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Review on Major Feed Resources in Ethiopia: Conditions, Challenges and Opportunities

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Feed both in terms of quantity and quality is a major bottleneck for livestock production in Ethiopia. Feed resources can be classified as natural pasture, crop residue, improved forage and agro-industrial byproducts of which the first two contribute the largest share. Currently, with the rapid increase of human population and increasing demand for food, grazing lands are steadily shrinking by being converted to arable lands, and are restricted to areas that have little value. Productivity estimates also vary probably due to variation in time and ecological change, rainfall, soil type and cropping intensity. Research and development testing over the last two decades identified promising forages that are suitable for pasture rehabilitation in a wide range of agro-ecological zones. Food crop residues are providing a considerable quantity of dry season feed in most farming areas of the country. However, crop residues are the fibrous byproducts and their feeding value are limited by their poor voluntary intake, low digestibility and low nitrogen, energy, mineral and vitamin contents. Agro-industrial byproducts have special value in feeding livestock mainly in urban and peri urban livestock production system, as well as in situations where the productive potential of the animals is relatively high and require high nutrient supply. Over the past four decades, several forages have been tested in different agro-ecological zones, and considerable efforts have been made to test the adaptability of different species of pasture and forage crops under varying agro-ecological conditions. Yield of improved forage grasses, legumes and tree legumes ranged from 6-8, 3-5 and 10-12 DM ton/ha respectively. The major challenges of pasture and forage resources are feed quality and quantity, ecological deterioration, overgrazing, land tenure, border conflict, drought, weed and bush encroachment, soil fertility, lack of seed and planting materials and irrigation. Ethiopia has an immense ecological diversity and a huge wealth of biological resources. The complex topography coupled with environmental heterogeneity offers suitable environments for pasture species, herbaceous legumes and browse trees/shrubs. Therefore, assessing the conditions, challenges and opportunities of the major feed resources is a paramount important for effective and efficient utilization of the resources to enhance the productivity of the livestock sector in the country.

Keywords: agro-industrial byproduct, crop residues, cultivated forage, diversity, natural pasture

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INTRODUCTION

The agricultural sector plays a central role in the economic and social life of the nation and is a

cornerstone of the economy. Livestock is an integral component for most of the agricultural activities in the country. The contribution of livestock and livestock products to the agricultural economy accounts for 40%, excluding the values of draught power, transport and manure (Winrock International, 1992). Livestock serve as a source of income and food security and also indicate prestige and social status in the rural community. Livestock are especially important sources of cash income to the poorer sections of the Ethiopian rural population and women, as is also true in many other developing countries (Delgado *et al*., 1999; Thornton *et al*., 2002). Beneficial income diversification investments can arise from cash income generated from livestock (Little *et al*., 2001). Sustainable livestock and crop production in Ethiopia is dependent on dramatic changes in livestock management systems. The key components of these changes are a shift towards more intensive feeding systems, with more emphasis on cut-and-carry feeding, and a gradual shift away from uncontrolled grazing, particularly on uplands and sloping areas. This may need to be combined with decreasing livestock populations in some areas – perhaps associated with small-scale mechanization of cropping systems, which currently rely on animal draught power for cultivation. The use of woody leguminous species in agro-forestry, alley cropping or browse coppice systems is one of the key elements of sustainable agricultural systems in Ethiopia. Legumes are especially emphasized because of their multipurpose utility, and their dual roles in animal nutrition and the maintenance or improvement of soil fertility and hence crop production.

One of the major constraints to livestock productivity is lack of feed, both in quality and quantity. Thus integration of livestock and cropping systems is essential for sustainable natural resource management and improved livestock productivity. Livestock feed resources in Ethiopia are mainly natural pasture, crop residues, improved pastures, forage crops and agro-industrial by products (Alemayehu, 2004). The contribution of these feed resources, however, depends up on the agro-ecology, the types of crop produced, accessibility and production system. Traditional livestock production system mainly depends upon poor pasturelands and crop residues which are usually inadequate to support reasonable livestock production (Tsige, 2000). During the latter part of the dry season, livestock feed is normally in short supply and is also of poor quality. Residues from cereals (wheat, tef, millet and sorghum for example) are the main source of forage but these are low in protein and have poor digestibility. The production of adequate quantities of good quality dry season forages to supplement crop residues and pasture roughages is the only way to economically overcome the dry season constraints affecting livestock production in Ethiopia. These present a valuable source of energy, which, if supplemented with protein from improved forages, provide an economic and productive ration for ruminant livestock. The use of deep rooted perennials such as browse legumes reduce the impact of the dry season feed shortage because browse species have root systems which better able to exploit soil water reserves than any other forage species. Increasing populations and declining land productivity results in increasing demand for arable land in the highlands of Ethiopia. This increasing demand for cropping land to produce food for humans, reduces the amount of land available for natural grazing and forage production. Generally, the feed resources availability and their contribution vary among agro-ecologies and production systems. Therefore, this paper summarizes the major feed resources and their contribution, challenges and opportunities in Ethiopia.

Status and contribution of natural pasture

Many researchers and development workers agreed that natural pasture comprises the largest feed resource, but estimates of the contribution of this feed resource vary greatly (Alemayehu, 2004). Alemayehu (1998) estimated that 80–85% of all feed comes from natural pasture while some estimates indicate the natural pasture provides 88–90%. Recently, the share of natural grazing pasture at the national level as livestock feed resource, has become reduced to about 57% (CSA, 2013) from an earlier level of 90% (Alemayehu, 1985). This is because the quantity and quality of native pasture varies with altitude, rainfall, soil and cropping intensity. Currently, with the rapid increase of human population and increasing demand for food, grazing lands are steadily shrinking by being converted to arable lands, and are restricted to areas that have little value or farming potential such as hilltops, swampy areas, roadsides and other marginal land. This is particularly evident in the mixed-farming highlands and mid-altitudes. Grasslands are generally located in regions of moderate precipitation, between 250 and 750 mm. Grasses in different parts of the country vary according to the altitude. Most grasses are used as forage and grasslands are usually for grazing, but also provide tall and strong grass for thatch. The grassland region of Ethiopia accounts for some 30.5% of the area of the country and is most extensive in the western, southern and southeastern semi-arid lowlands. On the more humid side, open grassland and grassland with some trees are common; grasses may cover as much as 90% of the area. In the drier parts, patches of bush are common and the proportion of grass is reduced to about 70%. On the other hand, natural pasture provide more than 90% of the livestock feed in lowlands, with a wide range of grasses, legumes and other herbs. In the highlands plant growth is slow due to low temperature. The high stocking density and intensity of cultivation is out of proportion to the

carrying capacity. In the lowlands, the short growing season suits only fast maturing plants; limited rainfall and recurrent drought, shrub invasion and overgrazing are major features of lowland grasslands. Overgrazing and seasonal feed shortage are evident in the country. Many studies have indicated that the grazing lands of the country are in poor to very poor condition and will deteriorate further unless there is immediate action.

Natural pasture productivity and rehabilitation

Recent information on the area and productivity of natural pasture is scarce because of the expensive (in terms of time and money) nature of data collection. Previous estimates of areas and productivity are very variable. The total grazing and browsing land was estimated to be 61–65 million ha (Alemayehu, 1998), but is changing due to increasing population and cropping. Productivity estimates also vary, probably due to variation in time and ecological change, rainfall, soil type and cropping intensity. The previous estimate of natural pasture yield for the lowlands was 1 DM ton/ha, while for the highland and mid-altitude on freely drained soils it was 3 DM ton/ha and, on seasonally waterlogged fertile areas, yields were about 4–6 DM ton/ha (Alemayehu, 1998). MoA (1984) estimate was 1.5 and 0.56 DM ton/ha for the highland and lowland respectively. Another yield estimate for different highland zones (MoA, 1989) indicated that for high potential cereal/livestock zones (HPC/LZ) of savannah grassland and humid temperate pasture was 2 and 2.5 ton ha/year respectively. For both low potential/cereal livestock zone (LPC/LZ) and for high potential perennial/livestock zone (HPP/LZ) the yield obtained from pasture (savannah grassland) was 1.5 and 2 DM ton/ha/year respectively. Natural grasslands constitute the main highland pastures. Besides grasses, they contain 28 trifolium species out of which eight are endemic (Kahurananga, 1986). The highlands have been divided into different altitude zones for the description of the grassland vegetation designated by the characteristics of the plants (Alemayehu,1985; Kahurananga, 1986). The proportion of legumes tends to increase with increasing altitude; particularly above 2200 masl, there is a wide range of annual and perennial trifolium spp. and annual medicago spp. At lower altitudes, native legumes are less abundant and commonly have a climbing or sprawling habit with a large variation in their range and density in wet bottomlands. This appears to be only partly due to edaphic differences. In the lowlands browse and shrubs are dominant plants when compared to grasses. Because of Ethiopia's diverse climate, there are a number of valuable wild grasses and legumes and browse plants. The highlands are rich in pasture species, especially legumes. Herbaceous legumes tend to increase with increasing altitude. There is a wide diversity of annual and perennial trifolium species and annual medicago in the highlands, particularly above 2000 masl. At lower altitudes, annual legumes are less abundant, but there are a number of browse species adapted to the dry conditions. Despite the fact that research on natural improvement is minimal, most trial results are positive. To improve the vegetation composition and the nutritional value of degraded pastures, research on over-sowing with legumes and grasses has indicated that vetches (*Vicia dasycarpa* and *V. atropurpurea*) and local clovers (trifolium spp.) were successful in the highlands. In mid-altitudes, the perennial *Desmodium uncinatum* has shown superior establishment with rhodes grass (*Chloris gayana*) and siratro (*Macroptilium atropurpureum*). Research and development testing over the last two decades identified promising forages that are suitable for pasture rehabilitation in a wide range of agro-ecological zones.

Grazing land management and recommended rules

At every point of resource management, community knowledge and participation, from the beginning to the end, thorough evaluation and monitoring is vital. Ethiopia's farming people have traditional laws that govern the community, adopted for thousands years. The presence of traditional community rules provides an opportunity in the management of the grazing and other land resources. Current government policies encourage peoples' participation and community participation from project conception through planning and implementation to monitoring and evaluation undertaken on the decisions of the resource users and managers. On top of these, protection and penalizing of illegal acts against management of grassland resources, the community exercise their own acceptable by-laws. This provides the best opportunity for correct management of grazing land resources. Based on these, a number of recommended management rules are developed to assist grazing land problems and management. These rules are based on community by-laws. Some of the recommended rules for grazing land management are respect, promote and encourage the traditional sustainable natural grazing land resource use by the local community, promote the means to zero grazing and controlled grazing and encourage people to see their animals in economic terms (market value) rather than social prestige, encourage the cut-and-carry system of feeding, forage development around homesteads crop farms and hillsides, promote agro-forestry which also increases firewood, construction material, implements and crafts and forage production, increase animal production through the best utilization of pasture and forages. Integrate soil and water conservation enclosure with sustainable forage production and mobilize indigenous and scientific

knowledge into different localities through networks. In addition to their role in animal feed, pasture and forages in Ethiopia can make a significant contribution to sustainable uses, like watershed management, soil erosion control, soil fertility maintenance, in general to natural resources management and thus to national food security.

Contribution and nutritive value of crop residues

In the highlands and mid-altitude, various food crop residues – cereals (tef, barley, wheat, maize, sorghum and millet) – pulse crop residues (faba bean, chickpea, haricot bean, field pea, lentil), oil crop residues and reject vegetables are providing a considerable quantity of dry season feed in most farming areas of the country. Currently, with the rapid increase of human population and expansion of arable land and with the steady decrease in grazing land, the use of crop residues is increasing. Crop-residues and stubble grazing are the major sources of feed starting from harvesting of food crops to the wet periods during the time at which feed from grazing areas is inadequate or almost unavailable. The research results indicated that in some localities under special crop–livestock production systems, the intake could increase up to 50% (MoA, 1997; Alemayehu, 1998). Similarly, in most intensively cultivated areas, crop residues and aftermath grazing accounts for about 60 - 70% of the basal diet, particularly, wheat straw is the dominant feed in wheat-based farming system (Seyoum *et al.,* 2001). The availability of crop residues is closely related to the farming system, the type of crops produced and intensity of cultivation. Moreover, most of the crop residues used as livestock feed fluctuate in seasonal supply and used without any treatment and/or strategic supplementation (Solomon, 2004).

The plant species, agronomic practice used, soil, temperature and the stage of growth influence the chemical composition and the palatability of straws. Crop residues vary greatly in chemical composition and digestibility depending on varietal differences (Reed *et al.,* 1989) and agronomic practices. Crop residues are the fibrous by-products which result from the cultivation of cereals, pulses, oil plants, roots and tubers and represent an important feed resource (Yayneshet, 2010). The feeding value of crop residues is limited by their poor voluntary intakes, low digestibility and low nitrogen, energy, mineral and vitamin contents (Alemu *et al*., 1991). The CP content of crop residues ranges form 2.4-7% and the value of IVDMD for straw is between 34 and 52%. However, the nutritional values of crop residues vary according to the type of crop used (Daniel, 1988). Residues from leguminous crops have better quality than the residues from cereals. Legume straws contain less fiber, high digestible protein than cereal straws (Solomon, 2004). Urea treatment is important for improving nutritive value of cereal straws and stovers. It has been used in tropical and in developing countries. Straw treatment with urea has advanced from providing for maintenance toward improvement of production. It is the ammoniating effect that improves nutrient content and intake of straw.

Agro-industrial by-products

Agro-industrial by-products have special value in feeding livestock mainly in urban and peri urban livestock production system, as well as in situations where the productive potential of the animals is relatively high and require high nutrient supply. Agro-industrial byproducts produced in Ethiopia include by-products from flour milling, sugar factory, abattoir and brewery by products. These byproducts are mainly used for dairy and fattening animals. Agro-industrial byproducts are rich in energy and/or protein contents or both. They have low fiber content, high digestibility and energy values compared with the other class of feeds. Alemu *et al.,* (1991) have also reported more than 35% CP and 50-70% *in vitro* organic matter digestibility (IVOMD) for oil seed cakes and 18-20% CP and more than 80% IVOMD for flour milling by-products. Some earlier production estimates of the major agro-industrial by-products are shown in Table 1.

Forage species diversity at different altitude

Areas above 3000 masl: The commonest grasses are species of poa, festuca, agrostis and, to a lesser extent, andropogon. In wetter areas sedges occur including the genera carex, eleocharis, and mariscus. Of perennial legumes, the most important are the deep-rooted *Trifolium burchellianum* (var. oblongum and subsp. johnstonii) and *Trifolium acaule*, which reach to over 4000 masl. *Trifolium tembense* is the most significant, but occurs only in the lower range. The shrubs *Erica arborea* and *Hypericum revolutum* are common.

Areas from 2000 to 3000 masl: The commonest grasses are species of andropogon, cynodon and pennisetum. Other common ones are species of setaria, themeda, eragrostis, sporobolus, bracharia, paspalum, phalaris, chrysopogon and *Festuca arundinacea*. Productivity may be extremely high during the later part of the wet season, but there is little growth after early October. Legumes are prolific in this zone; the commonest perennials are *Trifolium semipilosum*, and other frequently occurring ones are *Trifolium burchellianum* subsp. johnstonii, *Trifolium polystachyum* and Lotus spp. *Trifolium rueppellianum, Trifolium decorum, Trifolium steudnery, Trifolium quartinianum* and

Table 1. Agro-industrial byproducts and stats of production in Ethiopia

SN	Byproducts	Production (ton)
1	Sugarcane tops	78000a
2	Molasses	51000a
3	Filter press cake	35000a
4	Bagasse	300000a
5	Milling byproducts	48240b
6	Oil seed mills	40000b
7	Sisal waste	2100b
8	Brewery grains	5970c
9	Grain screenings	30000a
10	Sweet potato tops	60000c
11	Banana waste	5000d

Source: MoA, 1984; Note: a= annual production, b= 1981/82 production, c= 1978/79 production, d= 1982/83 production

vigna sp. are the most widespread annuals. In very wet bottomlands sedges are common. Of the legumes, *Trifolium tembense* is prolific. Arable land left fallow has a dense weed cover initially, but with heavy grazing it is colonized by grasses, including *Digitaria scalarum*, *Cynodon dactylon* and *Phalaris paradoxa*. With longer fallow *Cynodon dactylon* and pennisetum spp. become more common, *Trifolium semipilosum* and *Trifolium burchellianum* are also found in such areas. Of the browse species, erythrina is common.

Areas from 1500 to 2000 masl: This zone is characterized by tall grasses and a higher proportion of climbing-sprawling legumes, especially in less intensively settled areas. The commonest grasses are *Chloris pychynothrix*, *Cenchrus ciliaris*, hyparrhenia spp., *Setaria sphacelata*, paspalum spp., *Cynodon dactylon*, *Pennisetum plicatulum*, *Eleusine floccifolia*, eragrostis spp., cymbopogon and andropogon spp. Perennial legumes include *Neonotonia wightii*, indigofera spp., desmodium spp., rhynchosia spp., vigna spp. that grow down to about 1500 masl in the wetter western areas and commonly to 1800 masl in central areas. *Stylosanthes fruticosa* is found in scattered sites, mainly below 1800 masl, and may be common in degraded areas where few other species thrive. Of the annuals, *Trifolium steudnery*, *Trifolium rueppellianum* and *Medicago polymorpha* are quite frequent above 1700 masl. Of the browse species, albizia is common and sesbania is prolific on wet lake margins.

Areas between 1500 and 500 masl: These areas, which include the rift valley, are covered with acacia woodland. Today much of the acacia has been removed as the urban demand for charcoal has increased. Heavy grazing and low-productivity farming have followed the cutting of trees. The common grasses grown in this zone include *Chloris pycnothrix, Hyparrhenia anthistiriodes*, *Setaria acromelaena*, *Aristida kenyensis*, *Cynodon dactylon*, *Panicum atrosanguineum*, *Microchloa kunthii*, *Hyparrhenia dregeana*, *Cenchrus ciliaris*, Heteropogon spp., Pennisetum spp., and *Bothriochloa insculpata*. Of the legumes *Neonotonia wightii* and the less valuable *Indigofera spicata* are common. Browse species are dominated by *Acacia etbaica*, *Acacia nilotica* subsp. leiocarpa, *Acacia tortilis*, *Acacia seyal* var. seyal, *Euclea schimperi*, *Grewia tembensis*, *G. bicolor*, *Balanites spp.*, *Cadaba farinosa* and *Capparis tomentosa*.

Cultivated forage crops

Over the past four decades several forages have been tested in different agro-ecological zones, and considerable efforts have been made to test the adaptability of different species of pasture and forage crops under varying agro-ecological conditions. As a result, quite a number of useful forages have been selected for different zones. Improved forage crops have been grown and used in government ranches, state farms, farmers' demonstration plots and dairy and fattening areas. Forage crops are commonly grown for feeding dairy cattle with oats and vetch mixtures, fodder beet, elephant grass mixed with siratro and desmodium, rhodes/lucerne mixture, phalaris/trifolium mixture, hedgerows of sesbania, leucaena and tree-lucerne being the most common. In suitable areas, yields of oat–vetch mixtures are commonly 8–12 DM ton/ha. Yields of improved pasture and forage grasses and legumes range from 6–8 and 3–5 DM ton/ha respectively; and for tree legumes 10–12 DM ton/ ha. Due to land scarcity and crop-dominated farming there has been limited spontaneous introduction of improved pasture and forages. During the Fourth Livestock Development

Project (FLDP), different strategies and species for pasture and forage development were selected (Alemayehu, 2002). These strategies and forages have been promoted widely into the crop–livestock system, traditional grazing areas, and around homesteads, within soil and water conservation structures and under plantation crops and forestry. Climate and land availability provide a good opportunity for forage production. In Ethiopia, most improved tropical species can be grown in the areas from 1500–2000 masl and temperate species grow from above 2100 up to 3000 masl (Alemayehu, 2002). Introduced improved forage yield is higher than the naturally occurring swards and has higher nutritional value. In addition, the length of the productive season is longer for cultivated pastures than for native pastures, which provides an opportunity for dairy and fattening production to develop and use pasture and forage on a large scale. Greater use of leguminous fodder trees and shrubs assists in increasing soil fertility, controlling soil erosion and providing firewood and timber. These legumes are well adapted to the current edaphic and grazing condition, they can be readily integrated into farming systems, and they retain their feeding value into the dry season and show great success in the higher potential areas of the country.

Integration of sown forage crops into farming systems

The best adapted strategies and promising plants currently recommended for major zones are listed in Table 2. Pasture establishment is relatively difficult in the highlands compared to the humid, warmer and lower areas, because of the soil and climate. In the wet season waterlogging, relatively low soil temperature and reduced long and short radiation limit the establishment and subsequent growth of pasture in the highland. In these areas, for the best environmental condition for seed and seedling establishment and growth, perennial pasture is usually sown during the short rains (March and April) but annual forages are usually sown in June (IAR, 1983). Conventional methods of establishing forage crops are tedious and labor demanding, especially in the highlands; better ways are the low-cost methods such as backyard, under-sowing and over-sowing, which are more attractive to farmers. These strategies provide farmers with proper use of their land for cultivation of crop/pasture and forage/trees, where products can be used for food, feed and firewood respectively. Some perennial grasses like *Festuca arundinacea, Phalaris arundinacea* and *Setaria sphacelata* are well adapted to waterlogged conditions and easily established by root splits. There is also considerable opportunity for the use of fodder tree-legumes in agro-forestry. Woody legumes provide a fodder hedge planted around the backyard, firewood, wood for construction of houses and farm equipment, wind breaks, for ceremonial purposes and for stabilizing bunds and gullies. The current promotion of fodder trees-legumes in the national agro-forestry system is a good opportunity for extension of a forage program within farming systems and contributes to environmental protection and natural resource management and even to food security.

One of the best opportunities for highland farmers to use land efficiently will be through the introduction of pasture and forages in the farming system. In trials in the highlands on wheat and barley under-sown with lucerne, annual clovers, tall fescue, perennial rye grass, setaria and phalaris, the sowing of both cereals and forages was at the same time. All under-sown forages established successfully except lucerne and there was no significant reduction of cereal yield. The establishment of forages was much better under wheat than under barley (IAR, 1983). Since fallowing cropland is common in the highlands, under-sowing cereals with forages could significantly relieve the feed problems of the area. At research sites in the mid-altitude area, maize was under-sown with desmodium, phasey bean, chloris (rhodes grass), panicum and cenchrus after the first weeding. Almost all forages established, and there was no maize yield reduction (IAR, 1983). There is a good opportunity for integration of pasture and forage crops in the existing farming system. As a result of these findings, in Ethiopia heavy emphasis is put on the use of forage legumes in cropping systems (through under-sowing, improvement of fallows and establishment of tree legumes hedges) to partly address the major problems of long-term sustainability of crop production. Extensive use of tree legumes in a number of strategies can have an effect, in the long term, on firewood supplies, including the release of dung that would otherwise have been burnt. The increased forage supply and improved use of forage (dairy and fattening system) will provide another opportunity for generating dung. There is a wide opportunity for the use of forage legume crops to be incorporated in the farming system; adapted and recommended crops are cowpea, pigeon pea and *Phaseolus acutifolius*. These can be used for food and feed especially during the dry season.

Forage seed production and conservation

Many of the temperate and tropical pasture and forage crops that have been tested and grown in Ethiopia have no problem of flowering and setting seed. This provides a good opportunity for the country to establish local seed production in the existing farming system. The current local pasture and forage seed production systems adopted in the country are farmer contract seed production system, seed production on ranches, seed

Table 2. Recommended improved pasture and forage strategies and species

Strategy	Low altitude (500-1500 masl)	Medium altitude (1500-2400 masl)	High altitude (>2400 masl)
Backyard forage	*Leucaena leucocephala, Sesbania sesban, Cajanus cajan, Chloris gayana, Setaria spp., Panicum maximum, Pennisetum purpureum, Desmodium uncinatum, Medicago sativa*	*Chamaecytisus palmensis, Medicago sativa, Sesbania sesban, Cajanus cajan, Phalaris aquatica, Pennisetum purpureum, Vicia dasycarpa*	*Chamaecytisus palmensis, Phalaris aquatica, Vicia dasycarpa, Avena sativa, Medicago sativa,*
Under-sowing	*Lablab purpureus, Vigna unguiculata, Macroptilium atropurpureum, Desmodium uncinatum, Stylosanthes fruticosa, Vicia dasycarpa, Cassia* spp.	*Vicia dasycarpa, Macroptilium atropurpureum, Desmodium intortum*	*Vicia dasycarpa*
Forage strip	*Leucaena leucocephala, Sesbania sesban, Cajanus cajan, Panicum maximum, Setaria sphacelata*	*Chamaecytisus palmensis, Sesbania sesban, Cajanus cajan, Desmodium intortum Macrotyloma axillare, Trifolium semipilosum, Vicia dasycarpa, Phalaris aquatica Setaria sphacelata, Macroptilium atropurpureum, Macrotyloma axillare, Desmodium intortum ,Stylosanthes fruticosa*	*Chamaecytisus palmensis, Vicia dasycarpa, Phalaris aquatica*
Over-sowing	*Stylosanthes fruticosa, Macroptilium atropurpureum, Cassia* spp*., Desmodium uncinatum*	*Macroptilium atropurpureum, Desmodium intortum*	*Vicia dasycarpa, Vicia villosa*
Livestock exclusion areas	*Cenchrus ciliaris, Leucaena leucocephala, Sesbania sesban, Macroptilium atropurpureum, Stylosanthes fruticosa, Macrotyloma axillare, Desmodium uncinatum, Paspalum plicatulum*	*Chamaecytisus palmensis, Sesbania sesban, Macrotyloma axillare, Macroptilium atropurpureum*	*Chamaecytisus palmensis, Phalaris aquatica, Vicia dasycarpa, Medicago sativa, Avena sativa*
Conventional pasture and forage	*Stylosanthes fruticosa, Macroptilium atropurpureum, Desmodium unicnatum, Chloris gayana, Panicum maximum, Setaria sphacelata*	*Phalaris aquatica, Setaria sphacelata, Desmodium intortum, Vicia dasycarpa*	*Medicago sativa, Vicia dasycarpa. Phalaris aquatica, Dactylis glomerata, Avena sativa*

Source: Alemayehu, 2001

production on specialized plots and opportunistic seed production. Farmer contract seed production system involves the production of annual and perennials under contract with individual farmers and/or farmer's cooperatives. Seed production on ranches mostly focused on perennial legumes and grasses. Seed production on specialized plots is undertaken in a few areas by some governmental and non-governmental organizations. Opportunistic seed production involves the collection of seed from developed opportunistic pasture/forage sites. Under these systems over 200000 ton of forage seed were produced from 1988 to 2002. Of the seeds produced, vetch, lablab, cowpea, axillaris, siratro, stylos, desmodium, oats, rhodes, panicum, tree-lucerne, leucaena and sesbania are dominant. Large local seed production is under way using farmers' contracts (Alemayehu, 2001). Conservation and use of grass germplasm has made a significant contribution to the economic development of Ethiopia through the national pasture and forage research program. The International Livestock Research Institute ILRI (ex. ILCA) has done much to fill the gap by collecting grasses from different parts of Ethiopia and by acquiring access to world collections of forage grass germplasm. Currently over 371 accessions of grasses from 77 species and 37 genera, 2076 accession of legumes from 140 species and 35 genera and 185 accession of browse from 41 species 18 genera are collected and conserved. The Forage and Pasture Genetic Resource Conservation and Research Department was established under the Institute of Biodiversity Conservation and Research/Ethiopia (IBCR/E) to carry out the conservation of pasture and forage genetic resources.

Limitation of pasture and forage resources

Feed quality and quantity: Natural grazing is the major source of livestock feed, and in the lowlands livestock production is almost totally dependent on it. However, grazing lands do not fulfill the nutritional requirements of animals particularly in the dry season, due to poor management and their inherent low productivity and poor quality. In the highlands, with the rapid increase of human population and high demand for food, pastures are steadily being converted to farmlands. Marginal lands unsuitable for cultivation such as waterlogged, flooded soils and steep lands are left for grazing and their productivity is very low. Another population associated problem is environmental degradation due to deforestation and overgrazing, which have substantially reduced soil fertility and further reduced productivity.

Ecological deterioration: Gradual encroachment of cultivation into grazing lands is common in both highlands and mid-altitude areas. Many meadows in the flood plains have been converted into croplands. Due to vegetation clearance many steep areas have become vulnerable to wind and water erosion. Important browse that was dry season forage has been wiped out to supply urban fuel and construction wood. Natural grazing land is deteriorating rapidly due to lack of attention and its carrying capacity is declining due to high stocking, especially in pastoral areas. Pastoralism is becoming less and less possible and a riskier business. Since the ecosystem is very fragile, the abuse and mismanagement of resources have created severe problems for people in grazing lands; indigenous people who are adapted to live in the dry lands are facing an ecological crisis.

Overgrazing: Grazing and browsing animals overstock natural pastures; areas near water points are generally the most affected and grazing lands are dominated by unpalatable plants. In many pastoral areas, since the number of stock has socio-cultural value, it has a synergistic effect with the diminishing grazing lands. Soils are under risk of degradation with reduced infiltration, low permeability and a reduction in the water-holding capacity. The result is a decrease in the ability of the soil to support plant production.

Land tenure/change of ownership: In Ethiopia grazing land ownership is thought to be communal, where ethnic groups used to manage grazing lands. However, the federal or regional state can allow private investment in pastoral areas. Besides the loss of grazing land, investment may prevent free movement of pastoralists and initiate urbanization. If the nomadic pastoralists' sustainable way of life changes to sedentary farming, the tragedy of the commons will become real unless some adjustment is made.

Border conflict: Most extensive grazing lands are limited by ethnic boundaries and are often in border areas. There is conflict between tribes within the country and sometimes with neighboring countries. This has a profound effect on border grazing land.

Drought: One of the most unfortunate characters of Ethiopia's climate is great variability of rainfall from year to year. Ethiopia is known for recurrent drought and famine. Drought is particularly common in the pastoral area where rainfall is erratic and unreliable. Nomadic pastoralists have adapted to live with the situation but other factors have made them vulnerable to famine.

Weed and bush encroachment: As a result of overgrazing many natural grazing lands are invaded by unpalatable weeds and woody plants. Weeds are major problems in both perennial and annual pasture and forage crops; unless they are controlled productivity will be low. In Ethiopia weed control by herbicides, machine

mowing and topping and hand weeding have been tried; hand weeding is the best and cost effective method. Since family and hired labor is plentiful and cheap there is an opportunity to use it for weed control, so there is a considerable opportunity to foster the development of improved pasture and forage crops on a large scale without a major problem of weed infestation.

Soil fertility: The annual food and livestock feed deficit of the country is attributed directly to soil erosion and nutrient export. About half of the highlands are vulnerable to water erosion and the remainder has been cultivated without conservation measures for thousands of years.

Lack of seed and planting materials: The absence of quantity and quality seed and seedling production limits the vast expansion of improved pasture and forage development (especially around the dairy farming and fattening areas).

Irrigation: The irrigation potential of the country is high; the potential area for irrigation is estimated to be about 3000000 ha. Small-scale traditional irrigation has been practiced for decades throughout the highlands; small streams are seasonally diverted for limited dry season cropping. This is a good opportunity to grow off-season pasture and forage crops. Medium- and large-scale schemes are of much more recent origin, mostly in the rift valley for cash crops. There is some irrigated forage in the rift valley growing lucerne/rhodes mixture for commercial fattening and dairy farming. The potential for irrigated forage is untapped and still there is a great opportunity for producing seasonal and long-term irrigated pasture and forages.

Opportunities for improvement of fodder resources

Biological resources are fundamental to human well-being in agriculture, livestock, export earning, economic output and for their ecological services and functions. Ethiopia has an immense ecological diversity and a huge wealth of biological resources. The complex topography coupled with environmental heterogeneity offers suitable environments for a wide range of life forms.

Pasture species: Since Ethiopia is known to be the centre of origin and diversity for a number of domesticated crops, it is also known to be the centre of diversity for pasture and forage species. There are several centers of origin of the cultivated grasses (such as chloris spp., panicum spp., setaria spp. etc.). For the tropical species the main centre is Eastern Africa, from where many promising species and varieties have been selected. In Ethiopia, the large numbers of indigenous grass species and the very great variation within the species make the country a rich potential source of new and better tropical pasture grasses. Until now there are a total of 736 grass species from 181 genera that are documented in Ethiopia, of which 164 species from 68 genera are reported to be important (medium to high level) for pasture and forage purpose.

Herbaceous legumes: Ethiopia is a centre of diversity for herbaceous legumes such as the genera trifolium, vigna, lablab, neonotonia, and others. There are a total of 358 herbaceous forage legume species from 42 general documented in Ethiopia. Reports indicate that about 58 species from 31 genera are potentially important for pasture and forage. Currently 2076 accessions from 140 species and 35 genera are systematically collected and conserved.

Browse trees/shrubs: Browse trees or shrubs are important animal feed in Ethiopia especially in the arid, semi-arid and mountain zones, where large numbers of the country's livestock are found. They provide protein, vitamins and mineral elements, which are lacking in grasslands pastures during the dry and/or cold season and serve as standing feed reserves to be built up, so that herds are able to survive critical periods of rainfall shortage. In Ethiopia there are 179 browse species from 51 genera, which is not exhaustive, of which 51 species from 31 genera are recorded as promising browse species. Currently 185 accessions from 41 species and 18 genera are systematically collected and conserved by ILRI (IBCR/E, 2001).

CONCLUSION

Livestock feed resources in Ethiopia are mainly natural grazing and browse, crop residues, improved pasture, forage crops and agro-industrial by-products. Feeding systems include communal or private natural grazing and browsing, cut-and-carry feeding, hay and crop residues. At present, stock are fed almost entirely on natural pasture and crop residues. Grazing is on permanent grazing areas, fallow land and cropland after harvest. Forage availability and quality are not favorable year round and hence gains made in the wet season are totally or partially lost in the dry season. At present, around dairy and fattening areas there is insignificant production of improved pasture and forages. The contribution of agro-industrial by-products is also minimal and restricted to some urban and peri-urban farms (dairying, poultry and fattening). In the past four decades, considerable efforts have been made to test the adaptability of pasture and forage crops to different agro-ecological zones; several useful forages have been selected and recommended for different zones. The smallholder farmers, medium- and large-scale private enterprises could benefit from those findings.

REFERENCES

Alemayehu M. 2004. Pasture and Forage Resource profiles of Ethiopia. PP.19. Ethiopia/FAO. Addis Ababa, Ethiopia.

Alemayehu M. 2002. Forage Production in Ethiopia: A case study with implications for livestock production. Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia.

Alemayehu M. 2001. Forage and Seed Production. MoA, Addis Ababa, Ethiopia. Alemayehu, M. 1998a. Natural Pasture Improvement Study around Smallholder Dairy Areas. MoA Small Dairy Development Project (SDDP), Addis Ababa, Ethiopia.

Alemayehu M. 1998. The Borana and the 1991-92 Drought: Rangeland and Livestock Resource Study. Institute for Sustainable Development (ISD), Addis Ababa, Ethiopia.

Alemayehu M. 1985. Grass Land Ecology Study. MoA, Animal and Fishery Resource Development Department. Addis Ababa. Ethiopia

Alemu Yami, Zinash Sileshi and Seyoum Bediye. 1991. The Potential of Crop Residues and Agro- Industrial By-Products as Animal feed. In: proceedings of ESAP, 3rded.

CSA (Central Statistic Agency). 2013. Statistical Abstract.120p

Daniel, K. 1988. Role of crop residues as livestock feeds in Ethiopian Highlands. PP. 430-439. In: B.H. Dzzowela (eds.). Proceedings of a Workshop on African Forage Plant Genetic Resources, Evaluation of Forage Germplasm and Extensive Livestock Production Systems. Arusha, Tanzania,.27-30 April 1987.

Delgado C, Rosegrant M, Steinfeld H, Ehui S and Courbois C. 1999. *Livestock to 2020: The next*
food revolution. Food, Agriculture, and the Environment Discussion Paper No. 28. IFPRI (International Food Policy Research Institute), FAO (Food and Agricultural Organization of the United Nations), and ILRI (International Livestock Research Institute), Nairobi, Kenya. 83 pp. Available from http://www.ifpri.org/2020/dp/dp28.

Institute of Agricultural Research (IAR). 1983. Annual Report. Addis Ababa, Ethiopia.

Institute of Biodiversity Conservation and Research (IBCR/E). 2001. Stock Taking for Biodiversity Conservation Natural Strategy and Action Plan Project, Working Paper, Addis Ababa, Ethiopia.

Kahurananga, J. 1986. Studies on Trifolium Species (unpublished). Addis Ababa, Ethiopia.

Little PD, Tegegne Teka and Alemayehu Azeze. 2001. *Crossborder livestock trade and food security in the Horn of Africa: An overview.* A research report of the Broadening Access to Markets and Input Systems–Collaborative Research Support Program (BASIS-CRSP) and OSSREA Project on Crossborder Trade and Food Security in the Horn of Africa. Land Tenure Center, University of Wisconsin, Madison, Wisconsin, USA.

MoA. 1997. MoA, National Livestock Development Programme(NLDP). Main working Papers 1-3, Addis Ababa, Ethiopia.

MoA. 1989. Agroforestry Potential and Research needs, Addis Ababa. Ethiopia.

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

Reed, J .D and Goe, M .R. 1989. Estimating the nutritive value of crop residues: Implications for developing feeding standards for draught animals. ILCA Bulletin 34:2-9.ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia.

Seyoum, B., A. Getnet, T. Abate and F. Dereje. 2001. Present status and future direction of feed resources and nutrition research targeted for wheat based crop livestock production system in Ethiopia. In Wheat and weed: Food and Feed: Ed., P.C. Wall, Proceedings of two stakeholder workshop on improving the productivity of crop-livestock system in Ethiopia

Solomon Bogale. 2004. Assessment of Livestock Production Systems and Feed Resource Base in
Sinana Dinsho District of Bale Highlands, Southeast Oromia. M. Sc. Thesis. Alemaya University of Agriculture, Alemaya.141 pp.

Thornton P, Kruska R, Henninger N, Kristjanson P, Reid R, Atieno F, Odero A and Ndegwa T. 2002. *Mapping poverty and livestock in the developing world.* ILRI (International Livestock Research Institute), Nairobi, Kenya. pp. (Available from http://www.ilri.cgiar.org/InfoServ/Webpub/ fulldocs/mappingPLDW/index.htm

Tsgie Yohannes. 2000. Livestock feed security and associated impact on sustainable agricultural development. In: proceeding of the 7th annual conference of the production ESAP) held in Addis Ababa, Ethiopia. 26-27 May 1999, pp.51-61

Winrock International. 1992. *Assessment of animal agriculture in sub-Saharan Africa.* Winrock International Institute for Animal Agriculture, Morrilton, Arkansas, USA. 125 pp.

Yayneshet, T. 2010. Ethiopia Sanitary & Phytosanitary Standards and Livestock and Meat Marketing Program (SPS-LMM) Texas A&M University System: Feed Resources Availability in Tigray Region, northern Ethiopia, for Production of Export Quality Meat and Livestock