; GA= Ganta-Afeshum; MZ=Medebay-Zana; SD=standard deviation; X^2 = Chi-square.

Table 3. Farmers' response on critical feed shortage seasons of the year and coping mechanisms in five districts of Tigray region (% of respondents)

	Districts							
Variables	**KA**	**Hawzein**	**GA**	**Ahferom**	**MZ**	**Overall**	**X^2**	***P-value***
Months of the year								
February-June	80.0	86.7	84.6	93.3	86.7	86.3	1.17	0.88
July-September	20.0	13.3	15.4	6.7	13.3	13.7		
Copping methods								
Purchasing feeds	40.0	26.7	30.8	26.7	46.7	34.2	2.08	0.72
Feeding cactus	66.7	46.7	84.6	26.7	-	43.8	2.51	0.00
Sharing	20.0	20.0	23.1	20.0	26.7	21.9	0.305	0.99
Conserving feeds	53.3	46.7.0	61.5	46.7	60.0	53.3	1.15	0.88
Sale of animals	26.7	20.0	23.1	20.0	13.3	20.5	0.889	0.93
Others	13.3	13.3	15.4	33.3	30.0	20.4	3.21	0.52

KA=Kilte-Awlalo; GA= Ganta-Afeshum; MZ=Medebay-Zana; X^2 = Chi-square; Percentages exceed 100% within columns as respondents mentioned two or more feed shortage coping mechanisms.

RESULTS AND DISCUSSION

Household Characteristics

The overall mean age (years) of household heads and family size were 47.5 and 5.1, respectively (Table 2). These values are comparable with the average age of 47 years and family size of 5 reported for the households of the southern and eastern zones of Tigray regional state (Gebremeskel et al., 2013). Similarly, the average family size obtained in this study is close to the estimated family size of 4.98 of rural households of Tigray region (CSA, 2007). Family size may influence the need for improving adoption of forage and browse legume technologies (Mapiye et al., 2006). Similarly, it has been stated households with lare family size decide to use improved technilogies to improve productivity and income (Workneh et al., 2008). The overall average total landholding was 0.87 ha, which is similar to the value of 0.88 ha land holding per holder in the region reported by CSA (2007). It also agrees with Pender and Gebremedhin (2004), who reported less than one ha of land holding per household in Northern Ethiopia. About 70% of the household heads were able to read and write while the remaining households were illiterate. These figures are not consistent with Genzebu et al. (2012) who reported higher rate of literacy in Medebay-Zana district of Tigray region. However, it is in line with that noted by Gebremeskel et al. (2013) who obtained comparable illiteracy rates in Ganta-Afeshum district of eastern zone of Tigray region.

Seasonal Feed Shortage and Coping Mechanisms

In the study districts, feed shortage is quite common from February to June (Table 3). Some (13.7%) respondents also mentioned the occurrence of feed shortage during rainy season (July to September). This might be due to restricted movement of livestock as crops occupy most of the available land during rainy season (Alemu et al., 2013). Use of stored feeds (mainly crop residues and hay), feeding cactus pear (*Opuntia ficus indica*), and purchased feeds, sharing feeds with other farmers and reducing livestock number through sale were the most important copping strategies to feed shortage noted by respondents. Similar coping mechanisms to feed

Table 4. Average number of mulberry plant per household and respondents' years of experience in growing mulberry in the study districts (values are mean (SD)).

	Districts						
Parameter	**KA**	**Hawzein**	**GA**	**Ahferom**	**MZ**	**Overall**	***P-value***
Tree number	8.9 (2.3)	9.7 (2.9)	8.5 (1.8)	8.8 (3.9)	9.7 (2.4)	9.1 (2.7)	0.53
Experience(Year)	4.9 (1.2)	5.2 (1.0)	4.7 (1.0)	5.8 (0.9)	5.4 (1.6)	5.22 (1.1)	0.12

KA=Kilte-Awlalo; GA=Ganta-Afeshum;MZ=Medebay-Zana;HH=Households;SD=standard deviation.

shortage have been reported for different parts of Ethiopia (Alemu et al., 2013; Assefa et al., 2014). Greater proportion (P<0.05) of respondents in Kilte-Awlalo and Ganta-Afeshum utilize cactus pear during season of feed shortage than in the other districts.This could be due the wider availability of cactus pear in eastern zone, particularly in Ganta-Afeshum and Kilte-Awlalo than other districts. The availability and potential value of cactus pear as food and fodder plant in Eastern and Southern zones compared to other zones of Tigray regional State was also reported by Gebremeskel et al. (2013).

Number of Well-Established Mulberry Trees and Years of Experience

The overall average year of experience was 5.22 years (Table 4). This indicates that mulberry cultivation is a recent activity in the study areas, as is generally true in Tigray Regional State at large. The average number of well-established mulberry plant per household was 9. This implies that mulberry cultivation is not only a recent activity but its scale of operation is also very limited in those areas. The presence of low number of mulberry tree per household could be due to lack of awareness among farmers and livestock experts' vis-à-vis its role as livestock feed.

Initial Sources of Mulberry Planting Material and Planting Strategies

Government organization namely Bureau of Agriculture and Rural Development was the major source of initial mulberry planting material across visited study districts (Table 5). However, according to some respondents and development agents in Hawzein district, there is one NGO, namely Millennium village, distributing mulberry tree cuttings to the farmers targeting silkworm rearing. Farmers use cutting as an exclusive method of mulberry plant propagation in all the surveyed districts. Though mulberry can be propagated artificially from seeds (seedlings) or cuttings (Shayo, 1997; Sánchez, 2002; Singh and Makkar, 2002), cutting is the most common method of propagation (Gezahegn et al., 2005). It was observed that many of the respondents (76.7%) grew mulberry tree around their homestead followed by borders of their irrigation fields (Table 5). This agrees with the report of Shayo (1997) where farmers grow mulberry tree mostly around their homestead in Tanzania. Respondents who had access to irrigation grew mulberry plant around their irrigation field in combination with other perrinial fruit trees. Respondents noted that they have not observed any negative effect of growing mulberry plant in combination with other food crops. It was reported that planting of mulberry trees within hedgerows increases production of the system and efficiency of land use with less or no wastage of land under the alley cropping system (Ya et al., 2003).

Purpose of Growing Mulberry Plant and Farmers Awareness

All respondents noted that the purpose of introducing and growing mulberry tree was as feed for silkworm (Table 6). This is consistent with previous reports that indicated mulberry as feed for silk production in many parts of the world (Singh and Makkar, 2002; Venkatesh and Chauhan, 2011). On the other hand, reports indicate that farmers' in Tanzania and Kenya use foliage from mulberry trees as part of the diet of ruminants (Sanchez, 2002). Nearly ninty percent of mulberry owning households in all the study districts were not practicing silkworm rearing. Lack of attractive market for the silk produced, lack of the required skill for silkworm rearing, and awareness were among the constraints for silkworm rearing in the area. At the time of the survey, it was learnt that most farmers did not believe that they benefit from sillworm rearing. It has been noted that silk production appears to be not always profitable.Therefore, alternative ways of using mulberry foliage, such as use of leaves as feed for livestock, would be welcomed by farmers when sericulture fails to bring encouraging results (Liu et al., 2001). Majority of the respondents in this study were unaware about the use of mulberry as feed for livestock (Table 6). This is supported by Singh and Makkar (2002), who stated that the value and benefits of mulberry tree as

Table 5. Initial sources of mulberry planting material and establishment sites (% of respondents).

Variables	Districts							
	KA	Hawzein	GA	Ahferom	MZ	Overall	X^2	*P-value*
Initial sources								
GO	100.0	86.7	100.0	100.0	100.0	97.3	7.95	0.09
NGO	-	13.3	-	-	-	2.7		
Establishment site								
Backyard	73.3	80.0	92.3	60.0	60.0	76.7	8.87	0.06
Borders of irrigated fields	40.0	46.7	46.2	46.7	46.7	45.2	0.21	0.99

KA=Kilte-Awlalo; GA= Ganta-Afeshum; MZ=Medebay-Zana; X^2 = Chi-square; GO=Governmental organizations; NGO= Non-governmental organization organizations.

Table 6. Farmers' response on purposes of growing mulberry tree and awareness about the feeding value of the plant to livestock (% of respondents).

Variables	Districts							
	KA	Hawzein	GA	Ahferom	MZ	Overall	X^2	*P-value*
Purpose of growing								
Silkworm feed	100.0	100.0	100.0	100.0	100.0	100.0	-	-
Animal forage	6.7	20.0	7.7	13.3	13.3	12.3	1.55	0.82
Others	53.3	26.7	7.7	20.0	40.0	31.1	8.46	0.08
Farmers' awareness								
Aware	20.0	26.7	23.1	20.0	20.0	21.9	0.31	0.99
Not aware	86.7	80.0	84.6	80.0	86.7	83.6	0.49	0.97

KA=Kilte-Awlalo; GA= Ganta-Afeshum; MZ=Medebay-Zana; X^2 = Chi-square.

high quality supplements to low quality roughages in ruminant feeding systems have not been widely known and fully exploited. On the other hand, although the nutritive value of mulberry is recognized in Tanzania and Kenya, there has not been much planting of mulberry for feeding ruminant livestock (Sanchez, 2002). In our study, only small proportion of the respondents had the information about the use of mulberry as livestock feed after they have observed the consumption of mulberry by animals.This group of respondents stated that the leaves of mulberry are highly acceptable by all classes of ruminants and noted increased milk production and weight gain with the consumption of mulberry leaves. Furthermore, they mentioned that twigs, small branches and stems are also consumed by animals. The high preference of ruminants for mulberry plant was confirmed during field visit at the time of the survey (Figure 1). Sánchez (2001) also reported that one of the main features of mulberry as forage is its high palatability**.** The same source further noted that small ruminants avidly consume the fresh leaves and the young stems of mulberry even if they have never been exposed to it before and cattle consume the whole biomass if it is finely chopped. Regarding the method of feeding, about 50% of the respondents, who were aware, reported the feeding of mulberry to their animals either alone or mixed with other feeds, whereas the remaining 35 and 15% of the respondents fed alone and by mixing with other feeds, respectively.

In this study farmers who had the experience of feeding mulberry leaves to their dairy cows, fattening sheep and silkworm, expressed that animals prefer to eat mulberry leaves than concentrates and other exotic multipurpose forage tree leaves such as *Sesbania sesban* and *Leucaena leucocephala*. Furthermore, they stated that feeding mulberry leaves increase milk yield and body weight gain of animals. Respondents also mentioned that mulberry grows fast, is highly palatable, has higher biomass production as compared to other improved forage plants, and believe that it is even better than other improved forages in improving the performance of milking cows. As a result, they have been communicating this to the livestock production experts in various meetings for mulberry to be seen and promoted as a valuable forage crop. Lingaraj (2008) also indicated better animal preference for mulberry over other forages. Similarly, in India, farmers proved that feeding mulberry as part of the daily ration of cows, improved the quality and quantity of milk and reduced calving intervals (Datta et al., 2004). Doran et al. (2007) also noted mulberry to be excellent forage with many qualities comparable and in some

Figure 1. Sheep and cow eating mulberry leaves.

cases superior to alfalfa. According to Singh and Makkar (2002), the feeding value of mulberry leaves is rated high by the livestock owners due to its nutritive value, palatability and the potential to improve milk yield when fed to dairy animals.

In this study, respondents stated that, currently, the development agents are advising and teaching them to use mulberry as feed for silkworm. In order to complement farmers' response, development agents in the respective district of the present study were asked whether they are aware about the value of mulberry tree as forage for livestock. Accordingly, the majority of them did not know that mulberry leaves could be fed to livestock other than silkworm. Despite their unawareness, surprisingly, the vast majority of respondents (93%) in all the study areas indicated their interest in increasing the number of mulberry trees, if convinced about its importance as alternative livestock feed resource.

CONCLUSIONS AND RECOMMENDATIONS

Mulberry is being cultivated in Ethiopia primarily for serving sericulture which appears not to be an attractive business for small scale farmers. However, the introduction of the plant for silkworm production should be used as an opportunity for feeding livestock. Many rural households, albeit at limited scale, are cultivating the plant. Although most households lack awareness on its feed value, there are some that utilize mulberry as forage for livestock and appreciate the feeding quality of the plant. Thus, apart from promotion and dissemination of the mulberry for silkworm production, the governmental and non-government organizations should advocate and support the wide cultivation and use of the plant as animal feed. Further studies to explore the area under mulberry cultivation and its scale of use at the national level are suggested. However, there is a need to evaluate the chemical composition, nutritive value and supplementary effect of mulberry leaf on the production performance of ruminant animals.

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