Int.J.Curr.Res.Aca.Rev.2020; 8(3): 43-57

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 8 Number 3 (March-2020)

Journal homepage: http://www.ijcrar.com

doi: https://doi.org/10.20546/ijcrar.2020.803.006

Improving Lactating Dairy Cattle Productivity through Feeding Improved Forages and Their Management

Gizachew Delilo* and Asrat Ayza

Wolaita Sodo University, College of Agriculture, Department of Animal and Range Science, P.O. Box: 138, Wolaita Sodo, Ethiopia

**Corresponding author*

Abstract

In developing countries, despite feed-shortages, considerable-potential exists to increase-production levels across a range of growing, lactating and beef-animals by tackling the problem of crop-residues' feeding-value and imbalanced-nutrition. The data on improving milk-production efficiency in dairy-cattle through feeding suggests that there is considerable scope for enhancing milk-production by strategic-use of the existing forages-feed-resources. This is possible through the transfer of scientific knowledge and skills, in an easy-to use and implement-manner to the farmers and milk-producers. The aim should be to promote feeding of a ration in sufficient quantities containing nutrients essential-to lactating dairy-cattle. This review-article is therefore, outlines better approach used to improve forages feed-resources utilization and management, and to balance-rations at the doorsteps of smallholder-farmers in developing-countries, where the projected growth in income, urbanization and of human-population seeks a substantial-increased milk-and-meat production.

Article Info

Accepted: 05 February 2020
Available Online: 20 March 2020

Keywords

Forage-Resources, Utilization-skills, Dairy-cattle, Milk-production and Food-security, sub-Saharan-Africa.

Introduction

Dairy industry occupies a special position among the other agricultural sectors in many respects. Milk is produced every day and gives a regular income to the numerous small scale and/or smallholder producers. Milk production is highly labor intensive and provides an employment. Dairy cattle production is an efficient method of converting large quantities of roughage into milk (the most valuable component of human diet) contain the essential proteins most likely to be deficient in cereal based diets which are staple food of most people in developing world [12]. Dairy industry is the sector with the highest degree of protection due to economically vulnerable position of small-scale milk-producers. Milk, also known as white gold, can be used to make an enormous variety of high quality products. Improving milk production, therefore, is an important tool for improving household nutrition and income of the producers [54]. Ethiopia is known for its huge livestock population, which plays a vital role as source of food, income, services and foreign exchange contributing about >12 & 33% of total agricultural GDP, respectively [36,51]. In Ethiopia milk production was estimated to be 1.69MT[19]. Milk-production and consumption are expected to grow in the sub Saharan region to 3.8-4% annually until 2020[26]. In Ethiopia, the ever increasing human population at a rate of about 3% and urbanization, which is projected to grow to 39.2% by 2020[26] is expected to create greater markets and growth of demand for dairy-products which holds greater opportunities and potentials for milk producers and for milk production & processing industry development[35,36].

Despite the growing demand for milk and the huge ruminant livestock population the country holds, the contribution of dairy sub-sector in the country's economy remains below its potential [53]. This is indicated by the per capita milk consumption that appears to be declined from 26L to 19Ly^{-1} in 2000[32,35]. The low milk production in the country is mainly because of seasonal inadequacy in quantity and quality of feed resources, unimproved genetic-merit for milk production, disease prevalence and lack of appropriate feeding system, that have been listed as major problems hindering the development of dairy industry in Ethiopia[20].

In Ethiopia, dairy-cattle production is based on natural-pasture, crop-residues, hay, improved-forage, and agro-industrial by-products that accounts for 61.9,27.01,-6.55,0.55&0.78%, respectively, of the available feed resources[1,3]. Feed shortages and nutrient deficiencies become more-acute during dry-season Ethiopia where the livestock productivity severely affect. Research findings have indicated that there is annual feed deficit of about12.3 MTs of dry matter in Ethiopia[36]. Currently large gazing areas which constitute major feed resources are gradually being changed into crop cultivation to mitigate the need of the ever increasing human population in the country[49]. Consequently, the availability of crop residues have incre-ased, and constituted as high as 50-70% of the total available feed-resources during the extended dry-season in the mixed crop-livestock production system by replacing natural grazing areas[50]. This situation call-for seeking better-ways for alternative livestock feed resources-utilization as straws from cereal-crops.

Maize, wheat, barley and teff are the major crops produced[17], that contributes about 43.09% of the total cereal-grain production on the land-area of about 2.97 million-ha[3,4], which is reported to produce the largest bio-mass-yield of crop-residues & yield 5.9MTs of grain [19], which revealed about >7.8MT crop-residues produ-ced, which constitutes major livestock feed-resource in areas where maize is grown abundantly in Ethiopia. However, the annual *MS* production is said to be high, its utilization for livestock feeding is constrained by its physical nature and nutritional characteristics[54].

Nutritive value of maize-stover is characterized by low protein content, high fiber and lignin, as well as low content of minerals and vitamins. These nutritional deficiencies limit its digestibility, intake & hence animal performance-[2,34,50]. Studies on maize stover utilization as animal feed indicated that the stover is usually grazed *in situ* and so is subjected to trampling, soiling and shattering. As a result, less than 50% of the available stover is actually consumed by livestock [52,54]. This indicates that maize-stover is one of the less efficiently utilized feed resources.

Due to the increasing pressure on feed resources, it is inevitable that conventional animal feeds are becoming increasingly more expensive& unavailable. The decrease in the availability of natural grasslands and increase in crop residues availability in the country, dictates an alternative strategy to improve the utilization of crop residues such as maize-stover in order to maintain productivity of lactating dairy cows, particularly during the dry season when there is severe shortage of forage, and hence reducing dependence on grasslands and conserved hay.

Supplementing crop-residues with agro-industrial by-products and/or improving quality of the basal diet through treatment such as physical and chemical (alkali) treatment provide a better option for improved utilization and hence improved animal performance[8]. Among methods of crop residue treatment, urea treatment has a potential for increasing digestibility and intake of fibrous residues, acting both as alkali and source of supplementary nitrogen to materials inherently low in crude protein thereby enhance its utilization[55].

It is noted that feeding-value of *UTMS* on *DMI*, digestibility, & *ADG* increase by 20, 9 &35.5%, respective-ely compared to the *UMS* fed to crossbred calves[53]. Similar improved utilization of maize-stover by animals were reported as a result of urea-treatment[52]. Urea treated teff & barley-straw were well-known to substitute-*GH* without any effect on milk-yield of crossed dairy-cows[45].

Evaluation of *UTMS* as a potential-substitute for part or all of grass-hay in the ration of dairy-cows would be feasible alternative in areas where maize is the dominant crop. Such strategies would enable development of feeding system based on available feed resources through efficient utilization[13]. However, feeding-value of *UTMS* is not adequately assessed in diet of dairy-cows and information on its influence on productiveperformances of dairy-cattle is limited. Therefore, the present study was designed to evaluate the performance of lactating dairy cows fed on *UTMS* whether it used to replace parts or all of *GH* in cows-diet, esp. with objectives:

To improve manage, and utilize forages-based non-conventional feed-resources by using alternative methods of improvement-strategies such as physical-chemical treatments methods to feed lactating dairy-cattle.

To promote milk and dairy-products and, boost percapita consumption of high-quality protein and combat the problems of male-nutrition of farming communities in Ethiopia and the horn as well.

Dairy production in ethiopia

Role and status of dairy production

Dairy production is a biologically efficient system that converts large quantities of roughage into milk, the most nutritious food known to man. It is also stated that, where there is access to market; dairying is preferred to meat production since it makes more efficient use of feed resources and provides a regular income to the producer. It is also more labor intensive and supports substantial employment in production, processing & marketing[55]. Thus, the intensification of smallholder livestock systems through development of dairy farming is often advocated as an important livelihood option to increase the income, therefore, to contribute to poverty alleviation in rural area-[54].

In Ethiopia milk is produced in all agro-ecological zones and mainly from cattle (83%) and the reminder 17% is from goats and camels. Almost all indigenous cattle are owned by small holder subsistence farmers represent 85% of the human population in Ethiopia. The dairy cows produce food to the family, provide direct cash income, are capital assets, produce manure for use as fertilizers and fuel & source of power for transport and cultivation[35].

Despite the large livestock resource base and an ecological setting suitable for dairy production, the country is not yet self-sufficient in milk production, which has been growing slow. The average milk production of the indigenous cow/head/lactation is only 207.6kg lower than the average for East Africa which is 364.4kg and Africa 446kg/head/lactation[32]. The introduction of exotic-breeds was suggested as one option to improve the productivity of indigenous-cattle combining the adaptability (hardiness, disease tolerance, ability to walk long distance in search of feed & water and heat tolerance) of native cattle with the high milk production potential through cross breeding, has been practiced as a more sustainable way to improve milk production[29]. Today crossbred and high-grade dairy cattle varying in their exotic gene level are found in many agricultural institutions, cooperatives, small scale and large-scale commercial dairy farms in urban and peri-urban areas[62].

The ever projected increasing human population and urbanization is expected to create greater markets and growth of demand for dairy products. This increase in demand for milk and dairy products offers greater opportunities and potentials for milk producers and for milk production development[52]. Dairy production system based on crossbred and high grade dairy cattle can respond to such a demand under conditions of unfavorable infrastructure are found in the peri-urban and urban areas which have tremendous potential for development[29]. However, because of their high metabolic rate and their requirement for milk secretion, nutrient requirement for this genotype is higher than indigenous breeds. As the production system intensified, the type of available feed resources & nutrient supply to support them produce & reproduce becomes a challenge to the system[36].

Among the many problems faced by these dairy farms, scarcity of feed ingredients, low quality and their high prices are considered to be of major importance. For example, in the mixed crop-livestock highlands of Ethiopia average price of dairy cow feed increased from Birr 100/kg in 2005/2006 to Birr 3.00/kg in 2007/2008 about 300% increase[26]. In the conditions of the highlands of Ethiopia, the increasing pressure on land to grow food crops and the ever expanding human population has resulted in a reduction in grazing-land[25]. Besides, the seasonal variations in feed-quality and quantity, increase in feed-cost have been pointed out as the main limitation to animal production and cause fluctuation in productivity throughout the year, particularly in the dry seasons during which feed is scant and poor in nutritive value[21,28].

Nutrient-requirements of lactating cows

Nutrient requirement(*NR*) of dairy cows depend on factors such as breed, lactation stage, age, body weight(*Bwt*), body condition, stage of pregnancy, milkcompos-ition, exercise and climatic conditions, are factors taken into account if a cow's *NR* to calculated with any degree of accuracy[41,42]. However, the base line to determine cows *NR*; *BW*, amount of milk produced & its composition[33].

In the tropics there is no effectively developed feeding-standards based on animals *NR* and available feed resources & prevailing environment. However, as a base to calculate *NR* of livestock, feeding standards developed in the temperate environment have been adapted[37]. The diet of the cow must provide nutrients for maintenance of the body which is proportional to metabolic body size of the animal, and then for production. The major nutrients such as energy and protein requirements for dairy cows describe-ed as; *ME* requirement for maintenance is 552KJ/kg $W^{0.75}$ day and digestible *CP*; 2.86g/kg$W^{0.75}$ day. The *ME* and *DCP* required for the production of 1kg 4% fat corrected milk are 4.76*MJME* and *55gmDCP*, respectively[38].

Dietary-effect milk-yield and composition

The relative amounts of protein and energy that are available in the rumen at a given time is the major factor affecting rumen-fermentation & therefore milk components and production. Any diet or management factors that affect rumen fermentation can change milk fat and protein levels[24]. Studies on the effect of nutrition on milk yield and mainly milk composition most research suggests that the magnitude of change in milk protein content is much smaller than that observed for milk fat content. *MF* can be changed by 0.1-1.0%, while protein is seldom altered more than 0.1-0.4 points by nutritional changes[21]. The main dietary factors that could affect milk yield and milk composition includes concentrate (energy) levels, protein levels and fiber content & digestibility.

Effects of energy level

Increasing energy-rich concentrate supplementation level in the diet of dairy cows usually increases the rate of production of microbial protein and of propionate relative to acetate and long chain fatty acids in the rumen, resulting in increased rates of synthesis of protein, lactose and, to a lesser degree, fat in the mammary gland[12]. This further pointed out that increasing amounts of either post-ruminal glucose or ruminal propionic-acid is recognized as a method to improve milk and protein yield by reducing use of some amino-acids for gluconeogenesis spared amino acid being available to the mammary gland for the synthesis of milk protein. It is also reported that except for fat content and yield which decreases in curvilinear manner, increasing energy intake linearly increased milk yield, milk protein content & yield, and concentration of lactose and *SNF*[9]. A relationship between the energy supply to the cows and milk protein content, typically an increase of *10MJME* intake increases milk protein content by about 0.6g/kg[43]. However, lower energy and protein intake and lower ration digestibility were associated with reduction in feed intake, milk production and milk-protein content[23].

Effect of protein level

Increasing dietary crude protein (CP) were associated with linear increase in milk fat content as well as ruminal acetate, NH_3, and branched chain volatile fatty acids, which leads to the principal production effects of linear increase in yield of milk, *FCM* and fat content. Protein content and yield showed trends for quadratic responses to dietary *CP*, but there was no effect of dietary *CP* on lactose content and yield, and SNF yield[39]. A deficiency of crude protein in the ration may depress protein in milk; marginal deficiency could result in a reduction of 0.01-0.2%[41]. Protein content of milk increases only about 0.02% points for each 1% unit increase in dietary protein. However, feeding excessive dietary protein does not increase milk protein, as most of the excess is excreted. Diet protein type also could affect milk protein levels. Use of non-protein nitrogen (*NPN*) compounds, like urea, as protein substitutes may reduce protein in milk by 0.1-0.3% if *NPN* is a main provider of *CP* equivalent[21].

Effect of fiber content and digestibility

The amount and type of fiber that is fed can significantly affect rumen function, which affects the amount of rumination, saliva production, rumen *pH* and *MF* level[38]. *MF* is positively correlated with the concentration of neutral detergent fiber(*NDF*) in the ration. Furthermore, diets high in digestible fiber(*NDF and ADF*) are associated with an increased rate of production of lipogenic (acetate and butyrate) to glucogenic (propionate) volatile-fatty acids(*VFA*), with the change in the ratio of *VFA* leading to increased milk fat concentration[38]. established a linear relation between the marginal increase in *NDF* digestibility and animal responses, 1 unit of enhanced *NDF* digestibility is positively associated with 0.17kg-*DMI*, 0.23kg of milk-yield, and 0.25kg of 4%*FCM* yield[40].

Feed resources and nutritional characteristics

Feed is the most important input in livestock production, and its adequate supply throughout the year is an essential prerequisite for any substantial and sustained livestock production. Reports on the major livestock feed resource base in Ethiopia indicated that grazing on natural-grasslands contributes 61.92%, crop-residues 27.01%, hay 6.55%, improved forage 0.52%, agro-industrial by-products 0.78% and other type of feed 3.6% of total supply[15]. Conserved hay, agro-industrial by-products and commercial concentrate rations are the major feed resources used by urban and peri-urban dairy farmers[49].

Natural pastures

Natural pastures are naturally occurring grasses, legumes, herbs, shrubs and tree foliage that are used as animal feed. The total natural pasture used for grazing and browsing in Ethiopia was estimated to be 61-65 million hectares[3,5]. Natural pastures are most important feed resource in the feeding of ruminants which accounts for 61.92% of the feed supply. The availability and quality of natural pastures vary with altitude, rainfall, soil type and cropping intensity. The level and distribution of available soil nutrients and water are the main limiting factors. The productivity of natural pasture in the Ethiopian highlands ranges from 1-2 ton $DMha^{-1}$ on freely drained and relatively infertile soils and it could vary from 4-6 ton $DMha^{-1}$ on seasonally waterlogged fertile areas[21]. The intensity of cropping determines the area available for grazing. Livestock grazing is the predominant form of land use in pastoral areas, which receive <600-700mm annual rainfall. However, in the densely populated areas, the better soils are used for cropping and the slope of hills and the seasonally waterlogged areas are allocated for grazing. In some highland areas, there are seasonally water logged extensive grassland plateaus that restrict pasture use[1,12].

Natural pastures are usually grazed *in situ* or harvested and made into hay. The quantity and quality of feed obtainable from natural pastures declines as the dry season progresses. Conserving of natural pasture in to hay for dry season use is very important when feed supply is extremely low in the field. However, traditionally harvesting of native grass hay is usually delayed into the dry season, and thus leads to lose of nutritive value[25]. The author described that, hay harvested after maturation had *CP* contents <5%, which was below the level(7.5%) required for maintenance by ruminants. Furthermore, tropical grasses are also characterized by low nutritive value due to the higher lignin content and less degradable materials in their cell wall due to rapid rate of achieving maturity[13,15]. At advanced maturity, forages are characterized by high levels of *NDF*, *ADF*, lignin, and low N which resulted in poor intake capacity, digestibility and hence low animal performance. *NDF* value greater than threshold level of 60% resulted in decreased voluntary feed intake, increased rumination time and decreased conversion efficiency of *ME*[16,19]

It is reported that natural pastures that are mature usually do not fulfill the nutritional requirement of animals particularly during the dry season due to poor management and inherent low productivity and poor quality. As a result lactating cows are unable to meet their nutritional requirement and lose body weight and exhibit drop in fertility and milk production. Therefore, cutting at proper growth stage is a crucial management practice that determines its nutritive values[3,6,8].

The chemical compositions of hay collected from various sites in Ethiopia contained 87-94*DM*, 3.75-8.7*CP*, 64.2-77*NDF*, 37.9-43.7*ADF*, 4-7 lignin and 7.5-13.7% ash and energy value ranges *6.5-8.2MJME/kg DM*[39,43]. The data showed the low *CP* and high NDF content indicating that maximal livestock production cannot be achieved on hay alone. Therefore, for reasonable level of production, animals subsisting on hay require supplementary protein, which could be from oil seed cakes or non-protein nitrogenous(*NPN*) sources. The potential for the adoption of improved forage is high because of the possible opportunity for regular cash income generation from dairy sales, but forage cropping is in direct competition with current cash and subsistence cropping enterprises[30].

Currently, natural pastures which constitute major feed resources are decreasing from time to time and gradually disappearing due to rapidly increasing human population and expansion of cropland. Increasing urbanization and use of arable land for housing, recreation, floriculture and industrial development is displacing a significant amount of grazing land[1,41]. Particularly, the conversion of natural pastures into crop land to mitigate food requirement of the ever increasing human population, consequently, crop residues represent the largest feed resource available for livestock feeding. Crop residue, particularly during the extended dry season contributes as high as 50-70% of the total supply in the mixed crop-livestock production system [40]. Furthermore, the increased pressure on natural grazing lands leads to overgrazing and degradation, and its availability in the future may be further restricted by subdivisions of farms in to smaller units[39,40]. Therefore, special attention should be paid to improve utilization of crop residues.

Crop residues

Crop residues represent a considerable potential forage resource in the populated countries where land is devoted to human food production as a priority[26]. In Ethiopia lives-tock productivity is closely linked to the quantity and quality of the available fodder. The increasing demand for fodder, shortage of arable land together with shrinking and deteriorating communal grazing lands is likely to put further pressure on feed resources. This means a significant proportion of the feed produced on farm needs to come from the crops that produce for human consumption[8]. Residues of cereals and pulses account for about 27.01% of the total feed utilized and ranked second to grazing in mixed crop-livestock production system of Ethiopia[18]. It is also estimated that above 18.5*MMT* of crop residues are annually produced in the country out of which, 70% is utilized for livestock feeding in areas dominated by cereal straws[1,4].

The type and availability of crop residues is closely related to the farming system, the crop produced and the intensity of cultivation. Crop residues such as teff and barley straw are important in the highlands; livestock depend on these straws especially during the dry season when the grazing lands cease to provide feed for animals. Maize, sorghum and millet-stover are the major-crop residues used in the mid-altitude areas[44].

The contribution of crop residue as ruminant livestock feed varies widely, depending upon human population density, type of livestock, management-system, market access and climate. Proper-collection and storage of crop residues improves its utilization, as this affect the quantity and quality of the available residue. In Ethiopia majority of farmers in the mixed crop-livestock production system have the tradition of collecting and storing crop residues, for use during the dry season when forage of any kind in short supply[50].

Depending on the crop-type, crop-residues may be left on the field either as grazing for ruminants or as mulch, or they may be transported to the homestead for stall feeding or other alternative uses such as fencing, building and roofing materials or as fuel. Feeding of different maize parts by defoliation during the wet-season for livestock by smallholder farmers is also a common practice in most parts of Ethiopia[52]. However, particularly, maize and sorghum stover due to their bulky nature and lack of means of transportation to be among the factors that constrain the collection and hence greater use of stovers as feed[50]. The low utilization of crop residue despite their greater availability during critical feed shortage period is associated with their nutritive value.

Feeding value of crop residues is limited due to its poor voluntary intake, low digestibility and low nitrogen, mineral and vitamin content[48]. In addition they are very slowly fermented in the rumen. In fact, they consist essentially of lignified structural carbohydrates, since they represent the dead aerial part of the mature plant after harvest. However, they can represent the basic part of ruminants' diet provided that conditions for their good cellulolysis are met (rumen activity), and additional nutrients required for productive functions[13].

Better utilization of crop residues can be achieved through an appropriate supplementation and/or treatments. The breakdown of crop resides by chemical treatments among which urea-generated ammonia is probably the technique which best fits in with the socio-economical conditions found in tropical developing countries where inputs must be kept at the lowest level possible[47].

Agro-industrial by-products

Almost every types of plant that is produced for human food yields one or more by-products that can be utilized as feed for animals. Agro-industrial by-products are the by-products of the primary processing of crops, including bran and related by-products of flour mills, oilseed cakes from small and large-scale oil processing plants, brewery by-products and by-products of the sugar factory such as molasses. Agro-industrial by-products such as oilseed cakes and meals, wheat bran and molasses are important sources of relatively high quality feeds mostly used in urban and peri-urban livestock production which make up part of concentrate ration[1].

In Ethiopia major oilseeds-crops widely grown include neug, sesame, linseed, groundnut, rapeseed, and safflower. In 2009/2010 0.65MTs of oil seed were produced; sesame, neug, linseed, groundnut, rapeseed and safflower contribute 40.5, 24.5, 23.4, 7.2, 3.5, and 0.9%, respectively of the total production[26]. The cakes after food oil extraction are widely used as protein supplement to low quality hays and crop residues. The cakes are rich in crude protein ranging 200 to 500g/kg. About 95% of the nitrogen in oil seed meal is present as true protein, with apparent digestibility coefficient of 0.75 to 0.9 and is of good quality when biological value is used as the criterion for judging protein quality whereby that of the oil seed protein is considerably higher than that of the cereals[29]. Oil seed cakes are generally characterized by high protein, fat and low fiber content. The mineral composition of oil seed cakes are higher than the optimum level with regard to *P, K, & Mg* contents for ruminant diet, but lower in *Ca and Na* contents.

In addition to oil seed cakes, by-products from the flour milling industry such as wheat bran and wheat middling are potential nutrient sources for livestock. Wheat bran consists of the outer most layers of the seed along with some flour. It is the most popular and important livestock feeds and it is a good source of phosphorus, energy, protein & vitamins[29]. Findings revealed the chemical composi-tion of wheat bran, wheat middling and noug cake are 15.1,11.8 &31.2%CP, 82.1,88.5 and 69.3% in *In-Vitro OMD*, 13.14,14.16 and 11.*08MJ/kg DMME*[42]. Molasses could also be used by farmers to improve palatability and as binder in concentrate mix has *6.4%CP* &12.70MJ/kgDM *ME*[43].

Maize stover as ruminant feed

In small scale farming systems, animal production is integrated with crop production. The animals provide draught power, manure and meat and milk products for human consumption. However, as the expansion of crop land increases, the availability of grazing land decreases thus limiting the scope for increased livestock production. Under such circumstances crop-residue play an important role in supplying feed to ruminant animals[48].

Maize is one of the major cereal crops which ranks first in production and yield among main cereals in Ethiopia [16], and contributes about 25.09% of the total cereal grain production in the country[14]. It also produces the largest bio-mass yield of crop residues compared to other cereal crops. A research report showed that 1.77Mha of land have been devoted for the production of maize in Ethiopia and yield 3.9 MTs of grain. This yield figure showed that at least 7.8MTs of MS was produced[14]. Maize stover constitutes major feed resource where maize is grown abundantly, for instance in Eastern Showa Zone of Oromia Region about one million tons of stover were produced in 2005. Although, the annual production of maize-stover is said to higher utilization for livestock feeding is constrained by its physical nature & nutritional characteristics[50].

There is a wide variation in the nutritive value of maize-stover due to difference in variety, stage of maturity at time of harvest, management practices, harvesting and handling losses, plant morphological components (leaf-stem ratio), agro-climatic conditions and time length and degree of weathering in field between crop harvest and residue-collection. Harvesting maize soon after attaining physiolo-gical maturity, followed by immediate sun drying of grain and, improved-yield and quality of stover without adversely affecting grain-yield & quality. Furthermore, maize-stover quality depends on proportions of leaf & stem fractions. Leaf-sheath: stem ratio for eight maize-verities range from 50-68% for leaf and sheath and 32-50% for the stem fraction. leaf-fraction has higher palatability & digestibility than stem fraction, as well as a higher protein & mineral content[1,4].

In studying the feeding value of maize-stover at different stage of maturity for feeding growing heifer, alone could not satisfy the maintenance requirement of the sheep[1), leading to body weight loss, irrespective of the stover maturity stage. The author associated this with low crude protein 3.7% & high fibre-fractions(*NDF* 789g/kg *DM*, *ADF* 339 g/kg *DM* and lignin 53g/kg *DM*). However, supplementation with graded levels of Silver leaf hay improved total feed intake, digestibility, rumen fermentation and microbial nitrogen supply leading to improved nitrogen balance and body weight gain of the animals. It is concluded that supplementation with forage legumes that are grown on the farm appears to be a viable approach of enhancing the utilization of maize stover and other cereal crop residues as animal feed. However, due to the growing demand of land for crop cultivation there is little scope in allocating land for forage development [1,4,19,34].

It is reported that maize stover had low *CP*(3.6%), high NDF(76%) & ADF(48.4%)[33,36]. Further the same authors indicated that the *DMI*, apparent *OMD* and estimated *ME* were 1.3kg*DM*-/100kg *BWt*(48.4g/kgW$^{0.75}$) 59% 8.778MJ-/kg *DM*, respectively[17]. It was thus, suggested that urea treatment could improve the intake and digestibility of the stover and improves its utilization. This study showed that maize stover have a potential energy-(*8.7MJME*) despite it's the low intake.

The feeding value of maize stover evaluated using rumen-fistulated mature crossed cows and showed that the nitrogen balance in the rumen was -89-61gm/*kgDM*[30]. Similarly, negative nitrogen balance reported when stover is the sole diet[1,30]. The predicted *DMI* for maize-stover was 5.2kg/day which is about 1.93% of animal's live bodyweight[30]. *CP*,*NDF*,*ADF*, lignin composition were 33, 746.5, 492 & 68.6g/kg DM, respectively. The authors demonstrated that the *CP*(3.3% DM) was lower than the threshold value of 6% below which intake of crop residues depresses[1]. The low *CP* content & rumen degradability and high gut fill values observed in the feeding of maize-stover resulted in predicted *DMI* lower than that can support animal production[30]. It thus suggested that improvement strategies of chemical-treatment and supplementation are inevitable to improve feeding value of maize-stover[1,30].

Strategies to improve low-quality feed-resources

Seasonal inadequacy of the quantity and quality of available feeds are the major problems facing dairy cattle production in the developing countries. The rates of animals-growth and milk-production grazing tropical pastures or consuming *CRs* or *GH* alone are generally low and about 10% of animal's genetic-potential[26]. *CRs* feeding values and intake can be improved greatly by physical, chemical & biological treatments, supplementation with protein and energy rich feeds, use of forage-legumes and their combination. Moreover, traditionally farmers practice various strategies to improve utilization (feeding-value) of *CRs* such as maize-stover, these include; proper collection, handling & storage to reduce leaf shattering, thinning and leaf-defoliation during wet-season, & mixing with pulse *CRs* during feeding[1,18,23].

Increasing rate of offering the straw/stover to allow the animal select nutritious fractions of the roughage have been pointed out as one of the strategy to improve the utilization of cereal straw and stover. According to the authors instead of the conventional offering rate of 25gm *DM*/kg Bwt (2.5%BW on *DM* basis) increasing to *50gDM*/kg *BW* (5%-BW on *DM* basis) increased maize-stover intake milk-production of dairy cows. However, this feeding system still may not increase utilization of straw/stover as large amount of refusal were recorded.

Farmers in the mixed farming system of highlands of Ethiopia practice mixing of cereal straw and stover with leguminous (pulse) crop residues to increase intake and digestibility of straws.

However, this practice may not alleviate the poor feeding value of straws and stover as appreciable change in animal performance was not observed[44]. Therefore, to mitigate the effects of low feeding quality of cereal straw and stover, the most likely available strategies that enable to improve utilization of poor quality feed resources are supplementation and/or improving the quality through treatments.

Supplementation

The principal objective of supplementing low quality based feeds is either to improve animal production through improved utilization of the less nutritive feed by the animal or to meet the requirement of the animal for production[12]. Two basic concepts applied for optimizing the forages utilization for dairy animals, to make the digestive system of the cows as efficient as possible by ensuring optimum conditions for microbial growth in rumen, and to optimize production by balancing nutrients so that these are used as efficiently as possible for milk production[14]. These two concepts could be implemented by feeding a combination of non-protein nitrogen, minerals & bypass protein. Bypass protein supplementation is used to optimize the efficiency of use of the absorbed nutrients.

Correction of a nutrient imbalance by supplementation of a by-pass protein often increases intake on poor quality forages to a constant intake of around 80-100g /kg$W^{0.75}$/day [26]. It is suggested that for feeds with *CP* contents of <62g/kg*DM* & fiber digestion is inhibited, supplementary protein which is limiting nutrient increased intake by 14-77% following provision. The most commonly used supplements for lactating dairy cows are agro-industrial by-products these are milling and oil seed by-products such as wheat bran, middling, noug seed cake and other oil seed by-products[36] commercial formulated concentrate rations and brewery by-products in urban and peri-urban dairy farmers[58]. Oil seed-cakes and bran from cereals can increase crossbred dairy-cows milk-production by 35% owing to the supply of rumen un-degradable protein and high glucogenic potential.

It is widely accepted that supplementation improve intake of *CR* diet and hence animal performance.

Treatment of *CR* with alkali in combination with supplementation was found to result in better animal performance[18,51).

The goal of any feeding system or method is to provide the opportunity for cows to consume the amount of feed specified in a formulated diet. Considerations in the choosing of a feeding system should include housing facilities, equipment necessities, herd-size, labor availabi-lity, and cost. In the standard feeding system, nutrients can be effectively supplied by feeding either a total-mixed ration(*TMR*) or individual ingredients (forages and concent-rate separately)[41,44]. *TMR* allows for the mixing all feed-ingredients (forage and concentrate) together based on a prescribed amount of each ingredient. When consumed as a *TMR* without sorting of ingredients, more even rumen fermentation and a better use of nutrients should occur than feeding of separate ingredients. In the standard feeding system the amount of feed offered is regulated according to actual requirement of the cow & nutritional characteristics of the ration, thus proportion of concentrate and forage is balanced[13].

The other concentrate supplementation strategy is the ‘maintenance plus’ approach in this case the basal diet support maintenance plus some amount of milk, above this level cows are supplemented with 400 to 500gm concent-rate for every kg of milk produced. This approach is biologically unsound; milk-yield per se is poor determinant of cow’s *NR*[17]. The problem with this approach is that it fails to take into account the limited size of the rumen. As the amount of concentrate added to the diet increased, usually the case for high milking cows, the cow eat less of the forage offer. Therefore, the nutritive value of the added concentrate is the difference between the nutrients in the added concentrate and the nutrients lost through the reduced intake of forage. Therefore, at high level of concentrate supplementations there is substitution effects, reduces the efficiency of concentrate nutrients for milk production and expose animal for metabolic disorders such as acidosis and low fat syndrome[19].

In the Tropical environment due to low nutritive value of the forage, merely support maintenance requirement of the animals, any production expected from the animal need to be provided from the supplement. Therefore, the maintenance plus approach is usually applicable in the Tropical countries. Furthermore, there is no well developed feeding standard in the tropical environment to use the standard feeding system on the basis of actual nutrient requirement of the animal[40]. In addition why this approach makes it practical for small livestock holder is that no need of complicated and expensive feed analysis in the diet formulation, unlike the standard feeding system. In Ethiopia concentrate supplementation strategy, based on level of milk production at a rate of 0.5kg concentrate for every kg of milk produced is recommended for lactating cows[17,36,43].

Generally, since the main objective of supplementation is to improve the utilization of the basal feed (roughage), thus, to take effect the level of concentrate supplement should not exceed 30-40% of the total diet[39].

Physical and chemical treatments

Crop residues particularly cereal straw and maize stover are the most abundant of all agricultural residues and has a great potential as a feedstuff for ruminants in most semi-arid and sub-tropical regions[48]. Many farmers in Ethiopia conserve crop residues for use during critical period of the dry season. Since cereal straw and stover that form the bulk of crop-residues are characterized by low digestibility (<50%), low *ME* content (<7.5MJ/kg *DM*), low *CP* content (<60g/k*gDM*) and low content of available minerals and vitamins, thus severe weight losses occur when animals only fed on such feed resources[3,5,49].

There are, however, many possible methods which can be employed to improve the feeding values of crop residues. These include a variety of physical, chemical and biological treatments: involving soaking, chopping, grinding, pelleting, sodium hydroxide, ammonia, urea, pressure and heat in combinations with steam, pressure and ammonia, urine, enzymes, acids and fungi[3,5,7]. Two of the most widely tested and used methods of crop residue treatments are physical and chemical treatment.

Physical treatment usually implies a reduction of particle size. The method of processing the feeds, such as chopping is a factor which affects feed intake. When feed is chopped/ground into short pieces, the length of the long fibers is decreased, partially destroys the structural organization of cell walls and the animals have less opportunity to select between the different parts of the feed. This leads to increased feed intake and reduced time for eating, thereby accelerating their breakdown in the rumen. The major benefits of chopping or grinding roughages are to improve palatability, to prevent the selection of feed ingredients and to reduce wastage[29]. However, the benefits gained in improved feed intakes are usually offset by a more rapid passage of small particles from the rumen, which thus escape microbial digestion. Furthermore, although intake was improved, a reduction in digestibility was often associated with physical treatment and concluded that a combination of chemical and physical treatments would be most effective in upgrading crop residues[37,48].

Chemical methods are relatively effective in improving intake & digestibility of crop residues, and hence it's feeding value. The effect of chemical treatment includes hydrolysis of chemical bonds that involve lignin. The chemicals used in treatment of roughages are mainly alkalis. The most effective alkali is sodium hydroxide (*NaOH*) or caustic soda. It is however, not commonly used due to its high cost and risk of use. Soaking straw in solutions of *NaOH* result in increased digestibility[53]. However, this method cause a consider-able loss in dry matter including valuable soluble organic matter, the loss in organic matter contributed to environmental pollution, also inducing heavy urination, and faster rumen washout[49].

The most commonly used chemical methods worldwide therefore, consist of treating the residue with either ammonia or urea that is relatively less effective, but is cheaper and less hazardous to use compared to *NaOH*. In comparison with anhydrous ammonia urea is often the cheaper source and can either be added at the point of feeding in conjugation with soluble energy source such as molasses or used as a treatment agent. It is noted that dry matter digestibility was increased by 6% units when urea was added at the point of feeding but by 11% units when it was added to the straw 10 days previously through treatment[39,49]. The study indicated that urea treatment is effective in improving digestibility of crop residues. The potential for increasing digestibility and intake of fibrous residues through treatment with urea is of most practical significance in the tropics, acting both as an alkali and a source of supplementary nitrogen to materials inherently low in crude protein[48].

Urea Treatment to Improve Feeding Value

The use of urea to improve quality of crop residue through treatment is justified as: it is usually available as a product of (ammonium nitrate) with which farmers are familiar, sufficient urease to ensure breakdown of urea to ammonia does not appear to be a problem in a warm climate, urea breakdown the lingo-cellulose bonds of the residue which increase the rate and extent of rumen microbial digestion, improves the nitrogen status of the residue, and relatively safe and easy to use[49).

Urea treatment is the result of two processes: firstly, ureolysis takes place which converts urea into ammonia. This is an enzymatic reaction in which the telluric bacteria present on straw produce urease enzyme that breaks the urea into two ammonia molecules. Then, the generated ammonia during this reaction acts upon the contents of the cell-wall. This results in the breakdown of the fiber by saponification of ester bonds in the lignin-polysaccharide molecule, thereby enhancing the fiber invasion chance by rumen microorganisms. Further, it adds nitrogen to stimulate the growth of rumen microbes to provide microbial protein for animal[13,32,38].

The principal method in the treatment of crop residue consists of dissolving urea in water and sprinkling it on stover or straw layers. The level of urea used varies; the use of urea at 4.5%-6% with final moisture content of 50% after treatment, for upgrading *N & E* availability of maize stover [38]. Moisture, dosage of urea used, ambient-temp, treatment-duration & their interaction affect the activity-es of ureolytic -bacteria & hence determine the effecti-veness of the treatment. According to the authors, the optimum dosage of urea required per 100kg of air dry straw ranges from 4.5-6.2kg at moisture level of 50-60% resulting in improved straw *IVOMD[13]*. It is recommended treating maize stover with 5% urea as it has produced satisfactory results in Africa and Asia[13]. The treatment of the straw and stover can be done in pits, clamps (three sided wall structure built on the ground) using polyethylene sheets as inner linings. Airtight conditions are important during the treatment period. Polyethylene sheet is very effective for excluding air, but a number of locally available materials such as banana leaves can also be used[37).

Temperature and duration of treatment (incubation) are also important factors to the success of urea treatment. At high temperature, chemical reaction occurs rapidly and stimulates the dissociation of more ammonia gas. Different length of treatment time for different ambient temperature (4-8 weeks at 5-15^{0}C; 1-4wks at 15-30^{0}C; <1wk, at >30^{0}C) [13]. It is also suggested ensiling for 4 weeks when air temperature ranges from 10-30^{0}C, but should be reduced to 3 weeks when the air temperature rises to 21-36^{0}C[17] recommended 14 days in the tropics. Good result was obtained by incubating at ambient temperature of 21-24^{0}C for 21 days[38,44]. The pH of treated roughage should be alkaline indicating efficient cleavage of the lignocelluloses ester bonds.

Dark brown color of the straw with strong smell of ammonia and soft consistency are indicators of effective urea treatment[49].

Effect on chemical composition of maize stover

Urea treatment is a practical method of increasing the nitrogen content of low quality roughages which is efficient- ly utilized by rumen-microorganisms. The *CP* content of *UTMS* at 5% is 15.4% which is close to 3.8 and 2.7 folds higher than that of untreated stover(4.02%) & natural pasture *GH*(5.7%), respectively[47]. It is reported that a fourfold (2.8% vs.14.4%) increase in *CP* content due to 4% *UTMS* compared with the untreated-stover. Similar increases in *CP* content were also reported[27,37].

UTMS decreased *NDF* by 6% units(82.2-76.2%DM) and *ADF* of the cell-wall components[47]. However, high reduction in *NDF* by 9.5% unit (75.4-66.0%*DM*) & *ADF* by 3.7%*DM*[38], and lower reduction in *NDF* only by 3.7%(87.2-83.5% *DM*)[27]. A reduction in cell-wall fraction seams dependent on initial-amount, more reduction from less fractionated maize stover. Reduction in *NDF* and *ADF* is explained by the breakdown of lingo-cellulose bonds that leads to hemi-cellulose solubiliz-ation, hemi-cellulose as a cell wall component is most sensitive to delignification treatment such as ammonia from urea[37,47]. The results demonstrate the large increase in *CP* content and reduction in cell-wall components as a result of urea-treatment which enable to enhance feeding value of maize stover.

Effect on intake, digestibility and weight gain

Feed intake is probably the most important variable determining animal-performance; voluntary intake is generally correlated with the amount of nutrients that can be extracted from feed, i.e. its digestibility[36]. The individual cow's daily production depends on not only its genetic merit and lactation stage, but also a great deal on the quantity and quality of nutrients to its intermediary metabolism. This supply is the result of the voluntary intake and the nutrient density of feed intake. Voluntary intake depends both on: the appetite of the animal which varies according to the animal itself (age, physiological stage, former-nutritional status) and to environmental conditions (temp, humidity, etc.) under which the animal is kept, and the specific characteristics of the feed[35]. If the voluntary intake is too low the rate of production will be depressed, resulting in requirements for maintenance becoming a very large proportion of the *ME* consumed and so giving a poor efficiency of food conversion[36].

The voluntary intake of feed depends essentially on the rate of degradation of its digestible matter into particles of a size small enough to enable their passage from the reticulo-rumen to the lower gut. This degradation is achieved by means of the chewing process (eating and rumination) and the microbial fermentation which takes place in the reticulo-rumen. The cell wall content and the magnitude and nature of lignification of these cell walls are amongst the most important factors which govern the degradability and the rate of passage of forage[28].

There is a positive relation-ship between digestibility and their intake. Intake more than doubled as the digestibility of the food increases from 0.4-0.8. Foods that are digested rapidly (high digestibility) promote high intake. The primary chemical component of the feed that determines their rate of digestion is *NDF*, which is a measure of cell wall contents; thus there is a negative relation-ship between the *NDF* content of the feed and the rate at which they are digested. Forages with a high content of cell-walls(*NDF*) are digested slowly, are low in digestibility and promotes low intake. Disturbing forages cell-walls by mechanical or chemical treatment markedly increases intake[28].

Urea treatment has a positive effect on feed intake and digestibility of roughages. The positive effect on roughage intake is brought about by the increased rate and extent of digestion in the rumen, which lowers rumen retention times, thus allowing greater intake[34]. Urea treatment tends to increase digestibility of low quality roughages through its effects on plant cell walls. *UTMS* increase *IVDMD* by about 9% (55.7-60.6%), also higher than natural pasture *GH* which had 45%[37]. In vitro evaluation of untreated and urea treated maize at 4% level; *IVDMD* and *IVOMD* for untreated and treated were 56.6%,58.5 &60.4%, respective-ly[27].

Feeding animals on *UTMS* tend to improve their feed intake and growth rates. The *DWG* and *DMI* increased from 284gm and 2.07% Bwt on untreated stover to 385gm and 2.49% body weight on *UTMS* based diet, a difference of 35.5% in growth-rate and 20% daily intake were observed, calves on *UTMS* based diets perform well as compared to grass hay based diets which attain DWG of 377gm and *DMI* of 2.65% *BWt*[37] that, though the *DMI* of animals fed on hay based diet was significantly higher than that of animals fed on *UTMS*, there was no significance difference between these two diets in *DDMI* and *DOMI*. The authors stated that it is attributed to the superiority in digestibility of the diet containing *UTMS* compared to the hay based diet.

It is reported that urea-treatment increased daily live weight gain growing cattle from 513g on untreated stover to 744gm on treated maize stover when the two groups were supplemented with 1.5kg cotton seed cake. Stover intake increased by 8% from 2.62-2.83% of their Bwt[38]. The author noted not only improvement in intake; animals fed on treated stover had very healthy appearance at the end of trial. reported that dairy heifers and steers consume *UTMS* at ≥3% of their *BWt* when it is the sole diet. Treating maize stover with urea is sufficient to support maintenance plus small *DWG* in cattle (116g/day), while cattle fed untreated maize stover lost weight(-83g/day). Similar improved utilization of *UTMS* by goats were reported[47] recomm-ended that urea can be used to improve the nutritional value of maize stover during off season periods.

Lactating dairy cows fed UTMS based diet, resulted 5.12-5.*22kgDM*/day (57.9-59g of DM/kg$W^{0.75}$) [21]. Intake of *UTMS* decreased with increasing levels of concentrate feed as result of substituting the basal-diet by concentrate. Urea treatment increases straw intake by 10-50% depending on *DM* of the straw and efficiency of treatment, when the straw constitutes >40% of diet. Various findings reported that improvement in intake and digestibility of *UTMS* using sheep[27].

The effect of treatment on roughage intake and digestibility depends on the composition of the rest of the diet. When fed together with high quality hay, grass silage and concentrates, it is likely that the treated straw will be the first one to be refused by animals. Feeding high levels of concentrate together with ammoniated stover can lead to reduced intake of the stover[27,28]. If seen from the point of view of making efficient use of the low quality and yet the abundantly available feed resources, the small increment as a result of urea would mean a lot to livestock owners. In areas where straw is the main feed for ruminants, a proportional increase of 0.1 in digestibility can have enormous implication for resource availability and thus animal performance[37].

Effect on milk-yield and milk-composition

Few reports indicated that dair- cows perform well when they consume ammoniated-straw and stover[32]. Alkali treated-straw are only moderate quality-roughage indicating its limited potential-role as a basal-ration for milking cows fed to produce 15-20L of milk. However, a feeding trial using dairy-cows in Vietnam reported that urea treated rice-straw can replace Napier-grass in lactating cow diet at a high-level(75%) with increased milk-fat and without any negative-effect on milk production in medium yielding cows producing 9-10kg of milk[21].

A feeding-trial amoniated barley/teff-straw in lactating crossbred-cows in Ethiopia, noted to replace native hay, and ammoniating found to be economically feasible producing about 6.2 & 5.6kg milk day^{-1} for teff and barley straws, respectively[31]. Similarly, Lactating dairy-cows supplem-ented-concentrate on a *UTMS* basal-diet or *UMS*, cows fed *UTMS* produce 10.4kg milk whereas cows on untreated stover produce 9.5kg and there were no significant difference[27]. The reason behind less improvement in nutritive value of *UTMS* is associated with inefficient ureolyis which uses 20kg water for 100kg stover and low improvement in digestibility.

Feeding trial conducted in China to compare the effect of feeding *UTMS* replacing 50% of the basal grass hay for high yielding dairy cows. It is found that replacing did not significantly affect milk yield and composition, cows fed on half the basal diet *UTMS* produce 25.27kg milk with 3.3%fat, whereas hay based diet fed cows produce 26.24kg milk and 3.31%fat[37]. The authors noted the advantage as, obvious economic profit were obtained due to the replacement of expensive and usually unavailable grass hay with cheap and available maize stover. Similar results have been reported by replacing grass hay with treated stover fed to less milk producing dairy cows[50]. The results of experiment show that it is possible to produce milk based on a diet of treated straw, even though this will be only at low levels of production(0.5-5L)[18,45]. Supplementation of urea treated rice straw based diet at low levels of concentrate results in relatively high increases in milk production. Effect of feeding urea treated straw and stover on milk composition indicated that feeding urea treated rice straw increase milk-fat[22], others reported that milk composition was not affected[40].

Summary

Chemical-treatment of crop-residues in general improved its feeding-value by increasing *CP* by about 7 to 9% and reduced contents of *NDF* by 9 to 11% DM, which increased the crude fibers digestability and the hemi-cellulose availability for microbial fermentation.

Apparent digestibility coefficients of *DM*, *OM*, *NDF* and *ADF* was significantly higher(*P<0.01*) in cows fed *UTMS* than *GH* basal diet, and thus, *UTMS* replaced GH increasingly. The improvement in *DM* & fiber digestibility as the level of *UTMS* replaced GH increased could be due to the basal diet of *UTMS* as the amount of concentrate intake of all the dietary treatments were similar. Urea treatment leads to a significant increase in the nutrient digestibility of the basal diet by swelling of plant cell walls (improving fiber fragility) which allows greater diffusion of cellulolytic-enzymes, disruption of bonds between lignin and cell wall carbohydrates which increases availability of the carbohydrate for degradation by rumen-microorganisms & solublization of hemicelluloses. In addition urea provides extra nitrogen which increases rumen microbial activity and hence increases *DM* and nutrient digestibility.

Feeding *UTMS* to dairy cow as a substitute to *GHBD* have positive effect on daily milk-yield and milk-composition. Likewise, a lactating cow fed *UTMSBD* produces significantly higher milk-fat content and yield (*P<0.05*) than those fed *GHBD*. This improvement could be attributed to improved fiber digestibility & fermentable energy availability to improve rumen-microbial-activity that increased acetate to propionate ratio and hence milk fat-content and yield. Similarly, *FCE* "the ratio of 4%*FCM* yield to total *DMI*" increased in cows fed increased level of *UTMSBD*.

Live weight gain was significantly lower in cows fed *GH* alone basal-diet compared to those fed *UTMS* basal-diet that resulted a *BWG* of 0.46kg/day.

In this study, one can thus draw a conclusion that substituting parts/all of grass hay with *UTMS* in the diet of lactating cows increased 4-5% fat corrected milk-production, better *BWG* and feed conversion efficiency without affecting protein and solids-not-fat contents and yields as compared to the conventional natural *GH* basal-diet. Generally, feeding *UTMS* as a basal-diet could be scrupulous as a strategy that brings about efficient crop-residues utilization in feeding lactating dairy-cows, particularly during the dry-seasons when crop-residue constitutes the major available feed resource.

In conclusion, the improvement of animal feeding based on better utilization of crop residues not only led to better live weight maintenance & improved animal performance but to greater integration of crop/livestock-production systems through improvements in draught animal power and increased availability of organic manure. The use of crop residues is indeed enhanced after urea treatment. Yields of millet and sorghum, which are the staple food-grain, are increased by one-fifth to a third, improving food security and income of farmers, decreasing the rural exodus and reducing the pressure on soils. The technique contributes also to reducing the animal pressure on the environment.

References

1. Adugna Tolera, 2007. Feed resources for producing export quality meat and livestock in Ethiopia: Examples from selected Woredas in Oromia and *SNNP* regional states. Ethiopian Sanitary and Phyto-sanitary standards and livestock & meat marketing program. Addis Ababa, Ethiopia.pp.88.
2. Ahvenjarvi, S.,E. Joka-Tokola, A. Vanhalalo, S. Jaakkola, P. Huhtanan. 2006. *Effects of replacing grass silage with barley silage in dairy-cow diets*. J. Dairy Sci. 89:1678-1687.
3. Alemayehu Mengistu, 2003. Forage Resources-Profiles: Ethiopia. Website: http://www.fao.org/ag/agp/agpc-/doc/counprof/ Ethiopia/ethiopia.htm
4. Allen, M.S., 2000. *Effects of diet on short-term regulation on feed intake by lactating dairy cows*. J dairy Sc 83:1598-1624.
5. Ameha Sebsibe, N.H. Casey, W.A. Van Niekerk, Azage Tegegne and R.J. Coertze, 2007. *Growth performance and carcass characteristics of three Ethiopian goat breeds fed grain-less diets varying in concentrate to roughage ratios*. South African Journal of Animal Science; 37(4) pp.12
6. Azage Tegegne, Workneh Ayalew, Berhanu Gebre Medhin & Salvador Fermandez-Rivera, 2002. Opportunities for improved dairy-production in Ethiopia. In: Resource Mgt for Poverty Reduction, Approaches & Technologies. Ethio-forum, 2002. 118p
7. Betre Alemu, 2000. Promising multipurpose tree species and strategies of fodder production in Ada Woreda of Ethiopia. pp.245-267. In: Livestock Production & Environment-Implications for Sustain-able Livelihoods. Proc. Of 7th Annual Conference of *ESAP* held in 26-27 May 1999, Addis Ababa, Ethiopia.
8. Broderick, G. A. 2003. Effects of varying dietary protein and energy levels on the production of lactating dairy cows. *J. Dairy Sci*. 86:1370-1381.
9. Brown, W.H., S.S. Khalaf, A. Marmolejo, A.S. Swingle and F.M. whiting. 1990. Partial replacement of alfalfa hay with chopped wheat

straw in diets for lactating dairy cows. Department of Animal Sciences, University of Arizona. *J. Dairy Sc* 73:3172-3177.
10. Casper, D.P., L. Whitlock, D. Schauff, D. Jones and D. Spanger, 2004. Feed efficiency is driven by dry matter intake. *J. Dairy Sci*. 87:462.
11. Castrillo, C., M. Fondevila, J. Guada, A. de Vega, 1995. Effect of ammonia treatment and carbohydrate supplementation on the intake and digestibility of barley straw by Sheep. *Animal Feed Science and Technology* 51: 73-90.
12. Chenost, M and R. Sansoucy, 2001. Nutritional characteristics of tropical feed resources: natural and improved grasslands, crop residues and agro-industrial by-products, pp. 45-72. In: Speedy, A. and R. Sansoucy (Eds). Feeding Dairy Cows in the Tropics. FAO Animal Production and Health Paper 86, Rome. 283p.
13. CSA, 2010. Ethiopian Agricultural Sample Survey: Report on Livestock and livestock characteristics, Result at country level. Central Statistics Agency, Addis Ababa, Ethiopia, Vol. II (468): 12-15.
14. Diriba Geleta, 2004. Effect of Variety on Maize Grain Yield, Plant Fractions and Nutritional Value of the Stover. pp. 307-312. Participatory Innovation and Research: Lessons for Livestock Devel’t. Asfaw Yimegnuhal and Tamrat Degefa (Edn.). Proceedings of the 12th Annual conference of ESAP held in August 12-14, 2004 Addis Ababa, Ethiopia. 410p.
15. Getachew Eshete, 2002. An Assessment of Feed Resour-ces, Their management and impact on livestock produ-ctivity in the Ginchi watershed Area. An MSc. Thesis presented to SGS of Alemaya University, Alemaya. 172p.
16. Getahun Kebede, 2006. Effect of urea treatment & leucaena supplementation on the utilization of wheat straw by sheep. An M.Sc Thesis presented to the SGS of Alemaya University. 86p.
17. Getu Kitaw, 2006. Replacement of formulated concent-rate mix with Vetch (*Vicia dasycarpa*) hay to lactating crossbred Cows fed on urea treated wheat straw. An MSc Thesis Presented to School of Graduate Studies of Alemaya University, Ethiopia. 89p.
18. Heinrichs, A.J., K.E Bailey and C. M. Jones, 2007. *Milk Components: Understanding the causes and importa-nce of milk fat and protein variation in dairy herd*. J. Dairy Sci. 88:2269-2280.
19. Holloway, B., M.J. Otte and U. Martin, 2000. The role of livestock in economic development and poverty reduction. Proper livestock policy initiative Working paper No.10.Food and FAO, Rome, Italy. 57p.
20. Huhtanen, P. and M. Rinne, 2007**.** Effects of increasing the milk yield of dairy cows on milk composition. *Journal of Animal and Feed Sciences. 16 (9):42-58*
21. Joy, M.,X. Alibes and F. Munoz, 1992. Chemical treatm-ent of lingo-cellulosic residues with urea. *J. An Feed Sc and Technology* 38: 319-333.
22. Kelay Kassahun, 2002. Analyses of dairy cattle breeding practices in selected areas of Ethiopia. A PhD Dissertation, Landwirtschaft-Gärtenerischen Fakultät der Humboldt-Universität zu Berlin, Germany.175p.
23. Leng, R.A., 1991. Feeding strategies for improving milk production of dairy animals managed by small-farmers in the tropics. In: Andrew Speedy & Rene Sansoucy (Eds). Feeding Dairy Cows In The Tropics. *FAO* An. Production & Health Paper 86, Rome.
24. Linn, J. 2006. Feed Efficiency: Its economic impact in lactating dairy cows. Advances in dairy technology. 18: 19-28.
25. Masimbiti, W. 2001. Utilization of urea treated maize stover for dairy cows in Zimbabwe. An MSc Thesis, Uppsala, Swedish University of Agricultural Science. Sweden. 62p.
26. McDonald, A.A., R. A. Edwards, J. F.D. Greenhalgh and C.A. Morgan, 2002. Animal Nutrition, 6th edn. pp. 187-198, 544-549.
27. Mgheni, D.M., E.E. Ndemanisho, T. Hvelplund and M.R. Weisbjerg, 2001. Evaluation of the feeding value of two tropical cereal straws, maize stover, rice straw and their botanical fractions by nylon and mobile bay techniques. *African journal of science and technology* 2(1): 65-71
28. *MoARD*, 2007. Livestock Development Master Plan Study. Phase I Report-Data collection and analysis. GRM International BV. V-I. 119p. Retrieved from; www.grminternational.com.
29. Mohammed Ahmed M., S. Ehui and Yemesrach Assefa, 2003. Dairy development in Ethiopia. Paper presented at the ‘Successes in African agriculture conference In**:** WEnt, IFPRI, NEPAD, *CTA* conference paper no. 6. 1-3 December 2003, Pretoria, South Africa.
30. Morgan, J., 2005. Tropical dairy farming: feeding management for small holder dairy farmers in the humid tropics, Landlink Press, Thailand. 312p.
31. Nega Tolla and P. Vijchulata, 2006. Milk yield and reproductive-performances of lactating-cows as affected by intake of certain dietary macro minerals

in Ethiopia. *Livestock Research for Rural Development*. 18(9).

32. NRC, 2001. Nutrient-Requirements of Dairy-Cattle. 7th revised edn. National Academic press, Washington, D.C., USA. 408p.
33. Olmos, J.J., C. Colmenero and G.A. Broderick, 2006. Dietary Effect of Crude Protein Concentration on Milk Production & Nitrogen Utilization in Lactating Cows. *J. Dairy Sci*. 89:1704-1712.
34. Payne, W.J.A. 1990. Introduction to Animal Husbandry in Tropics. 4th edn. Tropical Agric Series. Longman Singapore Publishers, Singapore. 881p.
35. Phillips, C.J. 2000. Principles of cattle production. University of Cambridge. *CABI* publishing, Wallingford, UK. ISBN 0851994385, pp 288.
36. Ramirez, G..R., J.C. Aguilera-Gonzalez, G. Garcia-Diaz and A.M. Nunez-Gonzalez, 2007. *Effect of urea treatment on chemical composition and digestion of Cenchurus ciliaris and Cynodon dactylon hays* and zea mays residues. J. An & Veterinary Advances. 6(8): 1036-1041.
37. Rehrahie Mesfin, 2001. Biological & economical evalua-tion of urea treated teff and barley straw based diets to crossbred dairy cows in Ethiopia highlands. Swedish University. Uppsala, Sweden. *MSc* Thesis. pp. 1-12.
38. Rehrahie Mesfinad Inger Ledin, 2004a. Comparison of feeding urea-treated teff and barley straw based diets with hay based diet to crossbred dairy cows on feed intake, milk yield, milk composition and economic benefits. Retrieved January 4, 2009.
39. Rehrahie Mesfin and Inger Ledin, 2004b. Assessment of the Treatment and Use of Urea Treated Straw for Cattle Feeding in Selale, Central Ethiopia. *Ethiopian Journal of Animal Production. Vol. 4(1):23-32.*
40. Seyoum Bediye, Getnet Assefa, Abate Tedla and Dereje Fekadu, 2001. Present status and future direction in feed resources & nutrition research targeted for wheat based crop-livestock production systems in Ethiopia. pp. 205-226. In: P.C. Wall(Ed.). Mexico city, Mexico. 10-11 Oct. 2000. *CIMMYT*.
41. Sintayehu Yigrem, Fekadu Beyene, Azage Tegegne and Berhanu Gebremedhin, 2008. Dairy production, processing and marketing systems of Shashemene-Dilla area, South Ethiopia. IPMS (Improving Product-ivity & Market Success) of Ethiopian Farmers Project Working Paper 9. ILRI, Nairobi, Kenya. 62 pp.
42. Sisay Amare, 2006. Livestock Production Systems and Available Feed Resources in Different Agro-Ecologies of North Gonder Zone, Ethiopia. An MSc. Thesis Presented to Alemaya University School of Graduate Studies, Ethiopia. 111p.
43. Smith, T. 2002. On-farm treatment of straws and stovers. pp. 15-22. Proceedings of the final review meeting on Development and Field Evaluation of Animal Feed Supplementation Packages. Project organized by the Joint *FAO/IAEA* Division of Nuclear Techniques in Food and Agriculture held in Cairo, Egypt, 25-29 November 2000, Cairo.

How to cite this article:

Gizachew Delilo and Asrat Ayza. 2020. Improving Lactating Dairy Cattle Productivity through Feeding Improved Forages and Their Management. *Int.J.Curr.Res.Aca.Rev*. 8(3), 43-57.
doi: https://doi.org/10.20546/ijcrar.2020.803.006