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Review Article

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Review on Dairy Cow Feed and Feeding Aspects in Ethiopia

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Abstract

Ethiopia is one of the Sub-Saharan Africa's developing country with a large potential in livestock, being 1st among African countries and 9th in the world. Dairying is one of the livestock production systems practiced in almost all over the world including Ethiopia, involving a vast number of small, medium, or large sized, subsistence or market-oriented farms. Based on climate, land holding and integrated with crop production; dairy production can be; pastoralist, highland smallholder, urban and peri-urban and intensive dairy farming system are recognized in Ethiopia. There are over six distinguishable, indigenous cattle types in Ethiopia mainly Arsi, Barca, Boran, Fogera, Horro and Ogaden are evolved as a source of natural selection. The main objectives of this seminar paper are to review; the feed and feeding strategies of dairy cow in Ethiopia. Dairy animal rearing is an inseparable and integrated part of smallholder subsistence farming system. Dairy cattle production in the country is characterized by low productivity levels due mainly to genetic and nutritional constraints. The primary constraints to increased milk production under all production systems are inadequate feed resources, poor pasture development and the ever increasing feed prices. Unless feeding management is improved these animals may be limited to fully express their potential genetic superiority. It is fundamental approach to provide good quality diets to dairy cattle in sufficient amount to maximize production.

The major differences between feeding practices of two types of animal's local vs crossbred in the country are intake of green fodders and concentrates. The cross bred cows are usually stall fed while the local cows are generally sent out for grazing the whole day.

Introduction

Ethiopia has a cattle population of around 55 million heads, of which about a quarter are considered milking or dairy cows [1]. From the overall Ethiopian milk production, the rural system, including pastoral, agro-pastoral and mixed crop-livestock systems contribute about 98% to the total milk production of the country [1]. The remaining 2% is produced by peri-urban and urban farms, and commercial dairy farms. Dairy farms show low milk production, on average about 1.7 litres per cow/day [2], and poor reproductive performance. Although most of the milk (about 85%) is used for home consumption, domestic demand is projected to grow by 47% towards 2020 (GTPII, 2014). This can offer chances for the dairy farmers to increase their income from selling dairy products and enhance their livelihoods. The Ethiopian Livestock Master Plan [3] envisions a 93% increase in national cow milk production over the period 2015-2020 as a result of interventions on better genetics, feed and health services, and policy support.

In Ethiopia dairy production depends mainly on indigenous livestock genetic resources; more specifically on cattle, goats, camels and sheep. Cattle has the largest contribution (81.2%) of the total national annual milk output, followed by goats (7.9%), camels (6.3%) and sheep (4.6%) [4]. Despite its potential for dairy development, productivity of indigenous livestock genetic resources in general is low, and the direct contribution it makes to the national economy is limited.

Despite the large dairy cattle population, milk production per cow per day is very low in Ethiopia. The low productivity is principally due to inefficient nutritional and management practices, low genetic potential of the indigenous cows, high level of disease and parasitic incidence, poor access to extension and credit services, and inadequate information to improve animal performance [5]. Among these constraints, inadequate quantity and quality feed ingredients were identified as a major limiting factor to the development of dairy production in peri-urban and urban dairy systems [6].

Livestock feed resources in Ethiopia are mainly obtained from natural and improved pastures, crop residues, forage crops, agro-industrial by-products and non-conventional feeds [7]. The contribution of these feed resources, however, depends up on the agro-ecology, the type of crop produced, accessibility and production system [8]. Natural pasture is the major source of livestock feed in Ethiopia. However, its importance is gradually declining because of the expansion of crop production into grazing lands, redistribution of common lands to the landless and land degradation [9]. Urban and peri-urban dairy production depends on purchased concentrate and roughage feeds with limited grazing [10].

Milk Production Systems in Ethiopia

In the highland areas, agricultural production system is predominantly smallholder mixed farming, with crop and livestock husbandry typically practiced within same management unit. Among the systems, milk production system is the most biologically efficient system that converts large quantities of roughage, the most abundant feed in the tropics, to milk, the most nutritious food known to man [11].

Milk production systems in Ethiopia may be classified into two broad categories viz: commercial system, which produces milk mainly for market and subsistence systems, which produce milk mainly to meet household needs for milk products [12]. The commercial system generally operates in urban and peri-urban areas with or without holdings of land for feed production. Whereas, the rural milk production system is part of the subsistence farming system and includes pastoralists, agro pastoralists, and mixed crop-livestock producers. Specifically, they are classified into four major systems.

These are pastoralist, the highland smallholder, urban, peri-urban, and intensive milk production systems. Pastoralist milk production system is a system mainly operating in the rangelands where the peoples involved follow animal-based life styles that requires them to move from place to place seasonally based on feed and water availability. Even though information on both absolute numbers and distribution vary, it is estimated that about 30% of the livestock populations are found in the pastoral areas [11].

Pastoralism is the major system of milk production in the lowland areas. However, because of the rainfall pattern and related shortage of feed availability, milk production is low and highly seasonal and range condition dependent [13,14]. Pastoralists typically rely on milk for food and also use animals to save wealth. This system is not market oriented and most of the milk produced in this system is retained for home consumption. The level of milk surplus is determined by the demand for milk by the household and its neighbors, the potential to produce milk in terms of herd size, production season, and access to a nearby market [5]. The surplus is mainly processed using traditional technologies and the processed milk products such as butter, ghee, cottage cheese and sour milk are usually marketed through the informal market channel after the households satisfy their needs [15].

Urban and per-urban milk farming system is concentrated in and around major cities, and towns characterized by a high demand for milk. This system has been developed in response to the fast growing demand for milk and milk products around urban centers [16]. The system is estimated to consist of 5,167 small, medium and large milk farms, with about 71% of the producers selling milk directly to consumers [15].

The per-urban milk production system includes most of the improved milk stocks [17]. In urban and per-urban milk production system, the main feed resources are agro-industrial by-products. The total milk production from this system accounts to 34.649 million liters /annum. Of this total, 73% is sold, 10% is left for household consumption, 9.4% goes to calves and 7.6% is processed mainly into butter and *ayib* [12]. The most specialized and high-tech system is intensive milk production system. It is practiced by, state sector and very few individuals on commercial basis. These are concentrated in and around Addis Ababa. Urban, per-urban and intensive systems account 2% of the total milk production of the country [11].`

Table 1. Who are dairy producers?

Smallholder farm	Medium farm	Large scale farm
holding <5 x breed dairy cows and producing both crop and Livestock (Individual)	holding>5 to 10 x breed dairy cows mostly found in and around urban Area (Subsistence)	holding >10 x breed dairy cows mainly targeting profit from dairy Products (commercial)

Table 2. The breeds of animals the farms hold

Smallholder farm	Medium farm	Large scale farm
Local breeds	X breeds (50,75 & above 75% Frisian crosses)	X breeds (75 & above 75% Frisian crosses)
X breeds (50% Frisian crosses)		

Constraints to the Dairy Ssector

In Ethiopia, the livestock sector in general and the dairy sub-sector in particular do not make a substantial contribution to the national income, despite their large size, due to numerous socio-environmental factors. The poor performance of the dairy sub-sector is attributed to socio-economic, infrastructure and technical constraints, inadequate research and extension activities, and lack of policies relevant to the development of the dairy industry [18]. Among others, land tenure policies, feed availability, lack of adequate dairy services, lack of marketing outlets, and poor roads and transportation systems are the major constraints of the dairy sector in three East African countries viz., Ethiopia, Kenya and Uganda [18].

Another important problem reported by all the respondents (100%) was feed shortage, i.e., low supply and high cost especially of agro-industrial by-products. Most dairy farmers of Dire Dawa purchase feed for their dairy animals from Addis Ababa which is located at a distance of 515 km and transport it all the way to Dire Dawa. The transportation cost is almost comparable to the cost of the feed itself. The problem of feed shortage is also reported by [19]. and Galmessa *et al.* (2013) as one of the major factors that hinders urban and peri-urban dairy development in Oromia Region of western Ethiopia. Inadequate supply of quality feed is the major factor limiting dairy productivity in Ethiopia [18]. Improved feeding is crucial for satisfactory animal growth and feed supplements stimulate higher milk production. Feed, usually based on fodder and grass, are either not available in sufficient quantities due to fluctuating weather conditions or when available are of poor nutritional quality. These constraints result in low milk yield, high mortality of young stock, longer parturition intervals, and low animal weight.

In the highlands of Ethiopia, high population growth and density are causing shortage of grazing land on which livestock production by smallholders depends. In the lowland areas, the shortages of feed and water during the dry season forces animals and livestock keepers to trek long distances in search of feed and water. The quality of feed also deteriorates during the dry season in both the mixed farming and pastoral systems.

Apart from this, there is critical shortage and high cost of feed [20,21]. Besides, there are only few companies that produce concentrate feeds and therefore dairy processing plants depend on farmers' scanty produce. Feed supply is a major issue for smallholder dairy systems, as most systems operate under conditions of extreme land pressure. Feed conservation for dry season supplementation has been a major issue, as most technologies such as silage, haymaking, and urea treatment are not suitable for smallholders [18]. Fodder trees and mixed tree-legume protein banks can be a solution. Hence, improved nutrition through adoption of sown forage and better crop residue management and use can substantially raise livestock productivity.

Livestock Feed Resources Classification in Ethiopia

Feeds can be classified according to some of their general properties. The classification used hears is typical of that used in the feed industry. Feedstuffs can be classified as either concentrates or roughages [22].

Concentrates

Concentrates have low fiber content and a high content of either protein or energy or both. Cereal grains for example are considered as primary energy sources but also contribute a significant amount of protein. Energy source concentrates: are includes cereal grain (E.g. corn, sorghum and buck wheat), grain milling by-products (E.g. wheat bran and corn gluten meal), root and tubers (E.g. cassava and potatoes), food processing by-products (E.g. molasses, bakery waste, citrus pulp distiller and brewer's by-products), industrial by-products such as wood molasses. Protein source concentrates: Protein supplements generally are products with more than 20% crude protein. Some of these feeds are; oilseed meals (E.g. soybean, cottonseed, rapeseed, canola, linseed, peanut, safflower and sunflower meals), grain legumes (E.g. beans, peens and lupines) and animal protein (E.g. meat meal, tank ages, fishmeal's and whey feather meal [22].

Roughages

Roughages are bulky materials which have high fiber content and a low nutrient density. Hay, pasture, silage, straw and cottonseed hulls are examples of roughage. They are used primarily in feeds for ruminant or non-ruminant herbivores [22].

Available Feed Resources in Ethiopia

Natural grazing land is a predominant feed source for livestock in Ethiopia. Very little land is planted to introduced pasture or forage crops. This is especially true for the pastoral and agro-pastoral areas. Grazing areas are usually communally owned. Crop-residue and agro-industrial by-products represent a large proportion of feed resource in mixed crop-livestock system. Reliance on a crop residue for animal feed is ever-increasing or more land is cropped to feed the fast-growing human population [23].

Natural Pasture and Browse

Natural pasture supply the bulk of livestock feed which is composed of indigenous forage species and is subjected to overgrazing. Grazing occurs on permanent area, fallow land and a land following harvest. Both fallow land and crop stubble provide poor grazing for a very short period just after harvest of crops. The availability and quality of native pasture varies with altitude, rainfall, soil type and cropping intensity. The higher rainfall area of the pastoral zone is characterized by dense thorn bush of low carrying capacity. The basic types of grazing system are continuous grazing and rotational grazing [24].

Table 3: Availability of different feed resources in different production system

Coffee-Enset system	Coffee-crop system	Crop production system	Pastoral and agro-pastoral system
-Natural grazing	-Natural grazing	-Natural grazing	-Natural grazing
-Hay	-Hay	-Hay	-Standing hay
-Enset by-product	-Cereal crop residue	-Cereal & Pulse crop residue	-Browse shrubs & trees
-Sugar cane tops or leaves	-Oilseed cakes	-Oilseed cakes	
-Root crop leaves	-Enset by-product	-Sugar tops /leaves	
-Local brewery by-products	Sugar cane tops/ leaves	-Local brewery by-products	
	-Root crop leaves	-Molasses	
	-Local brewery by-products	-Milling by-products	
	-Molasses		
	-Milling by-products		
Sources: [23].			

Conserved Pasture Forage

Preserving of forage is a means of distributing forage throughout the year and is usually in excess during spring and early summer and in deficient for the rest of the year. So forage conservation is desirable to provide feed during the dry season. Conserved pasture forage can be categorized in to standing hay, harvested hay and silage. Oat, barley and wheat plant materials are occasionally cut green and made into hay for animal fodder; however, they are more usually used in the form of straw, a harvest by-product where the stems and dead leaves are baled after the grain has been harvested and threshed. Straw is used mainly for animal bedding. Although straw is used as fodder, particularly as a source of dietary fiber, it has lower nutritional value than hay [25].

Crop Residues

A wide variety of arable crops is grown on subsistence farm holdings and many of these crops have residues which can form an important source of livestock feed, following the harvesting of grain. Livestock in mixed crop-livestock farming systems two to three months into a dry season feed on cereal straws, stubble or other leftovers such as maize stover. The potential and abundance of crop residues that could be used for livestock feeding in Ethiopia in most cases, drown from grain yield, using multiplier is 13.7 million tons (13.6 million tons in the rural area and 136 thousand tons in urban areas) from cereals having CP value ranging from 3.1-6.7% with digestibility level about 40.7-54.1%. They are suited for all classes of livestock in the country according to their nutritional characteristics. Stover is the leaves and stalks of corn (maize), sorghum or soybean plants that are left in a field after harvest. It can be directly grazed by cattle or dried for use as fodder. Stover has attracted some attention as a potential fuel source and as biomass for fermentation or as a feedstock for cellulosic ethanol production [24].

Straw is an agricultural by-product, the dry stalks of cereal plants, after the grain and chaff have been removed. Straw makes up about half of the yield of cereal crops such as teff, barley, oats, rice, rye and wheat. It has many uses, including fuel, livestock bedding and fodder, thatching and basket-making. It is usually gathered and stored in a straw bale, which is a bundle of straw tightly bound with twine or wire. Bales may be square, rectangular, or round, depending on the type of baler used [26].

Agro Industrial by Products

By-products from sugar: The sugar industries in Ethiopia have factories at three sites (Wonji, Shoa and Methara). The present area of cane is 13,000 ha and the estimated yield of cane tops is 6 tones dry matter per hectare or 78,000 tones dry matter per year. Production of molasses in 1981/82 was 51,100 tons of which 29,000 tones were exported. At present the use of a molasses/urea mixture as a drought-relief feed has been started in a pilot scheme run jointly by the Ministry of Agriculture, the Ministry of State Farms and ILCA [27].

Oil-cake

Oil cakes are an excellent concentrate feed for ruminant livestock in Ethiopia which grows most of the temperate and sub-tropical oilseed plants such as linseed, groundnuts, rape, sesame, sunflower, cotton and Nug. Nug is a native annual composite, which produces Niger seed for oil, is also grown. The processing factories of oilseeds is widely practiced on a family basis or in small village mills [24].

Milling by-Products

The various milling by-products obtained through processing wheat, corn and barley are of great interest as livestock feed for state farms, city dairy holders and to a lesser extent for some dairy co-operatives. Wheat grain is processed in big mills, whereas in the case of teff, barley, maize and sorghum the whole grains are processed and used for food [24].

Slaughter Product

Large numbers of livestock, mainly cattle, sheep and goats are slaughtered every year of these, only a small proportion of the cattle are slaughtered in abattoirs with processing facilities. Addis Ababa Municipality, which is responsible for the abattoirs, produces meat, bone meal and blood [27].

Brewery by-Products

Brewer's grains are traditionally valued for lactating cows because of their palatability and milk-producing property. In addition to commercial beer production at the more than nine breweries are practiced in the country [24].

Feeds and Feeding of Dairy Cows

Forage production is a major constraint for improvement of the dairy sub-sector. The Government of Ethiopia states that "for their nutrition, most livestock of the country depend almost entirely on the herbage that grows on non-arable, natural, grazing lands" [28]. Insufficient feeding of livestock has been attributed to 40% of low productivity. Feed and feeding problems facing the dairy sector are insufficient quantity of forage produced on the farm, insufficient inputs for commercial feeds, a lack of quality feed formulation, and the absence of feed testing for analysis.

The feed sub-sector can be comprised of on-farm supply, communal grazing of government land, purchased feed/forage, and manufactured commercial feed. The feeds, fodder/forages and agro-industrial byproducts, available to small holder and commercial dairy farmers in Ethiopia can increase productivity by: increasing milk yields, lowering age of first calving, and shortening calving intervals. Common crop residues available to dairy farmers are straw made from teff, wheat, barley, mixed finger millet, rice straw, and sorghum and maize stovers. Farmers prefer wheat and barley straw which has a higher crude protein level, although teff straw is desired because of its high palatability and digestibility. Forages are the basis of dairy nutrition. Quality depends upon early harvest, proper drying and storing. Crude protein levels of 15% are possible. Improper and under-managed forage producing lands limit Ethiopia's production potential, even in commercial systems. Suluta, for example, has a reputation for productive hay land, but annual production is commonly 3,600 kg per hectare.

Cultivated forages available to producers include napier grass, alfalfa, Rhodes grass, guinea grass, desmodium, lablab, cowpeas, and vetch and oat/vetch mixtures. Forage trees are also effective forages; leucanenas, sesbania and tagasaste. Less than 1% of rural livestock producers reported on-farm production of improved forages such as Napier grass and alfalfa [29]. Only 60% of the smallholders use feed from own holdings [30]. This problem is exacerbated on the smallholders who have small land size. Fourteen percent of the smallholders use communal / government grazing and agriculture lands. Without appropriate management quality forage production, targeted to dairy, is low.

Additional nutrients are not available during all periods of the year. It is estimated that smallholders use green fodder grazing followed by crop residue (34%) and hay (13%). Producers' utilization of industrial by-products, e.g. oil cake, bran, and brewery waste is nonexistent (approximately 0.8% of all dairy smallholders). Small holders and commercial farmers normally purchase some percentage of their fodder and forage needs. Competing demands for fodder and forage beyond feeding livestock include; on-farm: household use in construction of mud houses and mattresses, and off-farm: re-distribution to Ethiopian finishing farms and export to Djibouti to supply quarantine stations. Seasonally, demand is highest in November and December. Prices is heavily dependent upon the effect of weather upon supplies, but the general perception is that prices have been on the rise since 2006.

Forage production is a major constraint for improvement of the dairy sub-sector. Feeding of livestock has been identified as contributing to 40%t of low productivity. The feed sub-sector can be comprised of on-farm supply, communal grazing of government land, purchases of feed/forage, and manufactured commercial feed. Fodder refers to crop residue, which is generally high in fiber and low in protein and energy. Forages are primarily grass species which can be of high quality if harvested in the early flower stages. A particular problem in pastoral areas have been the encroachment of unpalatable, invasive species, like Prosopis, reducing quality pasturelands.

Ethiopia Dairy Value Chains, USAID CA No. 663-A-00-05-00431-00 Land O'Lakes, Inc. IDD. The feeds, fodder/forages and agro-industrial byproducts, available to small holder and commercial dairy farmers in Ethiopia can contribute to increases in milk yield, a lower age to first calving and shorter calving intervals. (See appendix tables for a summary of nutritional values.) The problems facing the dairy sector are insufficient quantity of forage produced on the farm, insufficient inputs for commercial feeds, a lack of quality feed formulation, and the absence of feed testing for analysis. Common crop residues available to dairy farmers are straw of teff, wheat and barley and mixed, finger millet, a rice straw, and sorghum and maize stovers.

There is a preference for wheat and barley straw which has a higher crude protein level than other fodders but teff straw is also in demand as it is highly palatable and digestible. Forages are fed as dry grass hay. Forages are the basis of dairy nutrition. Quality depends upon early harvest, proper drying and storing. Crude protein levels of 15% are possible. Ethiopia has some excellent forage production lands, which are under managed. For example, Suluta has a reputation for productive hay land, but annual production is commonly 3,600kg per hectare. Cultivated forages available to producers include napier grass, alfalfa, Rhodes grass, guinea grass, desmodium, lablab, cowpeas, and vetch and oat/vetch mixtures. Forage trees are also effective forages; leucanenas, sesbania and tagasaste.

Less than one percent of rural livestock producers reported on-farm production of improved forages such as Napier grass and alfalfa [29]. Even producers' utilization of industrial byproducts, e.g. oil cake, bran, and brewery waste is non-existent (approximately 0.8% of all dairy smallholders). The 2008/09 CSA survey pointed out that about 60% of the smallholders use feed from own holdings. This problem is exacerbated on the smallholders who have small land size. Moreover 14% of the smallholders use the communal/government sources. The quality of feed can be low for dairy cattle which require a minimum nutritional level for maintenance and then additional energy for calf rearing and lactation.

These additional nutrients are not available during periods of the year. It is estimated that smallholders use green fodder grazing followed by crop residue (34%) and hay (13%). Dairy feed management practices, among other factors, contribute to the low level of milk productivity.

The demand for fodder and forage is high. Small holders and commercial farmers normally purchase some percentage of their fodder and forage needs. There are competing demands for fodder and forage beyond feeding livestock; household use in construction of mud houses and mattresses and export to Djibouti for the quarantine station. Seasonally the highest demand is in November and December.

Feeding strategies

Feeding strategies are an important indicator of the intensity of production. Grazing is still an important source of nutrition for dairy animals comprising around half of the overall diet in Ethiopia and 20% to 40% of the diet in India. There was some evidence for grazing accounting for a higher proportion of the diet in areas of low market quality, especially in India. Conversely, stall feeding tended to account for more of the overall diet as market quality increased. There was seasonal variation in the share of grazing especially in Ethiopia where grazing formed an important component of the diet during the 'winter' season when animals are allowed to graze. In general, seasonal variation in diet composition was more pronounced in Ethiopia than in India. Stall feeding accounted for a higher proportion of the diet in India than in Ethiopia.

Feed and feeding aspects of intensification

The contribution of grazing to total feed was high during the harvest season. Dairy cattle grazed from pastureland and crop aftermath during the harvest season. Grazing contributed more to the feed requirement of indigenous than crossbred cows. Indigenous cows were allowed to graze freely throughout the year and were expected to meet their feed requirement from grazing, especially in the rainy and harvest (crop aftermath grazing) seasons, and supplemented during the dry season when the condition of grazing pasture deteriorated. Crossbred cows that demanded better nutrition for better milk production were only allowed to graze for a limited number of hours in a day when grazing pasture was in better condition. They were mostly kept indoors during the dry season to meet their feed requirements through stall feeding.

The stall-fed diet composition varied among seasons and market quality sites. The proportion of dry fodder (mainly crop residues and hay) in the diet of dairy cattle comprised the highest share during the dry season. Whereas, green fodder (mainly grass from natural pasture and weeds from crop lands) in the stall-fed diet of dairy cattle contributed more in the rainy and harvest seasons. The contribution of concentrate to total diet was higher in high market quality sites. This was an indication of the change in the level of feed intensification (feeding practices) as market quality improved to bring an increase in animal productivity. The dominant concentrate components were wheat bran, noug cake and local brewery byproducts.

Price and source of purchased dry fodder and concentrate are shown in Table 4. The main feed types were crop residues, hay and industrial by-products. The price of the feeds varied depending on their nutritional quality. The price of grass pea straw (2.33 Birr/kg) was high compared to other dry fodder feed types [26]. have reported that grass pea straw had better crude protein content of 9.6% of dry matter compared to teff (5.4%), wheat (2.4%) and barley (3.4%) straw. Among concentrate feed ingredients, the highest price was

recorded for molasses (3.53 Birr/lt) and the lowest price was for industrial brewery by-products (0.15 Birr/lt). Price of molasses was higher because it was not produced locally but was brought from a distance, whereas brewery by-products were produced locally in Gonder and bought at a relatively cheap price.

A study by [9] on feed marketing in Ethiopia has indicated that crop residues and hay are major marketable roughage feeds. Within the village and within kebeles are the main sources to purchase dry fodder. Milk producers needed to leave their villages to purchase many of the concentrate feed ingredients.

Feeds, Feeding Systems of Dairy Cattle

Urban dairying is more complex as a large proportion of the cattle diet has to be roughage. Usually, roughage for feeding dairy cattle is expensive to purchase and difficult to find in urban areas. This statement is confirmed by 53.7 [31]. and 80 of the respondents in Addis Ababa and Mekelle towns in Ethiopia respectively who indicated feed cost to be very expensive. High feed cost negatively affects the profitability of milk in the market and is felt more by the urban dairy farmers compared to the peri urban dairy farmers who benefit from grazing their cows in open areas.

The main sources of forage for dairy cattle are purchased fodder, crop residues, natural pasture and weeds. These are obtained from roadsides, public land and their own planted Napier grass or from farmers who do not have livestock. A good number (41 percent) of dairy farmers in Nakuru town obtained their fodder for cattle from their own urban farms and 30 percent were purchased from forage vendors [32]. Different observations were reported for urban dairy farmers in Addis Ababa who used mostly (87 and 71 percent) respectively purchased hay and pasture from roadside. Seasonal variations in quantity and quality of the forages are a major concern especially during the dry season. A study by [28] showed variations in feed availability in peri urban dairy units of Tanzania and dairy cows received less than 30 kg/cow/day of forages during the dry periods. As a result, lactating dairy cows were able to produce between 71 and 83 percent of their potential milk production. During the dry season, dairy cows are fed on moderate (6-6.8 CP percent) quality pastures [28]. The crude protein (CP) content of pastures is lower than the forage crude protein content of 7 percent which would cover the maintenance requirements of ruminants [33]. Therefore, dairy cows depending on natural pastures during the dry season will not express their full genetic potential. However, in cross sectional studies in Bahir Dar and Gondar [34] and Dare-Dawa cities in Ethiopia, season of the year had no effect on milk yield at all stages of lactation. The reason behind this was that farmers in these cities conserve feeds that help to minimize variation in feed availability and therefore, the influence of climatic conditions was negligible. Deficiencies in nutritive value of natural pasture, stresses the importance of supplementation with energy and nitrogen especially during the dry season.

Urban and peri urban dairy farmers rarely feed concentrates at recommended levels and required quality. More often, dairy farmers feed concentrates to relax the cows when milking and not for increased milk production. Dairy farmers supplemented their lactating cows at the rate of 2-3 kg/cow/day at milking time without considering the actual physiological requirements of the animals [33,35].

Table 4. Feed source of different scale of dairy farms

No	Types of feed	Feed sources	Where it comes from
1. Small scale dairy farms Feed type and its sources			
1	**Basal diet** ▪ Grazing, weed ▪ Hay ▪ Green feed ▪ Straw ▪ Oats hay	▪ Own ▪ Own ▪ Own ▪ Own ▪ Own	▪ Communal grazing farm and land ▪ Part of his Farm land(kello) ▪ Part of his Farm land ▪ Crop residue ▪ Sown for feed
2	**Supplementary feed** ▪ Wheat bran ▪ Cereal halls ▪ Attela ▪ Salt ▪ Green feed	▪ Purchased ▪ Own processed ▪ Own processed ▪ Purchased ▪ Owen planted	▪ Flour factory ▪ 2nd grade grains ▪ Homemade local beer ▪ Retailers ▪ Back yarded improved forage
Medium Scale Dairy farms Feed type and its sources			
1	**Basal diet** ▪ Hay ▪ Crop residue	▪ Purchased ▪ Purchased	▪ Retailers ▪ Surrounding farmers
2	**Supplementary feed** ▪ Oil seed cake ▪ Wheat bran ▪ Pulse halls ▪ Attela ▪ Salt	▪ Purchased ▪ Purchased ▪ Purchased ▪ Purchased ▪ Purchased	▪ Edible oil factory ▪ Flour factory ▪ Bean and lintel grinding mills ▪ From homemade local bear ▪ Retailers

Large scale Dairy farms Feed type and its sources		
Basal diet ▪ Hay Supplementary feed ▪ Oil seed cake ▪ Wheat bran ▪ Concentrate ▪ Pulse halls ▪ Salt ▪ Molasses ▪ Brewery grains	▪ Purchased ▪ Purchased ▪ Purchased ▪ Purchased ▪ Purchased ▪ Purchased ▪ Purchased ▪ Purchased	▪ Wholesalers ▪ Edible oil factory ▪ Flour factory ▪ Feed industries ▪ Bean and lintel grinding mills ▪ Retailers ▪ Sugar factories ▪ Bear processing factory

Collection of forage from the sources requires transport. Different modes of transport are used to collect forage from the sources to the dairy units. Meanwhile, almost a half (50.8 percent) of the dairy farmers in urban centre of Addis Ababa used donkeys while 46.7 percent of them used vehicles to bring in feed to the dairy units [36]. The modes used to transport feed have an implication on the milk production costs and maintenance of high level of milk production throughout the year. Very unfortunately, milk price does not change for long time in accordance to seasonal availability of forages. The coping strategies and setting of milk price by dairy farmers especially during the dry seasons are not well known and documented. Zero and free grazing are the two main types of feeding systems that have been identified across the cities in East Africa [31,37,38,39].

Table 5: Characteristics of urban dairy keeping by households

Country	City/Town	Sample size	Descriptions of dairy farming		Reference
			Free range (%)	Zero grazing (%)	
Ethiopia	Addis Ababa	20	10	90	Richards and Godfrey 2003
	Dare –Dawa	33	9	72	Mureda and Zeleke 2008
	Makelle	168	10	90	Dayanandan 2011

Domestic Livestock Feed Supply

Types of Livestock Feed Supplied in Domestic Market

In general, the feed markets can be categorized into three main market types: markets for roughages, markets for agro-industrial by-products (AIBP) and markets for compound feeds/concentrate mixtures/formulated rations.

Roughages (Crop Residues and Natural Pasture Hay)

The types of crop residues in the country differ from place to place depending on the type of crop grown as determined by the agro-climatic conditions. The major crop residues supplied in the market are cereal crop residues like teff straw, barley/wheat straw, green maize fodder, sorghum stover and oat (*Avena sativa*) fodder. However, there is a limited supply of pulse crop residues. The area of grazing land has declined markedly particularly in the highlands, and this trend is continuing at an increasing rate due to expansion of crop cultivation and urbanization, and to a lesser extent through land degradation [40]. Hence, the supply of natural pasture hay is diminishing while crop residues are becoming increasingly important in the annual feeding cycle, already accounting for more than 50% of total feed in most areas. Sugarcane tops and bagasse are mainly produced by the state sugar factories. However, because of its bulky nature and difficulty to transport, most of the sugar cane tops are either burned or left in the field and used freely by any livestock producers living in the vicinity of the factories.

Agro-Industrial By- Product (AIBP)

The major feed resources as by-products of the agro-industries in the country are milling by-products (wheat bran (the coarse outer coat of wheat), wheat middling (finer which may contain bran, endosperm and germ), wheat short, rice bran and screenings), edible oil processing by-products such as nougseed (*Guizotia abyssinica*) cake (NSC), cottonseed cake CSC), linseed cake (LSC) and rapeseed (*Brassica carinta*) or Ethiopian mustard cake (RSC), groundnut, sesame, sunflower, peanut, safflower cakes, etc., molasses and spent brewery grain. The traditional brewery residue (*Tela atella*) and/or traditional liquor residue (*Katicala/ Areqe atella*) are also the by-products produced by small scale brewery and liquor plants, respectively. The major producers of wheat by-products are flour mills. Wheat bran is the most common by-product marketed and used for livestock feeding. According to [7], there are about nine state and 181 private owned grains milling factories in the country with operating capacity of 73% and 55%, respectively, mainly producing wheat by-products.

Feed Related Constraints of Dairy Sector

There are three aspects of feed problems, namely, the issue of increasing the efficiency with which the available feed is utilized (e.g. forages, crop residues, agro-industrial byproducts and non-conventional feeds), and the inability to make maximum use of the 7 limited total feed resources and the seasonal fluctuations in quantity, nutritive value, and water availability. The inability to feed animals adequately throughout the year is the most widespread technical constraint. Much of the available feed resources are utilized to support

maintenance requirements of the animals with little surplus left for production. Poor forage quality, that is with low protein and energy content is also a serious problem. Poor quality feed causes low intake rates resulting in low levels of overall production.

Feed Shortage

Feed shortage in terms of quality and quantity is the major constraint regardless of the dairy Production system and agro-ecology. Feed constraints could be seen from different dimension in terms of quality and quantity and seasonal feed supply to meet the nutritional requirements of dairy animals. Both roughage and concentrate feeds are either too expensive or unavailable in sufficient quantity and quality to improve dairy production [10]

According to [41] funding inadequate supply of quality feed and low productivity of the indigenous cattle breeds are the major factor limiting dairy productivity in the region. 42% of the respondents were reported feed shortage as the most single problems responsible for low milk yield and low productivity of the dairy system. According to [36] funding unavailability of feed probably limit the milk production potential of cows with good milk producing ability more than any other single factor and is the most serious constraint to improve dairying.

Bibliography

1. CSA. 2015. Agricultural Sample Survey 2014/15 [2007 E.C.], Volume ii, Report on Livestock and Livestock Characteristics (private peasant holdings). Central Statistical Agency, Ethiopia.

2. FAO. (2011). A Review of the Ethiopian Dairy Sector. FAO Sub Regional Office for Eastern Africa (FAO/SFE), Ethiopia.

3. ILRI. (2015). Ethiopia livestock master plan. Ethiopia livestock master plan. International Livestock Research Institute, Ethiopia.

4. CSA. (2009). Central Statistical Agency Database. CSA, Ethiopia.

5. Getachew, F. (2003). A Review of the small scale milk sector in Ethiopia. FAO prevention of food losses programme. Milk and milk products, post-harvest losses and food safety in Sub-saharan Africa and the Near East.

6. Belay, D., Yisehak, K., Geert, P. J. J. (2011). Analysis of constraints facing urban dairy farmers and gender responsibility in animal management in Jimma Town. *Af J Basic Appl Sci., 3*(6), 313-318.

7. Tolera, A. (2009). Livestock feed supply situation in Ethiopia, in: Proceedings of the 16th Annual Conference of the Ethiopian Society of Animal Production (ESAP) on Commercialization of Livestock Agriculture, Addis Ababa, Ethiopia, Part I, (pp. 21-38).

8. Ahmed, H., Abule, E., Mohammed, K. & Tredate, A. C. (2010). Livestock feed resources utilization and management as influenced by altitude in central highlands of Ethiopia. *Livest Res Rural Dev., 22*(12), 125-132.

9. Berhanu, G., Adane, H. & Kahsay, B. (2009). Feed marketing in Ethiopia: results of rapid market appraisal. Improving productivity and market success (IPMS) of Ethiopian farmer's project working paper 15. ILRI (International Livestock Research Institute), Nairobi, Kenya, (p. 64).

10. Azage, T., Berhanu, G., Hoekstra, D., Berhanu, B. & Yoseph, M. (2013). Smallholder dairy production and marketing systems in Ethiopia: IPMS experiences and opportunities for market-oriented development. IPMS (improving productivity and market success) of Ethiopian farmer's project working paper 31, Nairobi, Kenya, (p. 65).

11. Belete, A. (2006). Studies on cattle milk and meat production in Fogera district: Production systems, constraints and opportunities for development. M.Sc. Thesis. University of Hawassa, Awassa, Ethiopia.

12. Azage, T. & Alemu, G. (1998). Prospects for Peri-urban Dairy Development in Ethiopia. In: Proceedings of 5th national Conference of Ethiopian Society of Animal Production, 15-17 May 1997, Addis Ababa, Ethiopia, (p. 248).

13. Zegeye, Y. (2003). Imperative and challenges of milk production, processing and marketing in Ethiopia. In: Proceedings of 10th Annual Conference of the Ethiopian Society of Animal Production (ESAP). August 22-24, 2002, Addis Ababa, Ethiopia. (pp. 61-67).

14. Ketema, H. & Tsehay, R. (2004). Milk production systems in Ethiopia. Ministry of Agriculture, Addis Ababa, Ethiopia.

15. Tsehay, R. (2001). Small-scale milk marketing and processing in Ethiopia. In: proceeding of the south-south workshop on smallholder milk production and marketing: constraints and opportunities, Anand, India. 12-16 March.

16. Asaminew, T. & Eyassu, S. (2013). Smallholder Dairy Production System and Emergence of Dairy Cooperatives in Bahir Dar Zuria and Mecha Woredas, Northwestern Ethiopia. *World Jour. of Dair. & Food Sci., 4*(2), 185-192.

17. Ahmed, M., Ehui, S. & Yemesrach, A. (2003). Milk development in Ethiopia. Socio economics and policy research. Working paper 58. ILRI (International Livestock Research Institute), Nairobi, Kenya. (p. 47).

18. SNV (2008). Dairy investment opportunities in Ethiopia. A case study report. Addis Ababa, Ethiopia: SNV-Netherlands Development Organization.

19. Geleti, D., Hailemariam, M., Mengistu, A. & Tolera, A. (2014). Analysis of fluid milk value chains at two peri-urban sites in western Oromia, Ethiopia: Current status and suggestions on how they might evolve. *Global Vet., 12*(1), 104-120.

20. Yilma, Z., Guernebleich, E. & Sebsibe, A. (2011). A review of the Ethiopian dairy sector. Addis Ababa, Ethiopia: FAO Sub Regional Office for Eastern Africa (FAO/SFE).

21. USAID (2013). Value chain analysis for Ethiopia: Expanding livestock markets for the small-holder producers. Addis Ababa, Ethiopia: AGP-Livestock Market Development Project AID-663-C-12-00009.

22. Cheeke, P. R. (2005). Aplied Animal Nutrition: Feeds and Feeding. (3rd ed.). Oregon State University: PEARSON prentice Hall, (pp. 24-261) [27].

23. Alemu, Y. (2009). Nutrition and feeding of Sheep and Goat. In: Ethiopian sheep and Goat Production Improvement Program, (pp. 106-159) [34].

24. Getachew, F. (2003). A Review of the small scale milk sector in Ethiopia. FAO prevention of food losses programme. Milk and milk products, post-harvest losses and food safety in Sub-saharan Africa and the Near East.

25. Solomon, M. (2009). Forage development for Sheep and Goat. Ethiopia Sheep and Goat Production Improvement Program (ESGPIP), (pp. 162-213) [11].

26. Tesfaye, A. & Chairatanayuth, P. (2007). Management and feeding systems of crop residues: the experience of East Shoa Zone, Ethiopia. *Livestock Research for Rural Development, 19*(3), 31-37 [9].

27. Bartholomew, P. W., Ly, R., Doumbia, M., Khibe, T., Kone, N'g., Traore, B., Ba, S. *et al.* (2003). Agro-industrial by-products, cowpea residues and urea-treatment of hay for supplementary dry season feeding of mature zebu oxen in Mali. *Livestock Research for Rural Development, 15*(2), 120-125 [22].

28. Kavana, P. Y. & Msangi, B. S. J. (2005). On farm dairy cattle feeding experience in eastern zone of Tanzania. *Livestock Research for Rural Development, 17*(6).

29. Tefera, T. L. *et al.* (2010). "Commercializing dairy and forage systems in Ethiopia: An Innovation Systems Perspective." ILRI – IPMS. Working Paper No. 17.

30. CSA (Central Statistical Agency). Agricultural Sample Survey 2007/08. Volume II. Report on livestock and livestock characteristics (private peasant holdings). CSA, Addis Ababa, Ethiopia.

31. Shiferaw, Y., Tenhagn, B. A., Bekana, M. & Kassa, T. (2003). Reproductive performance of crossbred dairy cows in different production systems in the central Highlands of Ethiopia. *Tropical Animal Health and Production, 35*(6), 551-61.

32. Prain, G., Karanja, N. & Lee-Smith, D. (2010). African Urban Harvest: Agriculture in the Cities of Cameroon, Kenya and Uganda. International Development Research Centre, (p. 335).

33. McDonald, P., Edwards, R. A., Greenhalgh, J. F. D., *et al.* (1995). Animal Nutrition. Longman Singapore Publishers Pte Ltd, pp 601.

34. Ayenew, Y. A., Wurzinger, M., Tegegne, A. & Zollitsch, W. (2009). Handling, processing and marketing of milk in the North western Ethiopian highlands. *Livestock Research for Rural Development, 21*(7).

35. Richards, J. I. & Godfrey, S. H. (2003). Urban livestock keeping in sub-Saharan Africa: Report of a workshop held on 3-5 March 2003 in Nairobi, Kenya. Natural Resources International Ltd, Aylesford, Kent, UK. (p. 118).

36. MoARD, Livestock Development Master Plan Study Phase I, Volume C-Forage and Seed Production, Ministry of Agriculture and Rural Development (MoARD) and GRM International BV, 2007.

37. Guendel, S. (2006). A synthesis of urban and peri-urban agriculture research commissioned by the Renewable Natural Resources Research Strategy programme, 1995-2006 Final report (p. 31).

38. Kagira, I. J. M. & Kanyari, P. W. N. (2010). Questionnaire survey on urban and peri-urban livestock farming practices and disease control in Kisumu Municipality. *Journal of the South African Veterinary Association, 81*(2).

39. Dayanandan, R. (2011). Production and marketing efficiency of dairy farms in highland of Ethiopia- an economic analysis. *International Journal of Enterprise Computing and Business Systems, 1*(2).

40. Azage, T., Workneh, A., Berhanu, G. & Salvador, F. R. (2003). Opportunities for improving milk production in Ethiopia. (pp. 107-122). Presented in Ethio-Forum 2002. Resource management for poverty reduction: Approaches and technologies. Ethiopian Social Rehabilitation and Development Fund. Addis Ababa, Ethiopia.

41. Ulfina, G., Jiregna, D., Alganesh, T., Shiv, P. & Late, M. (2013). Dairy Production Potential and Challenges in Western Oromia Milk Value Chain, Oromia, Ethiopia.

42. CSA. (2012). Federal democratic Republic of Ethiopia. Central Statistical Agency. Statistical Abstract (CSA), Addis Ababa, Ethiopia.

43. Derese, T. (2008). Present situation of urban and per-urban milk production and quality of raw milk produced in West Shewa Zone, Oromia Region, Ethiopia, M.S. thesis, Haramaya University, Alemaya, Ethiopia.

44. Galmessa, U., Dessalegn, J., Tola, A., Prasad, S., Kebede, M. (2013). Dairy production potential and challenges in western Oromia milk value chain, Oromia, Ethiopia. *J. Agric. Sustain., 2*(1), 1-21.

45. Getahun, D. (2012). Assessment of the livestock extension service in Ethiopia: the case of southern region. *Int J Sci Technol Res., 1*(10), 24-30.

46. GTPII. (2015). Second Growth and Transformation Plan (GTPII) 2015-2020. The Federal Democratic Republic of Ethiopia, Addis Ababa.

47. Kivaria, F. M., Noordhuizenm, J. P. T. M. & Msami, H. M. (2006). Risk factors associated with the incidence rate of clinical mastitis in smallholder dairy cows in Dar es Salaam region of Tanzania. *The Veterinary Journal, 173*(3), 623-629.

48. Msangi, B. S. J., Bryant, M. J. & Thorne, P. J. (2005). Some factors affecting reproductive success in crossbred dairy cows on smallholder farms in coastal North-East Tanzania. *Tropical Animal Health and Production, 37*(5), 413- 426.

49. Preston T. R. (1986). *Strategies for optimizing the utilization of crop residues and agro industrial* byproducts *for livestock feeding in the tropics*. (pp. 145-166). In: ARNAB (African Research Network for Agricultural byproducts), towards optimal feeding of agricultural byproducts to livestock in Africa: proc. of workshop held at the university of Alexandria, Egypt, October 1985. ILCA, Addis Ababa, Ethiopia.

50. Sintayehu, Y., Fekadu, B., Azage, T. & Berhanu G. (2008). *Dairy production, processing and marketing systems of Shashemene–Dilla area, South Ethiopia*. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 9. ILRI (International Livestock Research Institute), Nairobi, Kenya. (p. 62).

51. Tegegne, A., Gebremedhin, B., Hoekstra, D., Belay, B. & Mekasha, Y. (2013). *Smallholder dairy production and marketing systems in Ethiopia: IPMS experiences and opportunities for market-oriented development.* IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 31. Nairobi, ILRI.

52. Tsehay, R. (1998). Prospects of Ethiopian milk development. (pp.149-159). In: Proceeding of the role of village milk cooperatives in milk development: Prospects for improving milk in Ethiopia. 22-24 April 1998, Addis Ababa, Ethiopia.

53. Yitay Alemayehu, Wurzinger M, Azage Tegegne & Zollitsch, W. (2009). Performance and limitation of two dairy production systems in the north western Ethiopian highlands. *Tropical Animal Health and Production, 41*(7), 1143-1150.