

Feed Resources, Feeding System and Feed Marketing for Dairy Production in the Lowland and Mid-highland Agro-ecologies of Borana Zone, Ethiopia

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ABSTRACT: This study was carried out to assess the types, sources, seasonality and marketing practices of feed, and the feeding practices of dairy cattle. Irrespective of locational and seasonal variation, basal diets like commonly natural pastures (grasses, legumes, herbs, shrubs and trees foliage) and recently crop residues (straws of teff, wheat, maize and sorghum, haulms of haricot beans) were available in lowland. Straws of barely, vines of sweet potato, and by-products of banana and Enset were exclusive to mid-highland along with above mentioned. Industrial by-products apt for enhancing dairy cattle productivity were commonly purchased during prolonged dry season and drought outbreak of both agro-ecologies. Standing hay (Kallo) and collected pods of acacia trees in lowland, and piled hay and crop residue in mid-highland area were means of feed conservation. During the dry season, adult cattle of lowland and mid-highland area were, respectively, walking an average of 7.75 km and 4.5 km in search of drinking water. Calves, lactating cows and bulls were the first, second and third locally prioritized categories of dairy cattle for supplementation. It will be paramount to quantitatively estimate the annual production potential, and wisely utilize the prevailing feed resources and design the strategy to avail water for boosting the dairy cattle productivity. Irrespective of apparently high purchase prices, empirical investigation of its relative benefits and effectiveness of supplementing dairy cattle with industrial by-products in the Borana zone was revealed to be crucial.

KEYWORDS: Feed resource, marketing, dairy cattle, lowland, mid-highland, agro-ecologies.

1 INTRODUCTION

Resultant from the favorable environment of Ethiopia for cattle production, cattle resource of the country performs important functions in the livelihoods of farmers, pastoralists and agro-pastoralists. Despite its substantial significance in the betterment of the livelihood, livestock development was constrained with inadequate feed supply and seasonal variations both of quality and quantity that subdue the production and productivity especially in delaying age of onset of puberty, elongating parturition intervals, lowering conception rates and overall lifetime reproductive performance of cattle (Gryseels and Anderson, 1983 and Mengistu A., 1997). This is because feed is the most important input in livestock production, and its unremitting supply at adequate quantity and quality is the prerequisite for the sustained expansion of livestock production.

Feed resources deficit in dairy production of Borana Zone is not apart from other corner of Ethiopia and other sector of livestock production; rather it is exacerbated due mainly to the fragile weather and degraded land condition resultant from overgrazing and invasive bush encroachment.

Like in mid-highland area, crop production is getting momentum as a means of income diversification in the lowland of the zone. The scenario is making cropping the strongest competitor of cattle production as it is expanded on plain areas with relatively moist and fertile soils those are most productive grazing land. On the other hand, the residue obtained from cropping can be an opportunity for dairying regardless of the limited understanding from the community. The communities, particularly lowland dwellers, are indigenously knowledgeable in improving the grazing land by managing their herds splitting into *warra* and *fora* groups, and classifying grazing area into open grazing and reserve pasture areas (*kallo*) which can serve

as standing hay for dry season those are the special feeding strategies to minimize risk of feed shortage and hence hold paramount share in the improvement of dairy cattle productivity (Ayana A. and Fekadu B., 2003). The report of Sandford (2006) also revealed that unless the pastoralists are wisely utilizing the locally available feed resources, at past and recent prices, purchasing supplementary feed is not economically feasible except as short term measure to survive their herd during drought problem.

Comprehensive and updated information of feed resources and feeding system of the zone which enable stakeholders to exploit the prevailing feed resource and react upon the underlined constraints are, however, not well documented. Therefore, it is important to assess the availability and marketing of feed resources, and feeding system of dairy cattle in both agro-ecologies of Borana zone.

2 MATERIALS AND METHODS

2.1 DESCRIPTION OF STUDY AREA

Borana zone is found at the southern part of Ethiopia occupying a total land area of about 95,000km² with lowland and mid-highland area agro-ecology based on their climatic condition. The lowland area is characterized by livestock production whose grazing land is predominantly communal with emerging privatization of land for crop and *Kallo* whereas the mid-highland is characterized by mixed livestock-crop farming activity. Rainfall delivery in lowland is bimodal with the long rains accounts for 60% of the total falling between March and May and the short rains comprising of 27% of the total falling between September and November with an average annual rainfall varying from 353 to about 900mm per annum (Kamara A, 2004) however rainfall is a single seasoned in the mid-highland with average annual rainfall ranging from 900 to 1400 mm (Data of National Meteorological Agency, Awassa Branch Directorate).

2.2 STUDY SITES AND PARTICIPANTS SELECTION

The study was carried out in the districts those were purposively selected from both agro ecology of the zone (lowland and mid-highland of Borana zone) from 2011 to 2013. Bearing in mind representativeness of the district to its respective agro-ecology, the study sites were selected in collaboration with the zonal development office. A total of two districts (Bule Hora and Gelana) from mid-highland area and four districts (Teltelle, Yebello, Arero and Moyale) from lowland were selected. Two *kebeles* were selected from the respective district based on the stratification on its proximity to market and fifteen household heads were selected from each *kebele* to be interviewed.

2.3 METHODS OF DATA COLLECTION AND THE COLLECTED DATA

The survey was conveyed employing semi-structured questionnaires. Consequently, information concerning the type of available feed resources by type, source and season of availability, trend of communal grazing land, feed marketing practices and feeding practices of dairy cattle were exhaustively assessed.

2.4 DATA ANALYSIS

The analysis for collected information was carried out with the appropriate computer software (SPSS Version 17). Necessary correction was made while entering and then regular checkup thereafter as well. T-test and chi-square were employed so as to assess statistical significance. An index was calculated for the data that required ranking employing the formula: $\text{Index} = \frac{\sum \text{of } [3 \text{ for rank } 1 + 2 \text{ for rank } 2 + 1 \text{ for rank } 3]}{\sum \text{of } [3 \text{ for rank } 1 + 2 \text{ for rank } 2 + 1 \text{ for rank } 3]}$ for the overall.

3 RESULTS AND DISCUSSION

3.1 FEED RESOURCES AVAILABILITY

The Borana zone was endowed with various types of feed resources that were the dominant source of intake for dairy cattle along the main four seasons of an area. Despite the variation in type and proportion of availability, various feed resources across both agro-ecologies of the study area were generally identified. Hence, the predominant and which comprised the largest basal diets to dairy cattle were grasses, legumes, herbs and shrubs and foliage of various tree species.

Table 1: Response of the community on the proportion of feed resources across agro-ecologies

Agro-ecologies	Proportion of various feed resources (%)						
	Natural pasture	Hay/Standing hay	Crop residue	Mineral	Pods	Green fodder	Industrial by-Product
Lowland	23.33	11.67	12.50	21.67	11.67	9.17	10
Mid-highland	25	8.33	20.83	22.92	10.42	10.42	2.08

There were also supplementary feed resources for the newly emerging practices of supplementing cattle with additional feed resources. Crop residue was common in mid-highland where mixed farming was practiced but also recently adoption to the lowland area either on purchase or from the nearly emerged crop farming was observed. Straws of *teff*, wheat, barley, maize and sorghum, and haulms of haricot bean were the major crop residues those were commonly itemized in supplementing dairy cattle of both agro-ecologies, where tops of sweet potato and by-products of banana and *Enset* were solely utilized by the mid-highland communities. The mineral salts which were locally termed as *Boke*, *Dillo*, *Magado* and *Chuluke* were commonly available in both agro-ecologies. Besides these local mineral salts there was introduction of block of table salt (*Amole*) in the mid-highland area from the central highland of the country. Choice of mineral salts type was reliant on the proximity of the source and thus *Dillo* and *Boke* types were highly preferred in lowland area. The industrial by-products like flour mill by-product and oilseed cakes were insignificantly utilized during the dry season of both agro-ecologies. Standing hay and pods (from acacia tree species) were identified only in the lowland, whereas cut and piled hay, vines of sweet potato, banana and *enset* by-products were solely in the mid-highland. Various studies also revealed that, given that commercial feed production and cultivation of feed has not been adopted in most areas of Ethiopia, natural pasture and crop residues are the major source of Borana cattle feeding (Bizuwerk et al., 2005; Desalew, 2008 and Teklu, Negesse, and Angassa, 2010).

Though diverse feed resources were screened out in the respective agro-ecology, it hardly meant that the underlined were sufficient for their herd. Correspondingly, the complaints of 64.9% and 57.9% of the participants of lowland and mid-highland were an illustration of feed shortage. However, respondents had less knowhow concerning the nutritive value of crop residue and standing hay which were generally characterized by low nutrient and higher fiber content, low digestibility and limited voluntary on consumption by the animals. Beyond range land degradation, pastoralists of lowland area were complaining that some feed resources that were preferable for dairying (enhancing milk yield and fat content) were completely extinct from the area and others were endanger of extinction.

3.2 FEED RESOURCES SEASONALITY

According to the current study the seasonal availability of the supposed feed resources were varied for feed type and agro-ecology of an area as depicted in Figure 1. About 72.2 and 73.7% of the respondents in the lowland and mid-highland, respectively, believed that natural pasture was available during all the seasons of survey sites. However, 26.9% and 26.3% of the respondents of lowland and mid-highland were, correspondingly, responded that it was grown only during the Gana season. Reciprocally, the feed resources like crop residue, pods and purchased feeds were predominantly available during the Bona season of both agro-ecologies.

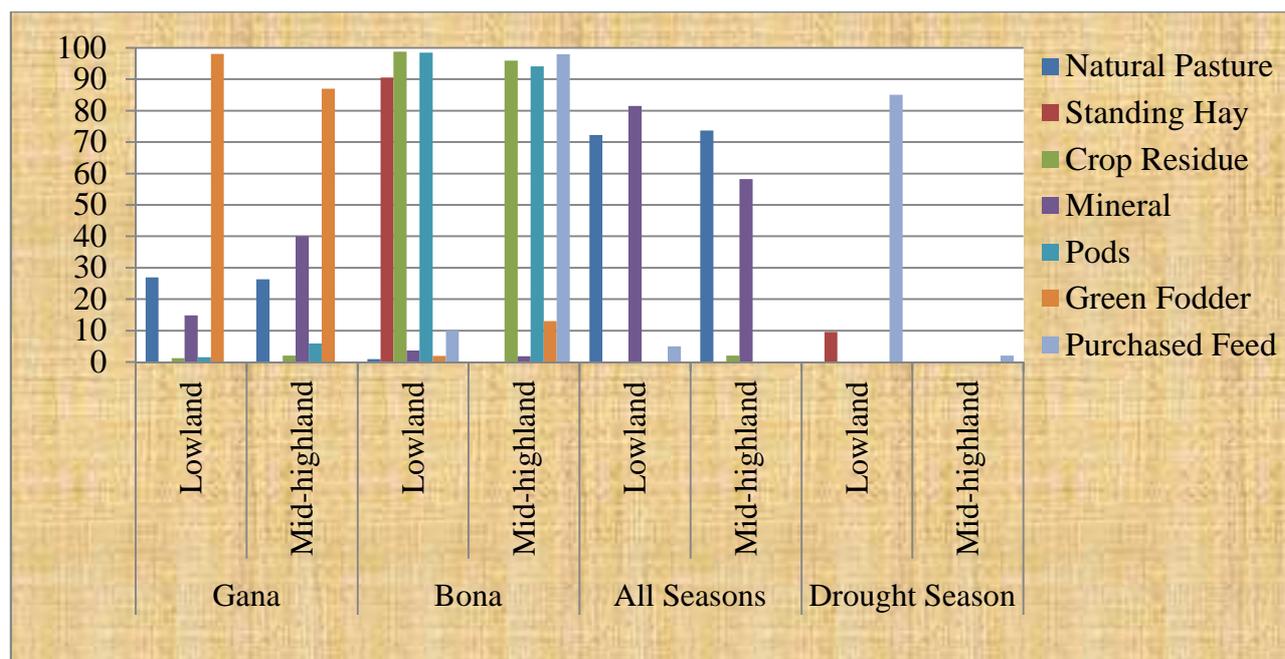


Figure 1: Seasonal availability of various feed resource for dairy cattle of Borana Zone

Standing hay feeding was practiced only in lowland areas of the survey site where it was entirely available during the dry season except insignificant conservation for the probable drought outbreak of specific areas. Minerals were available at the whole season of both agro-ecologies despite the lowland residents' who were supplying to their animals mainly during the Gana season whereas the mid-highland communities were supplying almost equally during the Gana and Bona seasons. Discrepancy in seasons of mineral salt supply might be associated with less willing of salt consumption by the animal during the time of water shortage due to its thirsting nature. The case of lowland area where water was highly deficit was an illustrative condition. Purchased feed resource (like packed hay) was seldom introduced to the lowland area during prolonged dry seasons or drought outbreak of lowland area mainly sourced from the central parts of the country. Irrespective of less occurrences of drought problems in mid-highland, there was some purchased feed (oilseed cake) during the dry season for supplementing prioritized cattle category, but insignificantly.

3.3 SOURCES OF FEED RESOURCES

Much of the feed resources of lowland area were communally owned in the lowland area with the contradicting reality in the mid-highland areas where mostly owned privately as summarized in Table 2 below.

Table 2: Sources of various feed resource for dairy cattle across the two agro-ecologies of Borana Zone

Sources of Feed Resources	Agro-ecologies	Available Dairy Cattle Feed Resources				
		Natural pasture	Hay/Standing Hay	Crop Residue	Pods	Green Fodder
Privately Owned	Lowland	1.6 ^a	51.1 ^a	95.5	0.8	1.8 ^a
	Midhighland	57.2 ^a	97.1 ^a	96.2	0	59.5 ^a
Communally Owned	Lowland	98.4 ^b	48.9 ^b	0.8	95.4	98.2 ^b
	Midhighland	42.8 ^b	2.9 ^b	0.8	0	40.5 ^b

Purchase	Lowland	0.0	0.0	3.7	3.8	0.0
	Midhighland	0.0	0.0	3.0	0	0.0
Government Provision	Lowland	0.0	0.0	0.0	0.0	0.0
	Midhighland	0.0	0.0	0.0	0.0	0.0
Charity from NGO	Lowland	0.0	0.0	0.0	0.0	0.0
	Midhighland	0.0	0.0	0.0	0.0	0.0

The column proportion bearing with the same subscript letters are significantly different from each other ($p < 0.05$)

According to 98.4%, 95.4% and 98.2% of the respondents of lowland area, natural pasture, pods and green fodders were communally owned, respectively. Almost all the mid-highland respondents owned natural pasture and green fodder privately. Irrespective of limited type and quantity of crop residues utilization in lowland area, 95.5% of the users owned it privately and likewise the figure was 96.2% for mid-highland respondents. Regardless of the government policy that prohibits privacy of grazing land in pastoral system, there was private enclosure for *kallo* and standing hay making at village level for their calves and weaker animals. The current study confirmed that the owner of private and communal standing hay was almost equivalent in the lowland area but it was purely in private manner in mid-highland which was the form of cut and piled hay. This was extended from land holding system of the area that was principally privatization.

There was also the practice of purchasing bell of hay at the time of drought outbreak in the lowland area, but it was done insignificantly. Though it was insignificant, there was the practice of purchasing crop residue either from the local crop producer and/or producer at adjacent districts/region of both agro-ecologies. Almost half of the respondents those were at the proximity to mineral source owned it communally whereas almost all the respondents of the mid-highland area (95.4%) were obtaining it through purchase.

3.4 WATER SOURCES FOR DAIRY CATTLE

Sources of water for livestock in lowland area were deep wells, ponds and bore holes as reported by 95.7%, 71.7% and 22.8% of the respondents, respectively. Mid-highland area was apart in that river was the main source of water for the livestock. Adult animals were watered trekking an average distance of 7.75 km and 4.5 km during the dry season in lowland and mid-highland areas, respectively. The relatively longer distance in lowland indicated that herds were wasting much of their energy in travelling to and from the watering points and hence contributed towards lower productivity of dairy cattle. Calves and weaker animals were watered at home on fetched water. Watering frequency of cattle was varied from one agro-ecology and season to the others. In lowland area cattle has been believed to be watered every other day and at the interval of 3 - 4 days during the wet and dry seasons, respectively. However, the frequency was shorter both during the wet and dry seasons of the mid-highland as the area was relatively enriched with water source.

3.5 TREND OF COMMUNAL GRAZING LAND

The grazing land which was the source of natural pasture, green fodder and standing hay was mostly owned communally despite the currently emerging privatization. This grazing land was at declining trend in both agro-ecologies though the magnitude of decrement varied as illustrated in Figure 3. Two decades ago, about 98% and 60% of grazing land in lowland and mid-highland areas was communally owned, respectively. The remaining 2% was privately owned by the communities at their adjacent garden for the newly born calves. The significantly higher figure of grazing land that was not owned communally in mid-highland was due to land holding policy of an area that favor privatization except the bushy and damp land that has been possessed communally.

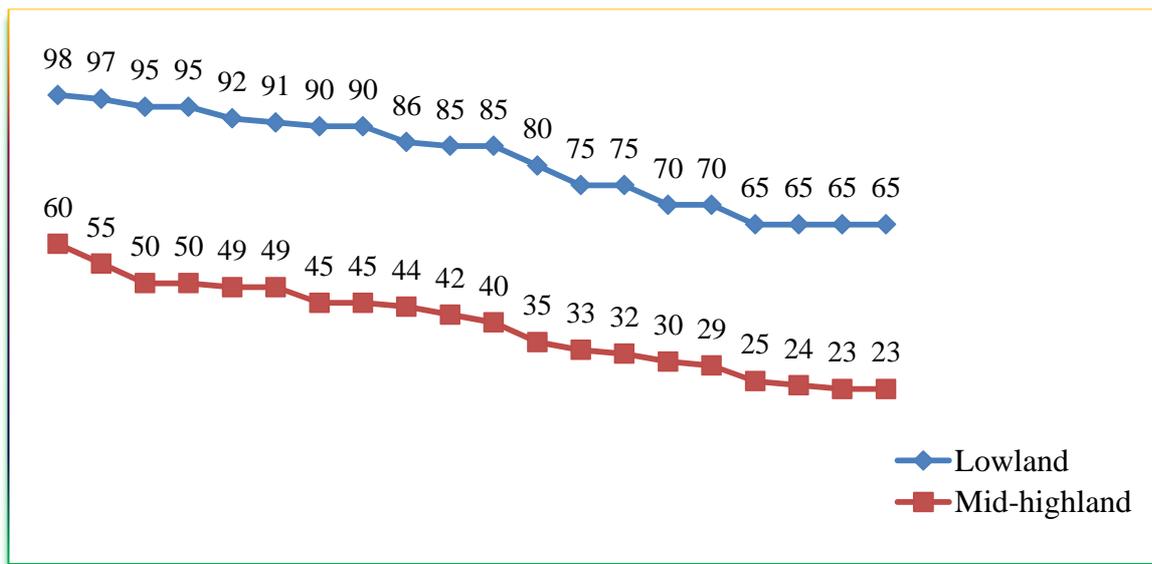


Figure 3: Trend of Communal Grazing Land of Borana Zone for the Last Twenty Years

Source: Own Computation from the Secondary Data of the Respective Agro-ecology

However, the grazing land was highly decreasing both in the lowland and mid-highland, respectively, so that it has been assumed that currently about 65 and 23% of grazing land was communal. The causes for this trend might be the recently observed highly expansion of cropping land and privatively owned grazing land in the lowland area. In fact degradation of rangeland has been creating marginalized land that is to be categorized under any of grazing land holding system. Hence, degradation was another cause for the downfall of the trend nevertheless its total area coverage has not been determined yet. Expansion of cropping land was the solely reason for shrinkage of grazing land of the mid-highland area.

3.6 FEED MARKETING PRACTICES

Many scholars have not been recommending purchased feed for pastoral areas due to its higher cost of return while purchasing and transporting from the place of its availability. However, natural pasture alone cannot fulfill the nutritional requirements of the animals, particularly during the dry season while its availability and quality was inherently low. Thus, feed was becoming a marketable resource in both agro-ecologies of the study area. The purpose of purchasing supplementary feeds in lowland was distinctly apart in mid-highland area. In the former area, it was for sustaining the herds during the prolonged dry season, drought incident and for post-drought recovery than for improved dairy production which was familiar in the latter area. Despite the rare occurrence of drought problem in mid-highland, the cattle categories to be prioritized was maintained during the dry season in feeding on hay made from locally purchased grass land and also purchased crop residue from others while theirs was exhausted. Marketed feed resources during the dry seasons of both agro-ecologies were concentrate feed resources (absolutely oilseed cake and milling by-products); roughage feed resources (hays, straws, and green grass), and mineral salts. Industrial by-products was acquired more of from the aid of governmental and nongovernmental organization in lowland than through purchase. But the source was reverse in mid-highland area. The respondents of lowland area stated that those who were at proximate to the sources were collecting local mineral salts by themselves with the exception of those who were far away of the source who usually own it through purchase. However, it was merely through purchase in mid-highland area where there was the case of additionally introducing block of table salt (*Amole*) by the means of purchasing from the central highland of the country.

During the aforementioned season of demand for feed purchase, marketing price of industrial by-products, roughage and mineral salts was markedly peculiar with spatial variability across both agro-ecologies of Borana Zone as illustrated in Table 3.

Table 3: Marketing Price of Feed Resources in Both Agro-ecologies of Borana Zone

Feed Resource for Purchase	Price in Eth Birr* per Unit of Measurement	
	Lowland	Mid-highland
Flour Mill By-product (kg)	4.50	3.25
Oilseed Cake (kg)	14.40	12.60
Crop Residue (Heap)	30	13.50
Hay (Bale)	60	**
Local Mineral Salt (Kg)	6	8
Block of Table Salt (<i>Amole</i>)	**	22

* indicates 18.65877 Eth Birr = 1 US\$ at the time of administering the survey

** indicates nonexistence of the feed type of same row in the agro-ecologies heading the column

The price of feed resources (crop residue and industrial by-product) was reliant on the type of crop from which it was produced. The participants also stated that *teff* straw was highly demanded and appeared to show significantly higher price whereas wheat straw was less demanded and has lower price across both agro-ecologies. Without differentiation of the type of the residue, the price of crop residue was generally estimated to be 30 Birr/Heap and 13.5 Birr/Heap in lowland and mid-highland areas, respectively. Marketing price for owning crop residue from local and the neighboring cropping zones was also seemed to be highly discrepant. Regardless of infrequent commercialization practices of hay in mid-highland, it was introduced to lowland area from the central highlands of Ethiopia at the average marketing price of 60 Birr/Bale. This marketing price was by far higher than the findings of study conducted by Sintayehu Gebre Mariam *et al* (2010) who reported that the average price for a bale of hay was about 32 birr.

Due to lack of flour mills and oil processing plants, non agro-industrial by-products were readily available in the study area. But, oilseed cakes and flour mill by-product were commonly bought from the nearby big towns and introduced to the study area. The marketing price of industrial by-product in Borana zone was markedly higher than in central areas of the country where it was reported by AGP-LMD (2013) that the current average price is Birr 305/quintal. On the other hand, marketing price of flour milling by-product in Borana zone was like central areas which was lower than oilseed cake where both were considerably higher in lowland than mid-highland (Table 3).

3.7 DAIRY CATTLE FEEDING SYSTEMS

Lowland of Borana Zone was characterized with semi-settled versus mobile systems of herd management. These indigenously referred to the *warra* and *fora* herd management divisions. The *warra* herds normally include milking cows, calves, and weak animals those were maintained at the encampments (*olla*) along with women, children, and the elders. The *warra* herds grazed on the communally enclosure (*kalo*) at their encampments. It was normally of circular movement within the surrounding of the semi-sedentary, though not less than a daily minimum round trip travel of 20-30km for water (Cossins and Upton, 1987). The *fora* split, on the other hand, are a mobile herd unit of mature animals and dry cows that migrate with young male household members to remote grazing territories. The mid-highland producers of livestock predominantly are known for its settle mode of production.

The degradation of the range land and erratic climatic condition are making the grazing land with shortage of pasture particular during the dry season so that the lowland dwellers have been overcoming it through providing their cattle with cut shrubs, grazing on communally conserved standing hay and moving them to an area where there was enough availability of feed resource. As the most important strategies to overcome feed shortage during the dry season, though it is statistically insignificant for lowland, there is also the currently observed practice of feeding dairy cattle with crop residue from their own small scale farming and introducing from agrarian areas through purchase, but at large scale feeding for mid-highland area was from their own cropping. Nonetheless, there was no any physical and chemical treatment applied to the supposed crop residue. Irrespective of communal enclosure for standing hay in lowland area, there was nonexistence of making cut hay but through purchase bales of hay and industrial by-products during the chronic feed shortage.

Mineral supplementation was predominantly carried out at home (96.7%) at the interval of 14.8, 17.8, 17.8, 17.9 and 17.7 days for calves, young, adults, lactating and castrated camels, respectively. About 76.6% and 67.3% of the respondents of lowland and mid-highland, respectively, were feeding dairy cattle prioritizing based on the category that comprised of the sex, age and physiological condition. There was no such prioritization according to 23.4 and 32.7% of the respondents of lowland and mid-highland, respectively, particularly during the wet season of the respective site. However, according to the computed index from the response of few participants all the categories of cattle, calves (< 1year old), lactating cows and bulls were, respectively, the first, second and third prioritized categories of cattle in both agro-ecologies (Table 4). Calves were allowed to graze on the enclosed kalo and be accessed for fetched water for drinking at the possible proximity to compact scarcity in lowland area. There were also pods, shrubs and green fodder availing. The separate management for cows was herding on stand hay; provision pods and sufficient mineral salt; timely watering, and accompanied ample medication facilities.

Table 4: Priority in Feeding Cattle Category during the Main Seasons of Both Agro-ecologies

Agro-ecologies	Ranks	Wet Season					Dry Season				
		Calf (< 1year)	Heifer	Lactating cow	Dry cow	Bull	Calf (< 1year)	Heifer	Lactating cow	Dry cow	Bull
Lowland	Rank 1	47.2	0	7.9	0	0	83.3	0	15.5	0	1.2
	Rank 2	4.1	0	43.2	0	2.7	15.9	1.2	76.8	0	3.7
	Rank 3	3	10.6	3	7.6	21.2	2.7	16.2	2.7	14.9	60.8
	Index	0.61	0.04	0.45	0.03	0.11	0.61	0.04	0.44	0.03	0.15
Mid-highland	Rank 1	40.6	0	9.4	0	3.1	63.6	0	21.2	0	15.2
	Rank 2	3.1	12.5	18.8	12.5	0	18.2	9.1	39.4	0	15.2
	Rank 3	4.2	4.2	8.3	4.2	20.8	15.4	7.7	11.5	3.8	38.5
	Index	0.73	0.16	0.36	0.16	0.17	0.79	0.08	0.50	0.01	0.37

Index = Sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular categories of cattle divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all categories of cattle

Bulls were prioritized in allowing them to graze separately, drenching some tablets for helminthes and not to be exploited for traction in lowland area. Prioritization of calves, lactating cows and breeding bulls resembled in both agro-ecologies despite the type of feed resources for provision.

The respondents were managing calves in providing feed resource that was more of fresh cut and succulent. Cows and breeding bulls were provided with salt, crop residue and tops and by-product of sweet potato and *Enset* during the dry season of the mid-highland area. Medication for some bovine diseases and parasitic infestation were regularly provided to calves, cows and breeding bulls. Intentionally, the bulls those were selected for breeding purpose were seldom employed for cropping.

4 CONCLUSION AND RECOMMENDATIONS

Natural pasture, standing hay and local mineral salt were the predominant feed resources for dairy cattle of lowland of Borana Zone. All were also common to mid-highland areas except well prepared hay than standing hay and introduced block of mineral salt on the top of local mineral salt. Supplementation on crop residues and industrial by-products from purchase during the dry season and drought outbreak of the lowland and own preparation of crop residue and purchase of industrial

by-products for the time of feed deficit in mid-highland were common feed resources. However, there was both availability shortage and nutrient content deficiency, particularly during the dry and drought outbreak season, of lowland than mid-highland area that limited the productivity of dairy cattle. Away from the findings, quantitatively estimation of the annual production potential, which can be obtained by multiplying each with the well pre-established conversion factor, do not expect the implication to be fundamentally inappropriate. Pastoralist of the lowland area should rehabilitate and wisely utilize the grazing land through timely enclosing and balancing its carrying capacity. Blindly refraining from industrial by-product associated with its price by no way can make effective the dairying activity of Borana zone and thus empirically investigating the relative advantage should be crucial. Crop residues unaided with an appropriate treatment with concentrate feed could not satisfy nutrient requirements the herds than for maintenance during adverse condition and thus it should be accompanied with full package.

The distant location from the encampments which was artificially harvested from rain water for availing dairy cattle during the dry season was needed to be altered towards the mechanized system that can safeguard the herds against energy wastage while traveling to and from the watering points and hence enhance productivity.

The well adapted prioritization practices on feed resources along with the categories of cattle to be supplemented principally during intake crisis should be capitalized for further strengthening in rearing more economical and socially feasible dairy production subsector.

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