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Improvement of the Feed Availability in Pastoral Zones of East Africa- A Review

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Abstract

Pastoral areas in East Africa mostly consist of arid and semi-arid land which are majorly occupied by livestock farmers. The areas are characterized by prolonged drought which adversely affects the availability of the pastures and fodder. Feed resource availability depends on the rainfall patterns and the browse found in the pastoral zones is majorly characterized by thorn bushes which are of low carrying capacity The quality and availability of the feeds in rainy seasons are high thus achieving the general livestock productivity while in the dry season, there is poor quality and quantity, low digestibility, low crude proteins and mineral deficiency. Other than droughts, some factors affect the availability of the feeds in these zones like land degradation which lowers the growth of the pasture, poor grazing management, land use, subdivision of land, inadequate skills to produce and conserve feeds, and lack of information. The quantity and the quality of the available feed resources can be improved by strategies such as pasture rehabilitation, conservation of fodder, integration of pasture and forage into the farming system, utilization of irrigation, improved grazing land management practices, like destocking and controlled grazing, and physical treatments such as soaking, chopping and chemical treatments, such as ammoniation and urea treatment. In conclusion, future efforts should aim at enhancing feed production and storage at the local level as well as developing sustainable use of land resources by pastoralists to produce feeds throughout the year to support constant livestock production. These developments in feed availability are essential in maintaining pastoralism livelihoods in East Africa.

Keywords: *Arid and semi-arid, Drought, Feed availability, Improvement strategies*

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Introduction

Animal nutrition is an important factor in livestock production and reproduction as an inadequate supply of good quality feed lowers the production efficiency (Khanal et al., 2022). Livestock have several nutrient requirements including energy, protein, minerals, and vitamins, which are dependent on the region and type of animal (Singh et al., 2022). Failure to meet the dietary needs of animals affects metabolic and digestive functions (Liao et al., 2024). Severe livestock feed shortages faced by pastoral communities in the Horn of Africa's arid and semi-arid lands (ASALs) have been due to climate change, recurrent drought, degraded rangelands, and reduced access to traditional grazing lands. Other causes of fed shortages include land tenure and land use changes, resource use conflicts, encroachment of invasive plant species, soil infertility, lack of knowledge on appropriate feed and feeding practices, and lack of inputs and planting material (Chamasula, 2022).

During the dry periods, the pastoralist experiences a lot of livestock loss and reduced livestock performance (Habte et al., 2022). Feed resource availability depends on the rainfall patterns and the browse found in the pastoral zones is majorly characterized by thorn bushes which are of low carrying capacity (Jiso et al., 2023).

The pastoral communities highly depend on naturally available forages, which include grazing pasture and browses while the agro-pastoralists may have crop residues as supplements for their livestock. The quality and availability of the feeds in rainy seasons are high thus achieving general livestock productivity. During the dry season, there is poor quality and quantity, low digestibility, low crude proteins, and mineral deficiency resulting in low livestock productivity and increased release of greenhouse gases (Cooke et. al., 2024**)**.

Livestock and its importance in Eastern Africa

The livestock sub-sector plays a large part in the agriculture business throughout the African region by contributing about a third of agricultural value and more than half in certain countries. Cattle flesh and other livestock products which include meat account for nearly 60% of the value of the edible animal product whereas small ruminants and poultry each contribute about 20% (Nkwana & Mazenda, 2024). The above indicates the importance of livestock in the economy and for food security throughout the continent.

In Eastern and Central Africa (ECA), livestock are central to the development of the economy at both the individual and national levels. It provides 20-30 % of the gross domestic product in some nations, as well as stimulates inter-state trading (Anno, 2025). Livestock is especially important in the ECA where more than 70% of the land is arid and semi-arid. Because of their ability to adapt to changes in the environment, livestock ensures food and income security for many pastoralists (Bodjo et al., 2024). Also, about 60-70% of the cash income of pastoral households is obtained from the sales of livestock (Leonardi-Cattolica, 2024).

Pastoralism is still a main livelihood practice in most households in arid areas to enhance livestock production (Barre et al., 2025. In the last one and a quarter decade, the pastoral population has doubled, therefore pointing to the strategic importance of the sector in the supporting of livelihoods in rural areas. Regarding the contribution of livestock to nutrition security, it's worth mentioning that livestock offers trace nutrients like vitamin B12 that are vital in the brain and body development of children according to Senyael (2025). Consumers get their requirements of proteins, fats, vitamins, and minerals mainly from meat, milk, and eggs which constitute about 65%, 27%, and 8% of the value of edible livestock products respectively (Priyadarsini et al., 2024).

Moreover, livestock is economically and nutritionally valuable; it also has social and cultural value. In most pastoral and agro-pastoral societies, cattle have been an important form of social capital investment used to facilitate most social-related functions such as relation to marriage, celebration of births, funerals, and other ceremonies. They are believed to signal asset ownership and perform a discriminating function within conventional support networks that are vital to societal well-being (Zerbo et al., 2025).

Production and Production systems

In Eastern Africa, livestock are kept under two systems namely the traditional and the non-traditional systems. The former comprises: (i) pastoral and agro-pastoral systems; and (ii) mixed systems in the semi-arid, sub-humid, and humid zones. The non-traditional systems comprise: (i) ranching (meat); (ii) smallholder and peri-urban commercial systems; and (iii) intensive livestock production in rain-fed or irrigated systems largely in North Africa (Bogale et al., 2022). The systems may also be categorized by agroecological zone. In Eastern and Central Africa, these systems are categorized as livestock only, rangeland-based Arid and Semi-arid constituting 21% of the total land area; livestock only, range land-based, humid/sub-humid constituting 11%; livestock only, rangeland based, temperate/tropical highlands constituting 1%, and mixed rain-fed arid/semi-arid constituting 9% (Stanimirova, 2021).

Livestock population within Eastern Africa

Livestock is an important sub-sector in the agricultural value chain of Eastern Africa. The available statistic shows that today the region hosts about 123 million cattle, 163 million sheep and goats, 5.3 million pigs, and 219 million chickens (Ngongolo et al., 2025). These livestock populations are mainly raised under extensive systems of pastoralism, which are still the main source of livelihood in arid and semi-arid lands(ASALs) (Ngongolo et al., 2025). Area-wise coverage of such wide-ranging livestock production systems is equally vast, accounting for nearly 60% of the geographical area, the rest 40% of the area is used for the cultivation of crops. The vast land usage exerts a great deal of pressure on feeds on pastures, fodder crops, and grains which support livestock and populations (Ahmed & Ali, 2024).

Livestock production in Eastern Africa too plays a key role in food security and resilience against environmental challenges. However, the growing demand for livestock products and population increases present significant challenges for sustainable management, specifically in terms of maintaining adequate pastureland and minimizing overgrazing especially in ASALs (Prusova et al., 2024).

Improvement of feed availability in pastoral areas

The quantity and the quality of the available feed resources can be improved by strategies such as pasture rehabilitation, biodiversity conservation, integration of pasture and forage into the farming system, utilization of irrigation, improved grazing land management practices use of urea molasses blocks, and physical treatments such as soaking, chopping and chemical treatments, such as ammoniation and urea treatment.

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Improving pastures in the pastoral zones

This will enable the farmers to always have quality and enough feed for their livestock. There should be the introduction of forage grasses and forage legumes that can improve pasture quality (Chand et al.,2022). The legumes play a great role in supplementing higher protein content to the grasses which contributes to meeting the body requirements thus resulting in better productive livestock.

Adaptable cultivated fodder species

There should be the establishment of adaptable cultivated fodder species in these arid areas. Pastoralists do not have a trend of growing forages for their livestock which can be attributed to many factors such as lack of information, training, seeds for planting, and impracticability of the grown forages to produce enough dry matter for the large number of livestock. In most parts of Kenya range seeds are not available in the formal markets thus challenging the efforts to improve their pasture lands

Farmers in Eastern Africa can enhance resilience to drought by adopting drought-tolerant forage species that are well adapted to semi-arid agro-pastoral systems. Among these, forage legumes include mainly *Clitoria ternatea, Macroptilium atropurpureum, Stylosanthes guianensis, Stylosanthes hamata and Stylosanthes fruticosa,* fodder grasses, that include *Cenchrus ciliaris, Chloris gayana, Brachiaria spp* and *Panicum maximum* for hay production (Kirwa 2019). Incorporation of fodder shrubs and trees in the likes of *Cajanus cajan, Gliricidia sepium, Leucaena leucocephala,* and *Calliandra calothyrsus* into these systems has also been shown to improve feed quality and ecosystem sustainability in agro-pastoral regions (Koura et al., 2022). These species are known for their effectiveness in enhancing feed quality on livestock and steeping up climate resilience (Ahmed et al., 2024).

These zones are characterized by prolonged periods of water scarcity which greatly affects the growth of the pastures. Farmers in these areas can either harvest rainwater or dig boreholes to fetch water for irrigating their pastures. This practice ensures that there is availability of pasture throughout.

Supplementation strategies

Supplementation can be done using concentrates such as dairy meals, pellets, and Urea Molasses- Nutrient Blocks.

Urea Molasses-Nutrient Blocks

Urea-molasses nutrient blocks (UMNBs) typically consist of 4–10 % urea, 30–45% molasses, and 6–15 % binder (Reshi et al.,2022). In the pastoral zones, the farmers largely depend on fibrous feed to feed their livestock which are of low quality and are deficient in nitrogen, readily fermentable energy, minerals, and vitamins. Protein supplements e.g. oilseed cakes are usually expensive and thus the use of non-protein nitrogen sources like urea has been adopted as an option for supplementing the low-nitrogen fibrous feeds. The combination use of urea and molasses helps the growth of micro-organisms in the rumen, which digest the fibrous feeds. Tekeba et al., (2012) found that dairy genotypes showed a significant improvement in daily saleable milk and milk energy off-take, milk quality traits, postpartum ovarian activities, body weight gain, body condition, and benefit-cost ratio due to UMNB supplementation.

Blocks are made hard enough to ensure that the animal gets a slow release of nutrients through the licking process. Blocks are normally offered to animals in a wooden box or bucket of dimensions slightly larger than that of the block, which restricts biting of the block by animals. The hanging of blocks in front of the animal using a wire passing through the centre of the block has been another approach. Cattle can consume 500 to 800 g/d, sheep and goats 60 to 125 g/d.

Rehabilitation and maintenance of communal rangelands

Rehabilitation and maintenance of communal rangelands is a long-term process that requires substantial resources (Robinson et al., 2021). The strategy should promote the institutionalization of community-based rangeland resource management (CBRRM) by involving communities and all stakeholders such as local authorities in the decision-making process for proper utilization and management of grazing areas available for the community. The management will have to be accompanied by the sensitization of policymakers to promote appropriate land tenure and policies to encourage livestock keepers to actively participate in community rangeland management activities (Kimaru, 2023). Land rehabilitation facilitates the growth of more feed biomass thus contributing to the improvement of feed availability in the pastoral lands. The strategies for efficient pastureland rehabilitation include management of open grazing land, use of enclosures, integrated crop-livestock, water harvesting, and conservation technologies, dryland forestry, and reseeding (Mudau et al.,2022).

Management of Open Grazing Land

Land degradation is often caused by overgrazing and poor land management practices. In pastoral communities, the open grazing land is governed by traditional regulations which are ineffective as they result in a lot of overgrazing and land degradation. This in turn leads to low biomass available for grazing their livestock. The agro-pastoralists on the other hand encroach on the open grazing lands with the cropping land thus leading to the shrinkage of the open grazing land. The open grazing lands can be managed by controlled grazing, restricted grazing, and reducing the stock number which will enhance the vigor of mature perennial grasses (Wróbel et al., 2023). Sustainable grazing management is already being used in Namibia, South Africa, and the Northern Rangelands of Kenya and Ethiopia (Arena, & Hawkins, 2024).

The use of enclosures is a practice whereby grazing is excluded for a specified period. Experience from Eastern Africa, for example, Ethiopia, indicates that enclosures can be viable systems for the restoration of degraded land if they have clearly defined users, resource boundaries, and realistic rules established locally (Mebratu et al., 2024). In Kenya, competition between livestock keepers for control of a diminishing range resource is fuelling the drive for range enclosure as the pastoralists attempt to do something about their declining resource base (Mureithi, 2011).

An integrated crop-livestock system of farming can be a good way to make feed available for the livestock in the dry areas (Sekaran et al., 2021). The crop residues act as a source of feed to supplement the naturally growing pastures. This practice increases carrying capacity and reduces the overdependence on the natural grass thus enhancing land rehabilitation.

Water harvesting and conservation technologies

Drylands are areas with limited water (and moisture) resources and hence management of water resources poses a major challenge in promoting sustainable utilization of the dry lands. Good water resource management in dryland is paramount to sustain the productive capacity of the land and to better cope with water scarcity and the extremes of droughts and floods (Patel et al., 2023). Rainwater harvesting techniques and management of land

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and water resources can also be used to help restore diversity to rangelands impoverished by drought and overuse, and when combined with pasture plants can improve grazing for livestock (Louhaichi et al., 2022). If the farmers embrace this technique, then their pasture will be well watered even in dry seasons.

Several techniques can be used for rainwater harvesting which includes collection and concentration of rainfall run-off in micro-catchments, cut-off drains, sand dams, ponds, and rock catchments. The management and conservation of dryland wetlands/watersheds are also critical in maintaining the productivity of rangelands. Dryland watershed management encompasses measures for the prevention of land degradation along riparian areas, rehabilitating degraded watersheds, and through compensation mechanisms for upstream (watershed) communities who undertake land-improving activities and promote compatible land uses (Patel et al., 2023).

Dryland forestry and Reseeding

Agroforestry entails the integration of woody perennials with crops, pastures, and livestock on the same land management unit. It is useful in providing fodder for the livestock as well as Combating desertification and conserving watersheds (Chappa et al, 2024). Since soil moisture is a limiting factor for plant growth in arid and semi-arid areas, it is recommended that agroforestry in dry lands incorporates (rain) water harvesting hence enhancing rehabilitating degraded dry lands.

The loss of indigenous perennial plants and shrubs in North African rangelands due increased population of people and livestock has therefore necessitated rehabilitation of denuded areas e.g. by reseeding the degraded areas with legumes (Abdelhak, 2022).

Feed Quality Improvement Practices

Most of the pastoralists rely on low-quality feeds which results in poor performance of their livestock hence lower profits. They lack the information, skills, and inputs required for the improvement of feed quality. These practices are chopping, water soaking, and urea treatment. The chopping and water soaking minimizes wastage of the feeds and improves utilization therefore ensuring its availability in scarce periods. Urea treatment application on the crop residues improves the quality of the feed before it's fed to the animals (Assefa et al., 2022).

In agro-pastoral systems where crop residues are available, it is important to promote feeding packages using crop residues, and agricultural and agro-industrial by-products to increase feed quantity and quality throughout the year. This should be in supplement to the normal grazing system. The research will contribute to developing feeding packages using available resources for optimum meat and milk yield.

Feed Conservation

Feed conservation practices and technologies can be used to improve the availability of feed in the pastoralist zones. The conservation strategies include storage of the feeds as standing hay or bailed hay, silage, etc. The farmers in these zones need to take advantage of maximum feed resource availability in the wet seasons by conserving the pastures and forage for use in the dry seasons. Fodder conservation by agro-pastoralists is done through haymaking using all available feed resources.

Silage is produced through controlled anaerobic fermentation of green forage material with high moisture content or crop residues. The anaerobic conditions foster rapid fermentation that produces natural organic acids, which prevent further changes in plant composition (Abdelhak et al.,2022). If silage is made properly, it will contain nearly all the nutritive values present in the forage that is conserved. Ensiling is the process of silage making; while a silo is the container used. It may be a trench, a pit, or a polythene bag or it can be done on the surface. All pasture and fodder crops can be ensiled. High-quality silage will be made if the grasses are harvested when flowering, legumes are harvested during pod filling and maize/sorghum are harvested during the milk stage. Napier grass can also be ensiled though this needs the addition of fermentable sugars to enhance fermentation.

Modern silage-making can be done by wrapping the fodder material and then allowing the development of the silage to proceed in the store. Otherwise, the silage is made and then wrapped for storage or for sale (Kagendo et al., 2023).

Ideally, a mixture of grasses and herbaceous legumes is desirable because legumes increase digestibility and intake of the conserved forage but mostly the grasses used for hay production as they are good and are convenient for cutting (Ogbu & Ilo 2021). The pasture should be cut just before flowering to have high digestibility and high protein content. Pasture for conservation should be cut 4 to 6 weeks after a paddock is closed.

Embracing biotechnology

There has been a lot of advancement in recent years in the use of biotechnology to improve feed quality and utilization. These can also be embraced by the arid land farmers to mitigate the unavailability of the feeds in these localities. The technologies include fibrous feed improvement, feed additives, and forage breeding (Asmare, 2014).

Fibrous feeds are usually of low digestibility. Fibrous feed improvement can be done by either using white rot fungi treatment on the roughages or silage inoculants modification (Bai et al., 2024). In silages containing low carbohydrate contents, the inclusion of amylase, cellulase, or hemicellulase enzymes has been shown to increase lactic acid production by releasing sugars for the growth of *lactobacilli* (Bao, et al., 2022). Thus, inoculation of silage bacteria genetically modified to produce such enzymes has been proposed to obtain better ensiling and/or pre-digest the plant material to lead to better digestibility in the rumen

Pasture and fodder plant breeding involves the use of biotechnology to develop forage and pasture that are better adapted and perform better by use of genetically engineered forage (Chand et al., 2022).

The Feed additives include antibiotics, probiotics, prebiotics, and enzymes. Antibiotics are used to improve feed conversion efficiency by shifting rumen fermentation, probiotics and prebiotics help in the proliferation of beneficial microbes for balanced intestinal microbial while the enzymes are for improving nutritive contents in the diets.

Phytase feeds enzymes dietary inclusion in monogastric and improves bio-available phosphorous, reduces the phosphorous load on the environment, and improves amino acid digestibility (Galgano et al., 2022). In ruminant nutrition, enzymes improve the availability of plant storage polysaccharides (e.g. starch), oils, and proteins, which are protected from digestive enzymes by the impermeable cell wall structures. Thus, cellulase can be used to break down cellulose, which is not degraded by endogenous mammalian enzymes (Giwa et al.,2023). Enzymes are essential for

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the breakdown of cell wall carbohydrates to release the sugars necessary for the growth of the lactic acid bacteria (Wang et al., 2021).

Other than proliferation, the probiotics and prebiotics are useful in the production of vitamins of the B complex and digestive enzymes, and for stimulation of intestinal mucosa immunity, increasing protection against toxins produced by pathogenic microorganisms (Tegegne & Kebede 2022)

Pastoral Field School (PFS)
A pastoral field school is an institution in a natural setting in which twenty-five to thirty pastoralist communities convene to learn about and practice improved livelihood and sustainable animal production. This approach derived from Farmer Field Schools has been embraced across Eastern Africa to strengthen the pastoral communities through strengthening key analysis, decision, and communication assets (Mbeyale & Hoeggel, 2014). generally, PFSs assist pastoralists in acquiring better practices in management, livelihood, food security, and natural resource management to meet challenges that are occasioned by climatic shocks (Abera, 2024). The PFS interventions have been successfully implemented around semi-arid areas where pastoralist communities are negatively affected by frequent droughts. These schools offer a learning environment to pass knowledge and effectively resolve issues within the social setting of communities, enhance social nationhood as well as encourage pastoralist communities to foster innovation measures in the prevention of the impacts of natural threats (Jenet et al., 2018). Furthermore, PFSs have a positive impact on the market engagement and income of pastoralists through market and feeding trials introducing better pastoral practices of livestock production and marketing (Khisa et al., 2013).

Conclusion

Pastoral farmers mainly rely on natural pastures to feed their livestock but due to some factors, pasture availability is affected. These factors include drought, overgrazing, lack of information, and lack of conservation techniques.

This calls for the farmers to embrace strategies for improving the availability of the feeds for their livestock. Some of the strategies suitable for adoption include land rehabilitation and management which greatly helps in enhancing the increase of the carrying capacity, conservation of feeds for use in drought periods, supplementation, adopting biotechnology, and establishing drought-tolerant pasture species.

Further research should be done to assess the level of adoption of the feed availability strategies in pastoral zones of East Africa.

Conflict
The authors declare no conflict with the publication of this manuscript.

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