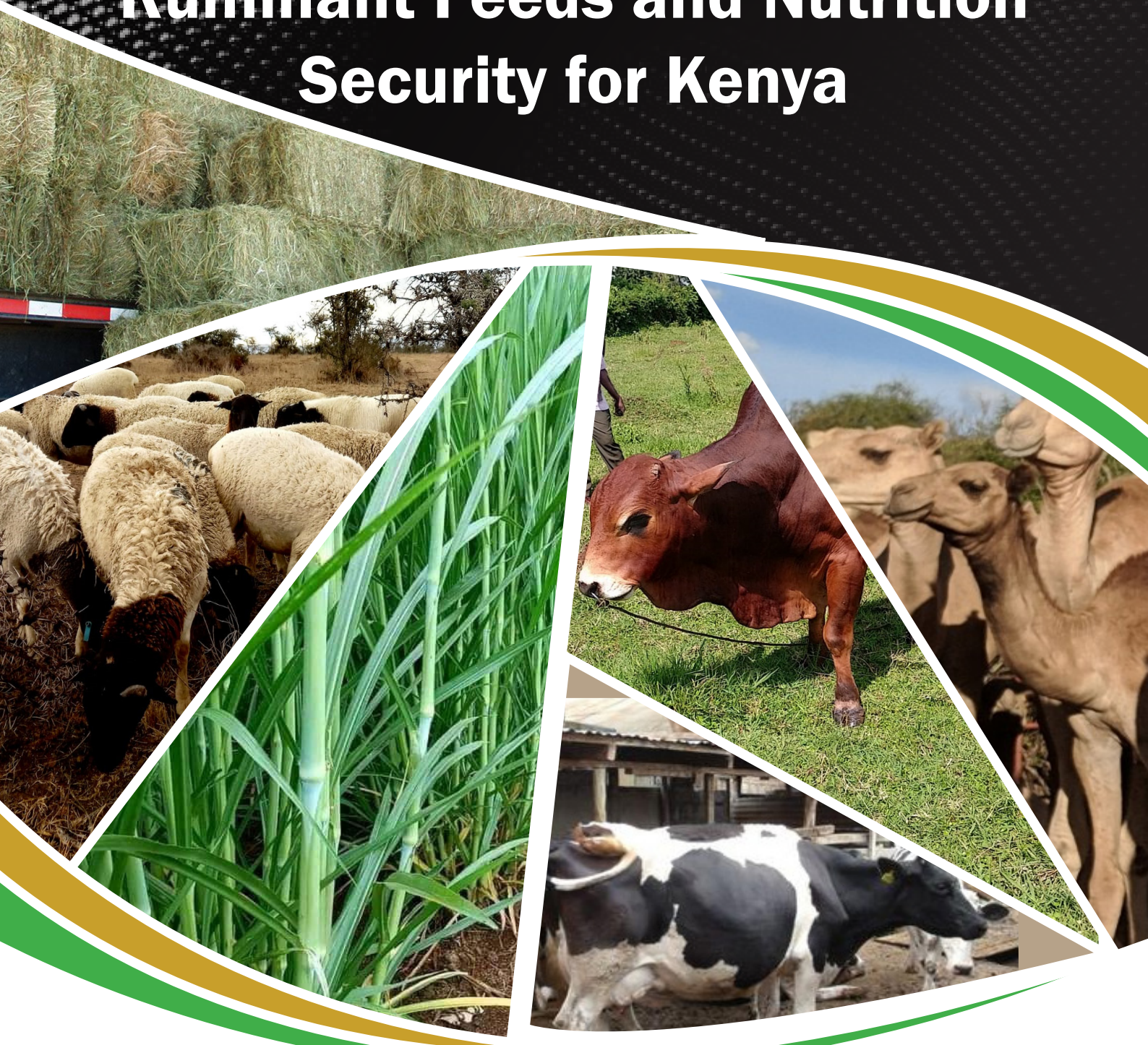
Guidelines on Sustainable Ruminant Feeds and Nutrition Security for Kenya



REPUBLIC OF KENYA

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Table of contents

LIST OF PHOTOS

ABBREVIATIONS AND ACRONYMS

ASALs	Arid and Semi-Arid Lands
BCS	Body Condition Scoring
BETA	Bottom-Up Transformation Agenda
DM	Dry Matter
ELRP	Emergency Locust Resilience Project
GHG	Greenhouse Gas
KALRO	Kenya Agricultural Livestock Research Organization
KCSAP	Kenya Climate Smart Agriculture Project
KES	Kenya Shillings
MT	Metric Tonne
TLUs	Tropical Livestock Units

DEFINITIONS OF TERMS

Agribusiness: Economic activities (crop production, crop processing, transportation and distribution) derived from or connected to farm products

Agro-pastoralism: Agro-pastoralism is a livelihood system that combines crop and animal production by sedentary, nomadic, and transhuman communities. Agriculture and pastoralism are complementary and synergistic in agro-pastoral systems.

Biological Control: The use by humans of beneficial insects such as predators and parasitoids, or pathogens such as fungi and viruses, to control unwanted insects, weeds, or diseases.

Climate Change: Refers to the changes, fluctuations, and variations in climate because of natural processes and anthropogenic activities with impacts on farm animals.

Crop Residues: The remains of a crop on a field after harvesting or extracting the primary product that has a feeding value to livestock.

Cultural Control: Modifying the growing environment to reduce prevalence of unwanted weeds or pests.

Extension Service: Extension service is another name for advisory services. In practical terms, the extension means giving farms (pastoralist and agro-pastoral community) the knowledge and skills to improve, for example, their livestock productivity, food security and livelihoods. The services provision is by experts usually employed by the Government, NGOs, or CBOs. Such services may also be provided to farmers by lead farmers with the necessary knowledge and skills.

Fodder Crop: Crops cultivated primarily for animal feed are cut or harvested and fed to livestock as green chop, hay or silage.

Feed Formulation:for commercial purposes refers to the exercise of determining volumes of ingredients and additives to blend to create compound feeds that meet the known nutrient requirements of targeted species and achieve production goals at optimised costs.

Feed Safety: A discipline in science dealing with handling, preparing and storing feeds to prevent foodborne illness in livestock and humans.

Gross Domestic product (GDP): is the total monetary or market value of all the finished goods and services produced within a country's borders in a specific time period. As a broad measure of overall domestic production, it functions as a comprehensive scorecard of a given country's economic health.

Hay: It is grass or fodder that has been cut or mowed, then air-dried to remove moisture content, then bundled in bales, and kept/stored until ready to be fed to livestock.

Integrated Approach: A holistic consideration of all parts or sectors that work well together or favour a system.

Intensive Livestock Farming: A system of commercial production where animals are under confinement and require many inputs to maximize productivity per animal and unit of land.

Invasive Plant Species:is as a species that is non-native (or alien) to the ecosystem under consideration; and, whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Livestock Industry: Activities involving all aspects of livestock development.

Livestock Producer: Any person who engages in livestock farming for production purposes.

Livestock Type: It is also known as livestock species—a group of domesticated economic animals that can produce fertile offspring.

Nutrition Security: The process of providing or obtaining the food necessary for the health and growth of animals.

Pastoralism: A production system entailing seasonal movement of livestock herds in search of better pasture and water, in which the owners depend solely on livestock and livestock products for sustenance livelihoods.

Peri-Urban: A transition from rural to urban land uses is between the outer limits of urban and regional centres and the rural environment. They are also referred to as urban spaces, the outskirts of the hinterland.

Physical Control: mechanical or hand controls where the pest is actually attacked and destroyed

Policy: A set of strategic decisions guiding actions selected to achieve some development goals.

Roughage: A livestock feed with high fibre content and low protein and carbohydrate levels. The nutrients are not readily available to the animal.

Rangelands: Lands on which the native vegetation is predominantly natural grasses, grass-like plants, forbs, or shrubs suitable for grazing or browsing.

Ruminants: An animal (such as a cow or sheep) with more than one stomach swallows food and then brings it back up (regurgitation) to continue chewing it.

Semi-Intensive Livestock Farming: System where livestock is housed and fed but can graze or move around to scavenge within or outside the farm.

Silage: Grass or other green fodder compacted and stored under airtight conditions, typically in a silo, without being dried, and used as animal feed in the dry season or winter.

Stakeholder: Individual, organization or institution, private or public, that in one way or another has an interest in and is concerned with the carrying out activities relating directly or indirectly to the livestock industry in the country.

Stocking Rate: Is a management decision of how many cattle to put on a pasture. The difference between continuous grazing or set-stock grazing and adaptive grazing is time.

Strategy: The pathway is taken to achieve a particular set of objectives.

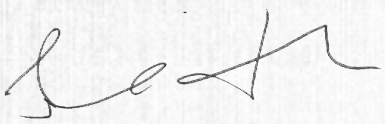
Urban Areas: Areas created through urbanization and categorized by urban morphology as cities, towns, conurbations (the merging of several villages), or suburbs.

Foreword

The livestock sector plays a key role in the socioeconomic development of Kenya, providing livelihoods to about 13 million Kenyans. It provides food, employment, income and export revenue to farmers and other stakeholders in the industry. The Government is committed to providing a conducive environment, for the continued development of the livestock industry as contained in the Constitution of Kenya 2010, Vision 2030, Sessional Paper No. 2 of 2008, Agricultural Sector Transformation and Growth Strategy (2020-2025) and the Bottom-Up Economic Transformation Agenda (BETA). Further, in collaboration with sector stakeholders, it provides technical support to livestock stakeholders through preparation of extension materials.

The feed and nutrition security guidelines have been developed through a consultative process with livestock feed experts from the State Department for Livestock Development, the Kenya Agriculture and Livestock Research Organization (KALRO), Universities and the private sector. The main aim of the guidelines is to address the major feed challenges in the livestock sector and specifically ruminants which undergo perennial feed shortages due to; unreliable rainfall patterns, inadequate pasture and fodder conservation strategies, high cost of feed ingredients, overstocking, inappropriate grazing strategies amongst others. The cyclic occurrence and regularity of drought has further aggravated the already delicate livestock feed situation leading to loss of body condition and in some cases mortalities of livestock thus affecting livelihoods of pastoral populations. The economic losses realized from livestock body condition losses and mortalities have been estimated in excess of KES 37 billion during the prolonged drought of 2022. In recognition of the growing population, urbanization and improved incomes from an increasing middle-income class there is need to increase livestock productivity to support the increasing demand for animal protein. The role played by livestock in national and household economies should be enhanced to improve livelihoods of livestock keepers by promoting quality feed availability and accessibility throughout the year.

Targeted effort should be initiated towards addressing the immediate, medium and long-term livestock feed availability, utilization, accessibility and stability to shore up the economic losses realized from the regular livestock feed shortages. These guidelines will therefore expand the scope of livestock feed provision through enhancing the various livestock feed supply chains to march the feed demand for the various parts of the country. This will ensure sustained benefits to all stakeholders in the livestock feed value chain for improved livestock feed security.



Hon. Jonathan Mueke
Principal Secretary
State Department for Livestock Development

Preface

Perennial feed and nutrition insecurity for livestock has persisted overtime hindering livestock production and productivity. These guidelines are designed to address feed insecurity by providing practical approaches to sustainable livestock feed production, access, utilization and ensure livestock feed stability in Kenya. They have been developed to give policy makers, extension workers, farmers, development partners and other value chain actors an opportunity to understand the basic principles and steps in the provision of livestock feeds throughout the year by taking advantage of innovative climate smart technologies and improved water use efficiency and, taking appropriate actions to mitigate feed insecurity. For an effective and efficient livestock feed production industry and delivery system, knowledge on suitable feed and feeding options for various agroecological zones will be vital as we optimize the utilization of locally adopted and available feedstuffs throughout the year. Fortunately, the science, technologies and innovations required are available. Users of these guidelines will be led through a series of drivers that impact on specified pillars for livestock feed production leading to determination of appropriate interventions that address the various feeding challenges across the livestock feed value chain. The guideline is divided into 5 chapters: Chapter 1 introduces the general overview of the livestock feed production including the current situational analysis. Chapter 2 describes the key drivers that influence the Pillars of feed security; production, accessibility, utilization and stability. Chapter 3 describes how the pillars will address the livestock feed security while Chapter 4 gives the strategic interventions to circumvent perennial feed shortages. Chapter 5 describes the feed security outcomes.

It is envisaged that the guidelines will give new direction on livestock feed production, distribution and utilization across the Country which guarantees sustainable livestock feeds accessibility throughout the year for all ruminant species.

Bishar Fille Elmi, OGW

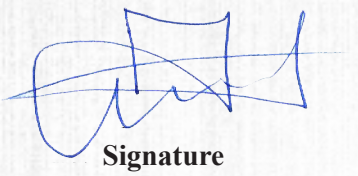
Director for Livestock Production

Acknowledgement

The Project Coordinators of the Emergency Locust Response Project (ELRP) and the Kenya Climate Smart Agricultural Project (KCSAP) appreciate the Technical Working Group (TWG) whose tireless efforts have made the development of this technical document on Animal Feed and Nutrition Security Guidelines a reality. The financial support from the World Bank and Kenya Government to support this process is highly appreciated. The participation of the State Department for Livestock Development, the Kenya Agricultural and Livestock Research Organization (KALRO), the Jomo Kenyatta University of Agriculture and Technology (JKUAT), Egerton University and the private sector is acknowledged for their consistent engagement from initial brainstorming workshops, technical design, development and dissemination. We recognise the guidance of the World Bank Livestock Consultant during the development of these guidelines.

It is from the vibrant and selfless engagements of the various stakeholders drawn from the State Department for Livestock Development, JKUAT, KALRO, UNIQUE Forestry and Land use GmbH, and Egerton University during this process that we have put forth visionary technical guidelines, with a view to setting the country on a trajectory that will ensure achievement of our national and county commitments towards sustainable and commercially-oriented Animal Feeds and Security system. Special appreciation goes to Albert Mulwa, David Yongo, David Palla, Domitila Njoki, Fredrick Aloo and Stanley Mutua of the State Department for Livestock Development, James Ondiek of Egerton University, Eric Mwatuni and Evans Mutuma of KCSAP, Douglas Indetie of ELRP, Dorine Ndinda of JKUAT, Benson Mulei and Paul Katiku of KALRO, Charles Odhong of UNIQUE Forestry and Land use GmbH, Joel Khobondo of the World Bank and John Muia, who contributed in the overall design and development of these technical guidelines. Those who have not been mentioned here, kindly take this acknowledgement as an expression of our sincere gratitude.

John Nginyangi
KCSAP National Project Coordinator



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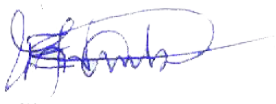

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Executive Summary

Feed and nutrition security exists when all livestock, at all times, have physical, social and economic access to feed which is consumed in sufficient quantity and quality to meet their dietary needs and feed preferences, and is supported by an environment of adequate sanitation, health services and care, allowing for a healthy and productive life. Feed and nutrition insecurity among livestock in Kenya has persisted overtime mainly due to; natural causes, economic situation and human activities.

These guidelines identify critical areas to improve ruminant nutrition in the face of climate change considering the essential and complementary role the feed sub-sector has to play for the sustainability of the livestock sector. The guidelines has five chapters covering the following:

CHAPTER ONE introduces the general overview of the livestock feed production including the current situational analysis. Livestock feeds and feeding is a key factor influencing animal production, health and reproduction. Availability of sufficient quantity and quality feeds that are accessible and affordable by livestock producers are key determinants of sustainable livestock production and productivity. Inadequate feed availability, access and utilization remain as key constraints to sustainable livestock production. Drought, which is usually associated with water and feed scarcity, is a frequent phenomenon and is a critical driver of feed and nutrition insecurity in Kenya.

CHAPTER TWO describes the drivers that influence the key pillars of feed production, utilization accessibility and stability. The main drivers of feed and nutrition insecurity include; poor rainfall performance, drought, overstocking, pests and diseases, land degradation, insecurity amongst others. An interaction of these factors has led to unsustainable feed availability, access and utilization leading to loss of body condition and high livestock mortalities.

CHAPTER THREE identifies key four pillars of feed security. These are availability, access, utilization and stability. The availability pillar comprises production, reserves, markets and imports components; whereas the access pillar consists of physical, social and economic components. The utilization pillar is determined by the level of value addition and processing, feed safety, quality, palatability, digestibility, hygiene, storage, and feed devoid of anti-nutritive factors; while the stability pillar covers the sustainability of the other pillars, which is manifested in the feed and nutrition outcomes which include - feed consumption index, body condition score and livestock mortality rates.

CHAPTER FOUR gives specific intervention options. They seek to flag out potential business opportunities for investment along the feed value chain. The intervention options under each category address the needs of the

target beneficiaries (individual farmers, pastoralists, agro-pastoralists/ groups, public and private service providers (extension agents), investors, various ruminant production systems, identified gaps for economic viability, and sustainability. These interventions are ordered thus - technical, institutional, policy environment as well as climate change approaches. The implementation of the interventions is expected to translate into improved feed and nutrition outcomes which include feed consumption index, body condition score and livestock mortality.

CHAPTER FIVE outlines the feed and nutrition security outcomes (cost savings, improved profitability, enhanced resource efficiency, enhanced competitiveness, animal welfare benefits, reduced environmental impact, improved resilience to climate change and, reduced overgrazing and land degradation.

In order to institutionalize feed and nutrition system in Kenya, a National Feed Inventory and Feed Balance Assessment which is a new and emerging innovation in the animal- agriculture sector, was conducted. The assessment results showed that Kenya is producing 46 million metric tonnes (MT) of DM as animal feed resources against the national feed requirement of 55 million MT of DM indicating a deficit of 9 million MT. The study further showed that competitive feed uses (alternative uses, wastages and losses) accounted for 46 % of the land feed production potential of 46 million MT of DM equivalent to 21 million MT of DM. Therefore, on actual basis, the amount of feed available to the animals within the country is 25 million MT of DM against a national feed requirement of 55 million MT as DM resulting in a 60 % feed deficit for the country, hence feed and nutrition insecurity.

CHAPTER 1

1.1 Background Information

The livestock sub-sector in Kenya plays significant role in the economy contributing about 10% to the Gross Domestic Product (GDP). The sub-sector accounts for over 30% of the farm-gate value of agricultural commodities, and employs over 50% of the agricultural labour force (KALRO, 2023). Additionally, with respect to livestock products marketing, meat production is the largest livestock enterprise with an annual output of approximately 702,090 MT valued at KES. 278.9 billion, followed by milk production at 4.1million MT valued at KES. 182 billion. Furthermore, other livestock products such as wool, hides and skins, and beeswax bring additional KES. 28 billion. The bulk of red meat comes from beef cattle with 67% being sourced locally and 33% imported mostly through porous borders. The capital value of the national animal resource base for the sub-sector is valued at KES. 795 billion while the total annual value of primary and value-added products and livestock by-products from all the livestock supply chains is estimated at KES 1,448 billion (USAID-KAVES, 2017).

The livestock population is distributed all over the country with ASAL hosting the majority. The ASAL comprises 23 Counties covering an area of 506,534 square kilometers of the land supporting 80% of the National ruminant population. Over 60% of the country's livestock herd particularly cattle, small ruminants and camels are under extensive production system in the ASALs. The Non ASAL consists of 24 counties which cover an area of 62, 605 square kilometers of the land constituting about 10% of Kenya's landmass and is home to about 20 percent of the national livestock ruminant population (GoK, 2022a).

The per Capita demand and supply of animal products and the projections are shown in Appendix 1. Currently, the per capita meat consumption is estimated at 16 kg, 4.5 kg and 110 litres of red meat, white meat and milk respectively (FAO, 2019). The country exports 22,000 MT of semi processed leather and leather products while 11,875 MT is exported raw. The consumption levels are expected to increase due to urbanization, improved incomes and population increase. According to the Kenya National Bureau of Statistics (KNBS, 2019), the national human population was approximately 47,584,296 and is projected to increase to 66,450,000 and 91,575,000 by the year 2030 and 2050, respectively. The per capita milk consumption is projected to grow from the current 110 litres to 150 litres and 180 litres over the same period, thus creating a demand for 10 billion litres above the current production of 5.5 billion litres under existing operational norms scenario by 2030. Without any gains in increased yields and output, domestic milk supply will fall short of demand by approximately 4.5 billion litres by 2030.

The number of dairy cows required to meet projected milk demand (per capita of 150 litres) in 2030 will be 4,506,103 with average milk production of 7.9 litres/cow/day under existing operational norms, and 1,779,910 herds of dairy cows with average of 20 litres/cow/day under aspirational scenario. With intensification the number of dairy herd will reduce but still meet the milk demand. Besides, beef continues to be the most popular red meat in Kenya, constituting up to 80% of the red meat consumed in the country. The bulk of beef production takes place in the Arid and Semi-Arid (ASALs) counties of Kenya which host 70% of the country's livestock herd. Beef production in the ASAL counties of Kenya is carried out mainly by pastoralists and large-scale ranches. Pastoralists produce about 80 % of the beef consumed in Kenya, while large-scale ranches produce another 2–5% and the remaining is produced by highland farmers as part of mixed farming (Mwangi *et al.*, 2022). In 2021 there were 16,182,356 heads of beef cattle at production of 244,217MT (GoK, 2022b). Average per capita meat consumption is 16 kg, but cities like Nairobi have the highest per capita beef consumption of up to 25 kg which is much higher than 11.5 kg in urban areas of Ethiopia (Deneke *et al.*, 2022). Per capita beef consumption is projected to reach 30 kg by 2050 hence the need to intensify production (FAO, 2019).

Intensification of livestock production is widely advocated to meet the increasing demands for livestock products. Livestock intensification involves practices towards feeding managements, disease control and use of improved breeds or cross breeding techniques. Substantial intensification of Livestock in Kenya, recognizes that there is a hierarchy in the triple bottom line. The economy is contained in the healthy people, and the people reside in the planet. Better cared for animals require less resources and can lead to reduction in GHG emissions and smaller environmental foot print. For livestock production, adoption of improved breeds that mature in short time reduces GHG emissions. The GHG emission reduction can be achieved through improvements in pastures quality. The GHG eductions are greater when grain finishing as is happening in feedlot and concentrate in the dairy industry is considered, Livestock production especially ruminants, further make efficient use of crop by-products through circular economy contributing further to environmental health. Manure management involve use of manure to generate biogas. The sustainable intensification promote data-driven management decisions with better livestock farming techniques, support farmers in sustainable food production, avoiding food losses and waste at farm level. This has raised profit margins for the farmer, thereby contributing to increasing agricultural share of national GDP. Seasonal feed availability, shortages of raw materials due to low production (especially protein sources), and water scarcity are a major hindrance to realizing optimal livestock production and productivity in Kenya, hence the proposed feed reserves, commercial fodder production, enhanced water access through irrigation, water harvesting and storage can be considered best practices.

1.2 Livestock Feed and Nutrition Situation in Kenya

Kenya's history is marked by recurrence of periodic droughts, which have been exacerbated in the recent past due to the escalating effects of climate change and variability arising from global warming. The ASALs bear the brunt of these effects, experiencing the greatest degree of devastation. These cyclic droughts have far-reaching socio-economic and environmental consequences, necessitating prompt and appropriate responses to safeguard lives, livelihoods and ecosystems that support sustainable livestock production.

Feeding is a key factor influencing animal production, health and reproduction. Poor animal nutrition remains a key constraint to sustainable livestock production in Kenya. The livestock feeds industry in Kenya has been growing steadily, attracting several new entrants every year due to the high demand for feeds posing danger as to the maintenance of the required feed quality standards. Numerous studies have shown that most enterprises are operated under poor animal husbandry and management practices resulting in malnourished animals whose production is well below the breed potential due to over reliance on seasonal rain-fed poor-quality forages. Natural pastures constitute the main feed resources for ruminants in most regions of the country. With only 20% of the country described as medium to high potential, the availability of these pastures varies with region and there is need for supplementary feeds in case of deficiencies. This calls for a lot of efforts towards ensuring availability of adequate feeding in order to enhance livestock productivity across all agro-ecological zones.

Availability of accessible and affordable feeds, in both quantity and quality is a key determinant of sustainable livestock production in Kenya. Drought, often associated with water and feed scarcity, is a frequent phenomenon in Kenya. Under the circumstances, lives and livelihoods of pastoralists suffer most. The increasing frequency and severity of droughts can mainly be attributed to the effects of climate change and variability. During such periods, the Government of Kenya as well as local and international development partners are always called upon for support with a view to protecting the lives and livelihoods of the affected communities.

However, most of the time, the exact animal feed requirements (fodder supply) in tons per year distributed by region, county and by specific livestock categories have not been determined with certainty as shown in Appendices 2 and 4. In this regard, the State Department for Livestock in collaboration with the Food Agricultural Organization (FAO) initiated the National Feed Inventory and Feed Balance Report in the 47 Counties that determined the livestock species, available feed and the subsequent shortfall in each County (Appendix 2). This document can then be used to plan for the feed shortages and annual distribution across all counties. Therefore, current status is attributed majorly to inadequate livestock policy to allow for regular feed assessment with intent to plan for envisaged shortages and inform conservation strategies. Consequently, the programming of drought related livestock feed repositioning for effective and efficient response options become increasingly important. However, the said programming is not sustainable. Hence the need for a paradigm shift from emergency responses to resilience building.

The key determinants to sustainable livestock productivity include availability of quantity and quality feeds as well as their affordability by smallholder farmers. Feeds alone account for between 60 and 80% of the total production costs for any livestock production enterprise (Association of Kenya Manufacturers [KAM]). Adequate feeding entails ensuring that the diet supplies all minerals as well as meeting the energy and protein requirements of the animal, which directly influence the health, fertility and productivity of livestock.

Thus, the animal feed industry needs to be better re-positioned for commercialization and competitiveness in the region by providing strategic guidance for improved feed policy and legislative environment. In an effort to drive sustainable feed value chain development and in line with one of the national big four agenda on food (feed) and nutrition security for our country, it has become necessary to develop a national feed strategy with a view to guiding the feed industry development for investment in Kenya. Further, production of animal feeds has a consequence on land use and land use change whose effect may lead to decreasing greenhouse gas (GHGs) emissions that contribute to global warming and climate change. The animal feed industry is therefore expected to mainstream emission reduction strategies for sustainable livestock production and productivity. The livestock sub sector has great potential to contribute to food security, income generation and wealth creation vide products such as, meat, milk, eggs, hide, skin, wool, blood, hair, manure and feathers that are used raw or processed. The animals also provide essential draught power in 70% of smallholder farms in the region.

1.3 Annual National Feed Demand and Supply

Kenya covers an area of 582,646 square kilometers and hosts 92.2 million heads of ruminants (5.1million dairy cattle, 21.65 million beef cattle, 25.3million sheep, 662,000 dairy goats and 35.4 million meat goats, 4.7 million camels among other livestock species). Non-Ruminants which include poultry (57.2 million), pigs (649,000), and rabbits (725,000) are produced under intensive or semi-intensive production systems. The non-ruminants mainly depend on non-roughage feeds (cereal and cereal by-products) placing them in direct competition with human beings for food.

The Kenya Feed inventory and feed balance assessment showed that Kenya is producing 46 million MT DM of animal feed resources against national feed requirement of 55 million MT DM indicating a deficit of 9 million MT DM. The competitive feed uses (alternative uses, wastages and losses) accounted for 46% of the land feed production potential of 46 million MT DM equivalent to 21 million MT DM. Therefore, on actual basis, the amount of feed available to the animals within the country is 25 million MT DM against a national feed requirement of 55 million

MT DM resulting in a 60% feed deficit, hence feed and nutrition insecurity.
This guide is therefore, intended to give practical interventions to address sustainable feed production and utilization for enhanced livestock productivity and improved livelihoods. The guide will target county governments to invest in appropriate interventions towards addressing perennial feed scarcity.

1.4 Feed and Nutrition Security

Feed and nutrition insecurity is a major hindrance to livestock production and productivity. Feed and nutrition security exists when all livestock, at all times, have physical, social and economic access to an adequate quantity and quality of feed which meet their dietary requirements and preferences, and is supported by an environment of adequate sanitation, health services and care, allowing for a healthy and productive life.

The main animal feed resources consist of roughages, concentrates, minerals, water and vitamins. Ruminants, in particular, rely heavily on roughages primarily derived from pastures, browse, fodders and crop-residues. Concentrates on the other hand serve as highly nutritious supplements to roughages and other feeds. They are compounded from energy and protein rich feedstuffs. Concentrates can be produced at farm level as well as commercially. Commercial concentrates are expensive and therefore the level of usage among smallholder producers is low.

To overcome the challenges posed by feed shortage, it is imperative to reduce reliance on rain fed feed production considering the recent erratic weather patterns resulting from climate change. As a solution, the implementation of irrigation either from the rivers, harvested water from the water pans/dams or other sources harnessing runoff is recommended. There is also great need to conserve fodder and grasses using various methods of hay, silage, haylage, pelleting and feed blocks/cubes for use during times of scarcity. In this regard, appropriate storage and distribution strategies should be put in place to facilitate the movement of feeds from regions of plenty to those experiencing deficits. This should be informed by a well-tailored information and data system that tracks feed availability, utilization and deficit so that relevant timely actions can be undertaken to avert loss of body condition and mortalities that have a direct effect on marketability of livestock and their products. A policy on regular inventory on livestock numbers and available feed stuff on a regular basis to inform contingency planning and some legal framework to allow for the enforcement of regulations within the livestock feed sector. The drivers of the feed insecurity, including natural fires, natural phenomena of floods and drought, diseases, land degradation, overstocking among others contributes to livestock feed shortages.

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CHAPTER 2

Drivers of Feed and Nutrition Insecurity

Drivers of feed and nutrition insecurity are the triggers contributing to livestock feed scarcity. Feed and nutrition insecurity in Kenya has persisted overtime mainly due to natural causes, economic situation and human activities. An interaction of these factors has led to unsustainable feed availability thus leading to high livestock mortalities. The drivers include climatic seasonality especially rainfall and drought, pests and diseases, unavailability and high costs of inputs, overstocking, feed resource losses, land degradation, insecurity and conflicts, invasive plant species, migration, land fragmentation, and poor feed planning and budgeting. Their effects are highlighted below.

2.1 Rainfall Performance

Climate change has resulted in variations in intensity, duration and frequency of rainfall and rainfall distribution. This has resulted to changing rainfall patterns characterized by delayed onsets and early cessation of rains as well as shortening the length of forage growing period. This has implications on pasture establishment, thus affecting rangeland regeneration, which is highly rainfall- dependent hence limiting livestock feed availability all year round. In Kenya, ASALs are more dependent on the short rains which have subsequently failed from 2020 while other regions have experienced depressed rainfall.

Progressive decline in precipitation has led to shrinkage and reduction of natural pastures resulting in deistitution of pastoral communities.

2.2 Drought

In Kenya, drought has been increasing in frequency and severity over time due to the effects of climate change and variability. This has led to land degradation resulting in limited establishment of pastures, making livestock feed availability a major challenge in livestock producing regions. The current drought has led to lowered marketability of livestock due to loss of body condition and in some cases increased livestock mortalities have been observed (Appendix 3). This has resulted in loss of livelihoods and household food and nutrition security. Kenya has reported 2.6 million livestock deaths, valued at KES. 37.7 billion in 2022. Due to the impact of previous cumulative failed rainy seasons, the livestock mortalities have averaged 20% of all the livestock population. The mortalities have been attributed to severe vegetation loss due to the extended dry spells coupled with increased trekking distances to water points. The resulting loss of livestock genetic diversity coupled with dilution or loss of adapted genes pose real threat to genetic pool of the national livestock population.

2.3 Pests and Diseases

With changing climate and ecological equilibrium, there has been emergence of new pests and diseases which have critically affected pasture performance, thus limiting the establishment and yield of pasture species. In the past two years, locust infestation destroyed approximately 3.4 million hectares of pasture and forage crops. The fall army worm has been reported to attack rye grass while the red spider mites infest Brachiaria grass (Mulato II) (Photo 2.1). The net effect of these occurrences is reduction in the quantity and quality of feeds available for livestock..

Locust | Red spider mite | Fall army worm

Photo 2.1. Examples of forage pests

2.4 Unavailability and High Cost of Inputs

Inputs are essential for feed production and constitute a significant proportion of production costs. Some of the key inputs required to ensure efficient production include seeds, machinery (tractors, balers), herbicides and fertilizers. Due to high cost of inputs, there is inconsistent supply and use of some of the key raw materials such as oil seed cakes and fish meals that are good sources of minerals, vitamins and amino acids, which have a major role on feed quality. Prolonged droughts coupled with overgrazing in the ASALs has resulted to the loss of important range grasses. However, attempts to restore the rangelands through reseeding with superior range grass species such as *Cenchrus ciliaris* (Fox tail grass), *Enteropogon macrostachyus* (Rye grass), *Eragrostis superba* (Maasai love grass), *Chloris roxburghiana* (Horse tail grass), *Themeda triandra* (Red Oats grass) and *Panicum maximum* (Guinea grass) though has not achieved much (Mnene, 2006), is a growing effort. The reseeding programmes have been hampered by limited capacity to produce and supply the grass seeds. Additionally, taxation of imported raw materials and machinery required for feed production has further made inputs unaffordable to farmers. This has limited both production and access levels of livestock feed in many regions.

2.5 Overstocking

The livestock populations in the Counties are shown in Appendix 4. According to the National Feed balance report of 2022, Kenya is currently supporting 24 million Tropical Livestock Units (TLUs) while the country has a potential of supporting 20 million TLUs. On actual basis, the land can only support about 11 million TLUs, implying overstocking.

Overstocking occurs when the number of livestock kept exceeds the land carrying capacity over time. This has been caused by migration of livestock in search of pasture and water, poor grazing management and pastoral culture. This has resulted to increased pressure on available feed resources as well as water, and land degradation. Community land (communal grazing), and cultural practices have made it difficult to control overstocking among pastoralists and agro-pastoralists, thus sustaining pressure on the available feed resources.

When overstocking occurs regularly, it results in overutilisation of the preferred grass species, not allowing them to seed, therefore depleting the natural grass seed banks. Consequently, this favours the sprouting and establishment of invader species which are not palatable thus reducing feed availability. High concentration of livestock also results in increased soil erosion further reducing pasture establishment after the long rains due to loss of top soil.

2.6 Feed Resource Losses

Post-harvest feed resource losses whisch include alternative uses other than as livestock feed and wastage account for about 46% of the total feed produced (GoK, State Department for Livestock Development, Unpublished). This occurs through burning of pastures and crop residues, poor feeding methods/structures and poor storage, thatching, and limited access to nutritious components e.g. acacia and prosopis pods that end up wasted. Poor feeding techniques and management as well as selective grazing also leads to wastage during feeding, which has implications on the availability of livestock feeds as demonstrated in Photo 2.2. The loss is equivalent to about 20,962 million MT, which can support about 9 million TLUs valued at KES 273 billion. In terms of bales, the lost DM is equivalent to 1.6 billion bales, valued at KES 822 billion.

Photo 2.2. Example of wasteful livestock feeding.

2.7 Land Degradation

Land degradation from over-grazing, under-grazing and deforestation has greatly affected rangelands productivity in Kenya as exemplified in Photo 2.3. This has been attributed to natural causes such as climate change, human settlement, intense rainfall, aridity, desertification and increased drought severity. Other causes include inefficient agricultural activities including poor soil-water management practices and overstocking. The result of this is soil erosion, increased sediment loading of water bodies, loss of soil fertility, salinity, reduced ground cover, inadequate quantity and quality of pastures and fodder, and reduced land carrying capacity. The impacts of land degradation include reduction in fodder and pasture productivity which are closely linked to poverty and feed insecurity.

Photo 2.3. A degraded showing denuded land and gulley.

2.8 Insecurity and Conflicts

Insecurity has resulted in displacement and loss of livelihoods, contributing to non-sustainable resource utilization. This has resulted in ineffective resource access and utilization leading to risk of encroachment of invasive species which have depleted pasture biomass yield and quality as well reducing their accessibility. This has led to overstocking in the secure areas where there is migration. There is also disruption due to conflicts leading to poor access to livestock markets and inputs.

2.9 Invasive Plant Species

Emerging invasive and parasitic plant species have rapidly depressed pasture establishment in the rangelands causing pasture inadequacy, hindering access and hampering regeneration. This is because these plants are not palatable to livestock and in some cases they could be poisonous. The most prevalent invaders are *Ipomea pandurata, Acacia reficiens, Prosopis juliflora, Cuscuta japonica* among others as shown in Photo 2.4. The invasive plant species cover substantial land areas in the country. The lack of control of these invasive species has led to massive expansion and colonisation of pastureland in the range lands reducing the available feed. Most of the desired grass species have been suppressed and others have depressed biomass performance and are of low quality. The frequency of uncontrollable invader species has increased due to climate change coupled with poor management practices.

Ipomea (*Ipomea pandurata*)

Prosospis (*Prosopis juliflora*)

Japanese Dodder plant (*Cuscuta japonica*)

Photo 2.4. Invasive plant species affecting livestock feeds availability

2.10 Migration

Lack of feeds and water has consistently led the pastoralist migrating with their animals in search of these necessities. Some of the livestock move within or across counties, in some instances, the migration can happen across international borders. Pastoralists near the borders find it easier to cross to the neighbouring countries to fend for their livestock. This migration also leads to conflicts due to competition for resources. Also, there is loss of marketable weight due to loss of body condition as a result of the long walking distances.

2.11 Land Fragmentation

Land fragmentation involves the sub-division of agricultural land into smaller uneconomical units. This consistently reduces the available land to produce livestock feeds. Population pressure and urbanization is the main cause of land fragmentation. The adverse effects of this is reduction in agricultural production and productivity due to uneconomical scales of production. The sub-divided land sizes therefore leave little or no area for livestock feeds production thus leading to feed and nutrition insecurity.

2.12 Poor Feed Planning and Budgeting

Poor or lack of contingency planning in preparation for feed deficits is a serious challenge that contributes to feed inadequacy. Generally, there are no budgeting and setting aside funds to cater for periods and circumstances of feed deficits. Limited access to inputs and lack of subsidies on feed production has also diminished feed access. Limited data on the current livestock feed requirements and knowledge of the production potential of the available land make it difficult to have proper plan for the intervention strategies.

Poor feed conservation practices, lack of knowledge on appropriate feed and feeding practices, and inadequate data on appropriate number of animals kept within specific production systems (stocking rate) constrain the efficient use of available feed and water resources. Thus proper planning and budgeting should embrace strategies to circumvent feed shortages and inefficient feed use. The vagaries of climate change are also negatively affecting the natural resource base especially in the fragile rangelands where 80% of the livestock are found. This should not be ignored in the planning.

In Chapter 3, issues affecting feed availability, access, utilization and stability are addressed as pillars that support proper livestock production management to enhance feed and nutrition security. It is envisaged that understanding the contribution of each of these pillars and how they interrelate are key to sustainable livestock production.

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CHAPTER 3

Key Pillars and Strategic Issues on Ruminant Feed and Nutrition Security

Successful feeding and good nutrition of ruminants depends on key pillars and issues that the National and County Governments should address. The four pillars that support feed and nutrition security are derived from the Integrated Food Security Phase Classification (IPC) framework (Appendix 5). They are (i) availability, (ii) access, (iii) utilization and (iv) stability. The results of the interactions between shocks and vulnerabilities or the drivers in Chapter 2 directly impact on the pillars. Identifying and analyzing the critical issues that limit feed security and nutrition under each pillar and their causal factors is an essential enabler to a better design of interventions for seeking solutions.

3.1 Pillar 1: Feed Availability

Feeds for ruminants are primarily from natural pastures, fresh and/or conserved grass/ fodders, farm by-products., and concentrates. Feed availability means sufficient quantities of appropriate quality for livestock feeding from domestic production and imports. The pillar addresses whether the feed is actually or potentially physically present for purchase or acquisition for consumption. It encompasses feed production, reserves, imports, markets, and transportation. The following are the critical issues under the feed availability pillar and their causal factors.

3.1.1 Strategic Issue 1. Low Feed Production

The following are among the major factors contributing to low feed production.

i. The lack of or limited accessibility of inputs, including clean and certified seeds, fertilizers/ manure to improve soil fertility, appropriate technologies, Innovations and Management Practices (TIMPs), pasture and fodder species, farm implements, tools and mechanization hindes the ability of farmers to produce adequate and nutritious feeds for livestock. It leads to low yields of pastures and fodder and thus limiting the potential for ruminant production and productivity.

ii. The lack of or limited investment and commercialization of feed production impedes the growth and profitability of the livestock feed industry, as well as limits feed production

iii. Limited efforts in the restoration of rangelands coupled with the adverse effects of climate change have led to excessive expansion of invasive and parasitic plant species, such as *Prosopis juliflora* (Mathenge), *Ipomea pandurata* (Indian Potato/Wild potato vine), *Lantana camara* (Lantana) Cactus and *Custcuta Japonica* (Japanese Dodder). These invasive species cause severe damages to pasture lands and grazing areas, further reducing their availability and quality.

iv. High incidences of diseases, such as rusts, maize lethal necrosis, head smut, and pests like locusts, and fall armyworms, negatively impact forage quality, productivity, and the production economy..

v. Non-pathogenic conditions, including air pollution, nutrient deficiencies, water stress, extreme temperatures, and mineral toxicities, also significantly impact fodder yields and quality.

vi. The occurrence of conflicts and insecurity in feed producing areas disrupts production activities and limits the availability of feeds to ruminants

vii. The breakdown of community governance structures over land tenure systems and utilization leads to overgrazing, thus causing land degradation and loss of fertile soil for feed production.

viii. Land fragmentations into uneconomical units especially in the high potential areas limit feed production

ix. Adverse effects of climate change and environmental shocks such as droughts, floods, and wildfires on fragile ecosystems limit feed production.

x. Over-reliance on rain-fed forage production and high dependence on natural pastures with low biomass yield. The impact is particularly severe during the dry season

xi. High post-harvest losses

xii. Poor and inadequate feed planning and budgeting for sustenance

3.1.2 Strategic Issue 2. Limited Feed Reserves

Having strategic feed reserves for use during periods of scarcity is an important consideration for sustainable livestock productivity. Below are some of the major factors contributing to the lack of or limited availability of strategic feed reserves:

i. Insufficient feed reserves due to low production and poor or limited storage facilities can lead to feed shortages during droughts, floods, and other natural disasters. Often this causes deterioration of livestock body conditions hence low value of affected livestock. In extreme situations, there are high mortalities as a result.

ii. Low adoption of feed conservation technologies lead to losses both in amount and quality of what would be potentially available. Limited quantities of feeds conserved often result in reduced feed availability for livestock throughout the year or when weather calamity strikes. Without appropriate conservation, there are spoilages and depreciation that reduce nutritional value and 'shelf-life'.

iii. Lack of or poor planning and budgeting for feed availability implies that insufficient resources are allocated to feed production, conservation and storage activities, resulting in wastage and feed shortages.

3.1.3 Strategic Issue 3. Feed Import Barriers

Feed resources required for specific and strategic production in the livestock industry may not be available locally. Thus importation of certain feeds or ingredients may be necessary. However, the following are among the major factors contributing to feed import barriers:

i. Unfavourable trade tariffs and taxes make imported feeds and feed ingredients more expensive and less accessible, reducing feed's affordability and availability, especially for smallholder farmers. The import barriers reduce economic growth and development, making it harder for countries to benefit from international trade.

ii. Lack of or non-streamlined strategies for importation results in the inefficient and ineffective supply of imported feeds and ingredients. Consequently there are high costs, delays and disruptions in the supply chain. This is often a big hindrance to smallholder farmers, who predominate the industry.

iii. Existence of inter-County levies and taxes during transportation restrict trade in feed resources among the Counties.

3.1.4 Strategic Issue 4. Unstructured Feed Markets

Market availability is crucial for accessing feeds that may not be available at farm level. This may not be the case. Below are some of the factors contributing to unstructured feed markets:

i. Hoarding, monopoly, unhealthy competition, inefficiency in the supply chain, brokerage and protectionism result in demand and supply in-equilibrium, leading to artificial feed shortages and uncertain price volatility. These imbalances lead to temporary deficits or surpluses, and prices may take time to adjust to reach the new equilibrium point.

ii. Limited availability of favourable credit hampers investment in the feed industry and makes it difficult for value chain actors to access finance to purchase inputs.

iii. Poor markets, poor market information networks and limited market research impede the transparency of the feed market, making it difficult for value chain actors to access information on availability and prices feeds, hence compromising availability.

iv. Unfavourable national and County Covernment levies create an additional cost burden for stakeholders and inhibit investment in the feed industry.

v. Lack of or limited organized feed distribution strategies and mechanisms from points of plenty to points of scarcity can lead to unavailability though the feeds exist and are unutilized elsewhere.

3.1.5 Strategic Issue 5. Inefficient Feed Transportation

Transportation can be an important determinant of feed availability. Inefficient transportation can be because of many factors, some of which are outlined below:

i. Poor road networks limit feed transportation to markets and increase transportation costs. It also causes unnecessary delays. It can cause significant negative social, economic and environmental impacts.

ii. Limited specialized modes of feed transportation constrain the efficiency and speed of transport. This can lead to increased feed contamination and spoilage, increased prices and reduced profitability.

iii. Insecurity along feed transportation corridors can cause great social, economic, and environmental impacts. Lack of security measures along transportation corridors leads to high transportation costs, reduced feed availability, and slowed economic growth and development.

iv. High transportation costs, poor quality transport and road safety risks can compromise feed availability if not moderated.

3.2 Pillar 2: Feed Access

This pillar refers to the ability of livestock to obtain feed that meets their dietary needs and preferences. Once the feeds are available, the next question is how it can accessed through different food sources (e.g., production, purchases, gifts, aid, gathering, or other forms) and whether enough can be obtained.. The ability to access enough feed will directly depend on physical access (e.g., own production and from reachable markets), financial access (e.g., purchasing power and access to credit), and social access (e.g., ability to secure feed through social networks and/or based on extended family, ethnicity, religion or political affiliation). Feed security requires that livestock keepers have access to feeds regardless of their economic or social status.

3.2.1 Strategic Issue 1. Limited Physical Access to Feeds

The following factors contribute to limited access to feeds:

i. Limited mobility due to insecurity, poor road network, and lack of appropriate transportation options such as trucks, trains, and boats, and unscrupulous transporters can limit the physical accessibility to feed resources.

ii. Limited information and communication by farmers unaware of the various types of available feeds and how or where to access them may cause a struggle to access and provide adequate nutrition to the domestic

ruminants.

iii. The cost of transporting feed to remote areas can be very high, as these areas may be far from major feed markets or feed centers. People who live in rural or remote areas may have limited access to feed because of the distances involved to the supply sources.

iv. Lack of or limited planning and budgeting leads to feed shortages, insufficient inputs, and funds availability to produce feeds. Failure to plan appropriately leads to not having the right animal feed mix.

v. The unfavourable weather conditions coupled with poorly maintained roads or lack of footpaths, bridges, or culverts crossings can make it difficult for people to access feed stores physically

vi. Competition of wildlife and livestock over natural pastures and predation particularly in the rangeland can be a hindrance to reaching some desired niches and localities.

3.2.2 Strategic Issue 2. Limited Social Access to Feeds

Social norms and interactions in the operating environments are important considerations for accessing available feed resources. Some of the factors contributing to limited social access to feed can be:

i. Gender biases that may lead to inequality in land ownership, accessibility and utilisation, thuslimiting some genders e.g. women to play appropriate roles.

ii. Drug and substance abuse can lead to financial constraints, neglect of livestock (ruminants).

iii. Issues such as mental health can constrain ability to access feed resources and markets.

iv. Most smallholder farmers have low technical skills and knowledge in feed production and conservation, as most rely on natural pastures.

v. Retrogressive cultural practices can be a challenge. For example, communities that believe in Female Genital Mutilation (FGM) may restrict the ability of women to participate in feed production. Additionally, beliefs in witchcraft and other negative cultural practices may impact access to feed resources.

vi. Ethnicity can also be a factor, with minority communities sometimes being segregated and facing challenges in accessing resources for feed production.

vii. Cattle rustling and insecurity can also disrupt feed access production and limit the ability of farmers to produce enough feed for ruminants.

viii. Changes in land use and land tenure systems restraining access to grazing land and pastures.

ix. Marginalization of some areas constrain access to services, inputs and markets with overall effect on access to ruminant feed resources

x. Limited inclusion of women and youth as key players in the feed value chain can be a hindrance, particularly if labour from these sources are not optimized in the production.

3.2.3 Strategic Issue 3. Limited Economic Access to Feeds

The economic environment and capability can be varied and may contribute highly to ability to access feed resources. Some of the considerations are highlighted beleow:

i. Farmers with limited financial resources may struggle to afford high-quality commercial feeds in sufficient quantities because of the high costs involved. This is further confounded by high transportation costs.

ii. Limited Access to market information and research makes it difficult for farmers to decide what feed to purchase, the alternative feeds available, and the current market prices. Also, for less informed farmers, there may difficulty to negotiate fair prices.

iii. Unscrupulous business practices have a significant impact on feed access. Such businesses include fraudulent practices in the sale of inputs and unethical behaviour by middlemen in the sale of feeds, which negatively impact farmers' profitability.

iv. Competition of food and feed between animals and humans limit the access of feeds to ruminants

3.3 Pillar 3. Feed Utilization

This pillar refers to the ability of livestock to utilize the feeds they have access to in a way that meets their nutritional and productive needs. When feed is available, and ruminants have adequate access to it, the next question is whether animals are maximizing the consumption of sufficient nutrients (carbohydrates, proteins, minerals, vitamins), which is usually a factor in feed quality, safety, processing/ preparation and feeding practices. Availability and access to water is also an important factor that influences the proper utilization of other ingredients. Some of the strategic Issues are highlighted below.

3.3.1 Strategic Issue 1. Poor Feed Quality

The quality of feed resources or ingredients therein can be a hindrance to proper utilization. Therefore, there are some important considerations to enable optimal utilization of the feeds maximize nutritive values.

i. Poor feed handling (processing, conservation, feed formulation, storage, transportation, adulteration) leads to spoilage, nutrient loss and contamination, thus reducing the quality of the feed. These negatively impact on proper utilization by the ruminants.
ii. Few of the operational laboratories are not accredited, can analyse limited quality parameters, are located far from the farmer, take long periods to analyse samples, and the high cost of analysis is prohibitive, particularly to the small-scale farmer
iii. Limited skills of the feed business operators can lead to inefficiencies, poor quality feeds, and reduced profitability.
iv. Limited regulation of feed business operators leads to substandard feeds, reduced productivity, and increased incidence of nutrition related diseases of affected ruminants.
v. Few watering points and/or contaminated water sources. This can cause adverse effects on affected ruminants that often include malnutrition, poor health and mortality.

3.3.2 Strategic Issue 2. Unsafe Feed Resources

Feed safety is not only a national concern but also an issue of global concern affecting trade and commercialization. The major factors contributing to unsafe feed resources are highlighted below:

i. Poor feed handling and contamination during processing, conservation, storage and transportation. Common contaminants include mycotoxins, harmful microbes, pesticide residues, heavy metals and petroleum products.
ii. Feed adulteration causes changes in quality and most often compromises feed safety
iii. The few accredited laboratories are in urban areas, and most cannot handle feed safety issues.
iv. Harmful deposits from industrial processes and mining activities resulting to air, water and feed pollution.

3.3.3 Strategic Issue 3. Inadequate and Inefficient Feed Processing and Value Addition

Value addition should be strategic and target realizable benefits arising from utilization of a given product. However, this is often not the case if the processing is not appropriate. Some of the issues arising from processing that compromise proper utilization are highlighted below.

i. Low level of mechanization leads to inefficient feed processing leading to reduced productivity and (chaff cutters, panga)
ii. Limited Access to quality feed ingredients leads to production of substandard feeds, reduced productivity, and increased incidence of animal diseases, some of which can be zoonotic.
iii. The high cost of modern feed technology, equipment, and electricity limits the adoption of new technologies.
iv. Limited technical skills in feed formulation, processing, and value addition lead to production of substandard

feeds.

v. Multiple and non-harmonised licensing requirements by different agencies constrain feed processing and value addition business. As a results, there is scarcity of authentic manufacturers or outlets especially in the rural areas where the services are needed most.

3.4 Pillar 4. Feed Stability

The stability pillar refers to the ability of the ruminant feed system to withstand shocks and stresses without disrupting feed availability, access, or utilization. Once the last three pillars (availability, access and utilization) are embraced,, the next crucial worry is the stability of the system. A stable system should ensure the ruminants are and will always be feed- secure, including during future forecasts. Stability should be forecasted in the short, medium, and long term. Adverse effects of climatic change, unfavourable economic factors, undeveloped Feed Markets, weak institutions, unfavourable policy, the legal and regulatory environment, social and political factors can all be sources of instability. Below are some of the strategic issues surrounding stability of ruminant feed and nutrition security that are important to consider.

3.4.1 Strategic Issue 1. Adverse Effects of Climate Change

Climate change is a reality and can cause cross-cutting effects across the pillars. Some of important aspects to consider include:

i. The degradation of ecosystems, encroachment by invasive and alien plants, intensification of floods and droughts, increased pests and disease incidences, and depletion of natural resources. These aspects lead to increasing uncertainty about forage yields and quality as well as water availability.
ii. Inadequate attention to sustainable rangeland management and conservation as a factor in preserving their contribution to the ruminant feed and nutrition security, especially in ASALs.

3.4.2 Strategic Issue 2. Poor Economic Performance

The prevailing economic situation is a major determinant of the interactions among the players in food and nutrition security not only for the livestock but also for human players involved along the value chains. Below are some of the issues to be considered.

i. Poverty and insufficient purchasing power due to low returns from livestock farming, high level of unemployment, low wage for workers.
ii. The lack of favorable policies and environment that promotes feed resources and ruminant development
iii. Continuing insecurity of land tenure and access to land, water and other natural resources, particularly for women and youth involved in agricultural and livestock production.
iv. Insufficient investment in the feed sub-sector and rural infrastructure for both the small-scale feed producers, agro-pastoralists and pastoralists.
v. Low farmer incomes emanating from low ruminant production and productivity

3.4.3 Strategic Issue 3. Undeveloped Feed Markets

The option of having developed and functional feed markets can ensure stability in feed availability and access. However, there is lack of developed markets for feeds. Some of the challenges to consider include:

i. Low or lack of market networks that are transparent and regulated
ii. Poor infrastructure and limited market information resulting to lack of awareness. This leads to constrained trade in feed resources that can stabilize the industry.
iii. Existence of many feed resources whose distribution, availabilities and qualities are uncertain.

3.4.4 Strategic Issue 4. Weak Research Institutions

Research plays crucial role for continuous development in animal feed and nutrition industry. Improvements in genetic potential of domestic ruminants should be matched with feeding and nutrition technologies developed through research. The following are some aspects in weak research institutions that need consideration:

i. Low research and innovations in feed technology development deprives the feed production industry scope for improvement. Enhancing the available feed and fodder germplasm adapted to various environments is a perpetual necessity. Application of research results from universities and institutions if embraced would augment new developments.
ii. Poor strategic research technology dissemination and capacity-building opportunities limit the uptake of new ventures and processes.

3.4.5 Strategic Issue 5. Unfavourable Policy, Legal and Regulatory Environment

This section contains some of the factors contributing to the unfavourable policy, legal and regulatory environment:

i. Poor compliance with feeding quality and safety standards reduces farmers' trust in feed products, thus limiting the growth of the feed industry.
ii. Unfavorable terms of trade for the import and export of ruminant feeds and feed ingredients increase the feed production cost, hence reduce the livestock industry's competitiveness.
iii. Poor implementation of regulations governing the use of new or non-conventional feed resources restrains their exploitation, thus reducing the potential for developing alternative feed resources
iv. Unfavourable policies on land use, rangeland conservation, and idle land constrains access to land for feed production, thus reducing the potential for expanding feed production. The current land subdivision in the country that does not restrict land fragmentation has resulted in parcels that are uneconomical for agricultural production.
v. Insufficient investment in the feed sub-sector and rural infrastructure for both the small-scale feed producers, agro-pastoralists and pastoralists
vi. Inadequate political commitment and prioritisation of feed and nutrition security including failure to fully implement past pledges, promises and insufficient accountability.

3.4.6 Strategic Issue 6. Negative Social Factors

The major social factors contributing to feed and nutrition security instability are covered in this section and they include:

i. Insufficient attention paid to the role and contribution of women and their special vulnerabilities. These are confounded by the many forms of legal and cultural discrimination they suffer
ii. Population growth, urbanization and rural-urban migration
iii. Lack of or limited opportunities for diversification of livelihoods, and growing inequalities between population groups in the country
iv. Low levels of education and literacy impacting poor feed production practices, conservation, and utilization
v. Slaughter of animals with poor body condition and consumption of uninspected and certified to be fit predispose vulnerability to diseases and malnutrition.
vi. Cultural beliefs that keeping of large herds is prestigious which in essence is detrimental to the environment

3.4.7 Strategic Issue 7. Unfavourable Political Situation

Political stability creates enabling environment for human livelihood operations. Without political stability, there would uncertainty in any undertaking. Normal operations rely on inter-dependence, which can be critically influenced by the prevailing political, some of which are highlighted:

i. Existence of curtails that are influenced by political inclination (perceived or actual)
ii. Manifestos that may not be favourable for some critical aspects
iii. Political patronage that may not be supportive
iv. Resource based conflicts that may take diverse and conflicting political support

Lack of or limited political commitment and prioritization of the feed and nutrition security. This can include failure to conduct frequent reviews and partial implementation of past commitments as well as insufficient accountability.

CHAPTER 4

Strategic Interventions to Address Ruminant Feed and Nutrition Insecurity

This chapter focuses on the possible intervention options to address the strategic issues highlighted in the four pillars (availability, accessibility, utilisation and stability) covered in Chapter 3. The interventions address the needs of the national and county stakeholders. The stakeholders include individual farmers, pastoralists, agro-pastoralists, public and private service providers and investors. Considerations embrace agroecological zones, ruminant production systems, economic viability, and sustainability under the prevailing climate change challenges. The involvement of the public and private sectors, development partners, institutions (research, universities), public-private partnerships (PPPs), cooperatives, and the farming community will be critical to implement the interventions successfully. Their involvement will hinge mainly on ensuring an enabling policy and regulatory framework, effective coordination, monitoring and evaluation, research and extension, data and communication, infrastructure, funding, and capacity building to catalyse the adoption of the interventions. The interventions are to improve ruminant nutrition, increase performance (survival rates, growth, fertility, milk production), and enhance food and nutrition security, incomes, and livelihoods of the farming community and other stakeholders.

4.1 Pillar 1. Feed Availability

Feed availability is influenced by production, feed reserves, markets, and transport system, among other factors. The following are the interventions to address issues in feed shortage or un-availability:

4.1.1 Intervention 1. Strategies to Increase Feed Production

i. Increased forage seeds and planting material availability:

- Facilitate seed production and multiplication - create an enabling environment for public-private partnerships (PPPs) on forage seed multiplication and distribution to thrive at the county level
- Create efficient functional partnerships between KALRO, universities on the one hand, and seed companies and other private seed multiplication and distribution enterprises to promote the commercialisation of forage seed production
- Organise seed fairs and field days at county and community levels to create awareness and establish linkages for forage planting material access
- Establish strategic community and county seed banks
- Review existing laws and policies concerning the certification of institutions to produce and sell seeds and other forage planting materials (reduce the long bureaucracy) and exempt indigenous forage seed systems

from the bureaucracy. Also, minimise bureaucracy on forage seed and planting material importation

- Develop new promising forage varieties with better nutrient profiles through innovative plant breeding technologies (to seek and establish partnerships with research institutions)
- Introduce science in seed development, e.g. biotechnology
- Increased availability of necessary machinery, equipment, implements and ICT technologies (feed mixers, forage harvesters, hay balers, mowers, silage balers, etc.) (Photos 4.1, 4.2, 4.3 and 4.4)
- Incentivise the domestic "jua kali" sector and equipment distributors to innovate on simple locally manufactured feed implements suitable for small-scale operations

Photo 4 1. Hand-held tractor

Photo 4 2. Hay baler

Photo 4 3. Hay baler

Photo 4 4. Electric feed chopper
(Source KALRO- Kiboko)

- Tax exemption on importation of feed value chain machinery, equipment and implements
- Develop organised service provider groups to support the livestock feed value chain by hiring out of services, developing forage producer groups, and advocating for synchronised value chain activity rollout.
- Update, out-scale, and promote KALRO crop suitability advisory maps (Available at Android Apps on Google Play and website: https://selector.kalro.org/)
- Minimise regulatory requirements for the importation of forage seeds and planting materials.
- Certified seed producers to decentralise the services for easy availability of certified seeds.

ii. Increase investment in feed production and commercialisation efforts:

- Enhance agribusiness practices in feed commercialisation (Record keeping, minimum efficient scale)
- Incubation for startup feed agribusinesses and funding
- Increase availability of feed ingredients (local production)
- Encourage microfinance institutions to focus on the feed sub-sector

- Develop strategies to attract private sector investment in the feed value chain
- Encourage private-public sector investment (participation)
- Establishment/strengthening of feed and pasture seed aggregation centres
- Establishment/strengthening of farmer-producer organisations for marketing and market linkages.

iii. Control of excessive expansion of invasive plant species:

- The species include (*Prosopis juliflora* (Mathenge), *Lantana camara* (wild sage) catcaceae (cactus])and other species with similar effects in identified local situations
- Promote control of invasive species through sustainable utilisation (Utilisation of woody species for biomass production - charcoal briquettes, wood carvings, utensils- wooden spoons, construction poles/posts, utilisation of pods and seeds as feeds and feed ingredients, utilisation for human food, utilisation for human herbal medicine, e.g. Cactaceae species.
- Improve early detection and rapid response to identify invasive species early and take immediate action to control their spread. Early species detection can be done through regular monitoring and surveillance programs, which trained personnel or scientists can do.
- Enhance biological control using natural enemies of invasive species, such as predators, parasites, and diseases, to control their populations. This method can be an effective and sustainable control method, but it requires careful selection of the biological control agents to ensure they do not harm native species.
- Enhance cultural control by modifying human activities and land-use practices to reduce the spread of invasive species. This method can include changes in farming practices, such as crop rotation and weed management, or changes in recreation practices, such as limiting the transportation of plant materials between different areas.
- Improved physical control involves using mechanical or manual methods to remove invasive species, such as pulling or cutting plants or using barriers to prevent their spread. This method can be adequate for small-scale infestations but challenging for larger or more established populations.
- Improved chemical control involves using herbicides to control invasive species. This method can be effective but can have negative impacts on non-target species and the environment, so it should only be used as a last resort and with careful consideration.
- Citizen science (community engagement): This involves engaging and empowering local communities to help monitor and control invasive species. This method can effectively raise awareness, mobilise action against invasive species, and gather data on their distribution and impacts.
- Enhance education and outreach by raising awareness and educating about invasive species, their impacts, and how to prevent their spread. This method uses various channels, including schools, community events, and social media.

iv. Reduced incidences of diseases and pests - diseases, e.g. rusts, head smut, maise lethal necrosis; pests, e.g. locusts and fall armyworms:

- Promote Integrated Pest Management (IPM) holistic approach that combines different pest control practices, including biological, cultural, physical, and chemical methods. Combining techniques reduces reliance on one, leading to more sustainable and effective pest management.
- Improved crop rotation involves alternating crops to break the pest cycle. This practice helps reduce pest populations and diseases specific to a particular crop.
- Biological control involves using natural enemies of pests, such as predators, parasites, and pathogens, to control pest populations. This approach is sustainable, environmentally friendly, and has long-lasting effects.
- Plant breeders can develop crops resistant to pests and diseases. These pest and disease-resistant varieties can reduce the need for chemical pesticides and the incidence of pest and disease outbreaks.
- Improved sanitation involves removing sources of pest infestations, such as pulling weeds and debris that harbour pests and cleaning tools and equipment that may spread diseases.
- Improving education is critical to preventing and managing pest and disease outbreaks. The farming community

and other stakeholders can be educated on the importance of pest and disease management, integrated pest management, and the proper use of pesticides.

- Early detection can prevent the spreading of diseases and pests. Regular monitoring and surveillance can detect outbreaks early, and quick action can prevent the spread of pests and diseases.
- Pheromone traps are to control pest populations by using synthetic pheromones to attract pests to a trap. This approach is an environmentally friendly and effective way of controlling pests.

v. Mitigate conflict insecurity which disrupts feed production and supply chains:

- Encourage community peace-building efforts through activities that build community integration - for example, building schools, sporting activities, and other social amenities at the shared border of conflicting communities and clans.
- Promote affirmative actions and programs to uplift the marginalised
- Strengthen inter-community dialogue & negotiations to mitigate potential resource-based conflict
- Disarming the local communities to reduce the proliferation of illegal small arms.
- Encourage integration measures among different communities through intermarriages and participation in joint activities.

vi. Restore community governance over land tenure systems and utilisation:

- Integration of community governance into national and county government decision-making and policy processes.
- Lease out idle private land for feed production
- Establish range management committees and community dialogues
- Establish/strengthen range management committees
- Develop and implement the range management bill/act and regulations at the county level

vii. Increase feed productivity:

- Timely feed harvesting at optimum quantity and quality (at 50% flowering)
- Promote intercropping of fodder with legumes. For example, Maasai love grass (*Eragrostis superba*) intercropped with green leaf desmodium (*Desmodium intortum*), Rhodes grass (*Chloris gayana*) intercropped with Lucerne grass (*Medicago sativa*) or purple vetch (*Vicia americana*) in the ASAL areas, and Napier grass (*Pennisetum purpureum*) intercropped with green leaf desmodium in the non-ASAL areas.
- Promote Good Agricultural Practices (GAPs) s and intensification
- Increase area under multipurpose trees (MPTs), multipurpose shrubs (MPSs), and agroforestry. Readers are referred to Nair *et al.* (2021) for further information.
- Improve soil fertility and structure using fertilisers, manure, and compost.
- Promote Sustainable Land Management (SLM) systems of the rangelands, rangeland reseeding and natural land regeneration
- Promotion of community grazing plans and patterns

viii. Address adverse effects of climate variability and environmental shocks on fragile ecosystems:

- Identify, select, disseminate and upscale locally adapted drought-tolerant forage varieties taking into consideration the KEPHIS regulations and guidelines.
- Intercrop grasses with legumes or fodder trees
- Develop agro-silvopastoral systems in both rangelands and non-ASAL areas
- Promote co-production and dissemination of traditional and scientific early warning systems
- Promote the use of both traditional and scientific early warning systems that monitor weather patterns and provide farmers with information on how to adapt to changes in weather patterns (reserving feeds timely)
- Promote climate-smart ruminant farming practices, including drought-tolerant feed crops (Brachiaria, cobra, and sorghum species).

- Enhance conservation agriculture and water harvesting technologies.
- Enhance water availability in all seasons for use during the dry season by encouraging farmers to form fodder production cooperatives for effective harvesting of water from various sources (rain, surface, underground) storage and harvesting infrastructure (boreholes, dams, pans, farm-gate water harvesting equipment) and use (irrigation)
- Identify, select and disseminate forage varieties that can withstand flooding and water logging conditions and reduce soil erosion. Planting cover crops (cowpeas- M66 (*Vigna unguiculata*), dolichos lablab (*Lablab purpureus*), mung bean or Njahe (*Vigna radiata*), desmodium species, mukuna (*Mukuna pruriens*), crotalaria (*Crotalaria retusa*) will also enhance land degradation mitigation measures, including community-driven sustainable rangeland rehabilitation and management and practices (re-afforestation, agroforestry, silvo-pastoralism, natural forest conservation, community forest management, boundary plantings)
- Promote activities that enhance control and eradication of invasive species through sustainable utilisation
- Incentivise communities to implement community land restoration, including soil and water conservation, under the Participatory Integrated Community Development (PCID) model
- Promote proper animal mix for improved grazing management (cattle, sheep, goats and camels)
- Re-engineer community governance structures to promote participatory rangeland management and sustainable grazing regimes; enforce sustainable stocking rates and recommended carrying capacity management; and promote investment in research and development for local production of diversified alternative high protein and high energy rich feeds in the long term

ix. Proper feed planning and budgeting (County, farmer cooperatives/organisations, individual farmers, pastoralists) :

- Establish the ruminant population by species and herd structure (census)
- Establish/determine feed requirements for the species and classes in quantity and quality (DM, ME, CP, Stocking rate/ carrying capacity)
- Establish the feed resource available (roughages, concentrates, minerals, premixes)
- Establish the feed balance (surpluses, deficits)
- Develop a national/ county ruminant feed action plan

4.1.2 Intervention 2. Strategy to Enhance Strategic Feed Reserves

i. Enhance feed storage capacity :

- Encourage the construction of on-farm and community-based feed reserve facilities for small-scale farmers through government subsidies and partnerships with private sector players.
- Implement a public-private partnership to establish strategically located feed storage centres across the countries.
- Train farmers on the use of appropriate storage technologies to minimise losses.
- Establish a national feed reserve fund to support farmers during feed scarcity financially.
- Reduce costs of feed conservation through large-scale operations, including the bulk purchase of conserved materials (cooperatives, farmer organisations, communal conservancies)
- Develop strategic feed conservation sites/ feed reserves/ grazing reserves/ feed banks/ feed centres in villages, wards and counties
- Conserve feeds under favourable weather conditions (temperatures, moisture) to avoid spoilage.
- Enhance infrastructure to the feed centres/conservation sites (roads, port, railway)
- Construct feed storage structures/stores near feed centres and production sites.
- Harvesting and storage of idle natural pastures in the rangelands.

ii. Enhance feed storage infrastructure:

- Construct feed storage structures/stores within the vicinity of feed centres and producers
- Utilise idle capacity and increase the efficiency of the existing structures through review and redesigning of the current feed storage structures

- Promote modern feed storage structures
- Train artisans on skills and technology on the correct materials and designs for constructing hay barns and silage banks
- Equip stakeholders with relevant skills for filling hay barns and silos
- Sensitise stakeholders on hazards, e.g. spontaneous fires, rodents, rain/wind storms

iii. Establish adequate storage capacity at feed centres and strategic feed reserves

- Enhance access to cheap and affordable credit
- Establish a fund/grant to plan and construct feed storage facilities at the feed centres.
- Encourage PPPs to establish storage facilities for farmers at an affordable fee.

iv. Mitigation measures on unfavourable weather conditions

- Timely planting and harvesting to synchronise the activities with the right weather conditions
- Facilitate farmers in acquiring silos, silage tubes/ bags and in the construction of silos for silage storage
- Ensure proper orientation of the storage structure (The length of the storage structure should not face the wind/ rain direction)
- Use weatherproof designs in constructing feed storage structures
- Solar drying of hay during rainy weather conditions under greenhouse structures
- Enhanced Early warning system, especially on forecasted unfavourable weather conditions giving appropriate advisories

v. Enhance post-harvest feed handling and storage (Pests; termites and rodents):

- Construct feed stores with vermin control structures
- Control rodents (mice, rats, moles) from inhabiting the feed stores
- Use insecticide to control termites from invading the feed stores.

vi. Improved methods of feed conservation, processing and densification :

- Hay and silage making
- Feed pelleting
- Feed briquettes
- Feed meals
- Feed blocks

vii. Prevent malicious and deliberate feed damage (Arson, puncturing of silage tubes, livestock trespass):

- Beef up security- fencing, locking, use CCTV cameras, mobile apps, security guards
- Control the vice through education and the legal system
- Construction of fire breaks

viii. Improved planning and management of feed reserves (County and community level):

- Develop and implement a comprehensive county feed reserve management plan that includes regular assessment and monitoring of feed reserves, demand forecasting, and frequent replenishment provision.
- Incorporate an ICT feed management app (LifeSim, digital cow, KALRO selector etc.) that farmers can use to plan their feed reserves, forecast feed demand, and access information on feed prices.
- Promote dry and wet season grazing areas
- Establishment of feed camp options for livestock maintenance during the drought seasons; In-Residential and out-feed camps

4.1.3 Intervention 3. Strategies to Improve the Availability of Commercial Feeds

i. Improve the importation of feed ingredients:

- The country cannot produce feed ingredients such as amino acids, premixes and additives. Thus a short-term strategic importation is required as a stop-gap measure
- Incentivise local feed manufacturers to manufacture feed concentrate in large quantities for feed deficit periods.

ii. Introduce favourable tariffs, taxes and trade agreements:

- Lobby the government to ensure fair tariffs and taxes
- Join industry Associations
- Take advantage of preferential trade agreements, e.g. the African Continental Free Trade Area (AfCFTA) agreement

iii. Promote investment in research and development for local production of diversified alternative high protein-rich feeds in the long term:

- Insect feed sources- Black Soldier Fly Larvae (BSFL), Crickets, termites
- Tree legumes

4.1.4 Intervention 4. Strategies to Promote Feed Market Efficiency and Functionality Markets

i. Limit brokerage and protectionism:

- Farmers can sell their produce directly to consumers or retailers, eliminating the need for a middleman. This way, they can earn higher profits and avoid paying brokerage fees
- Farmers can form cooperatives and sell their produce collectively. This practice gives them greater bargaining power and better product prices
- In contract farming, farmers sign an agreement with a buyer, specifying the terms and conditions of the sale This approach helps farmers secure a steady product market and reduces their dependence on brokers
- Several online platforms connect farmers directly with buyers. This platform helps farmers reach a broader market, eliminating the need for intermediaries
- Governments can provide subsidies, loans, and technical assistance to farmers, helping them reduce their costs and improve their productivity. This assistance allows farmers to earn higher profits and reduce their dependence on brokers
- Farmers need education on their rights and the various options available to them. They need to be aware of the market prices of their products and should be able to negotiate effectively with buyers. The educated farmer avoids exploitation by brokers

ii. Control feed hoarding:

- Governments can impose price caps on essential goods to prevent hoarders from profiting from the increased demand. The price caps help keep prices reasonable and ensure consumers can access necessary items
- Governments can monitor retailers and wholesalers to ensure they do not hoard essential goods. They can impose fines or other penalties on individuals or businesses that engage in hoarding practices
- Governments and businesses can collaborate to share information and coordinate their efforts to mitigate hoarding. The collaborations help ensure that essential goods are available to consumers and reduce the risk of shortages
- Encourage youth to venture into commercial feed production

iii. Enhance feed price stability:

- Establishing feed centres in Counties helps stabilise prices by adjusting production based on market demand.
- Relying on a single feed source can leave farmers vulnerable to price fluctuations. Farmers can spread their risk by diversifying their feed sources and potentially finding lower-priced options

- Farmers can plan and purchase feed when prices are lower, such as after harvest or during periods of oversupply They can also consider buying in bulk to take advantage of volume discounts
- Market information informs farmers and feeds traders about market trends and news to avoid losses and take advantage of opportunities
- Introduction of warehousing and receipt system in feed production

iv. Control monopoly and encourage healthy feed competition:

- Encourage competition by reducing entry barriers, enforcing antitrust laws, and promoting free and fair trade.
- Regulating dominant firms' market power through price controls, regulating mergers and acquisitions, and breaking up monopolies can help prevent unfair practices and create a more level playing field
- Promote market transparency through mandatory disclosure requirements and consumer protection regulations.
- Encouraging innovation through measures such as patent protection, research and development grants, and promoting entrepreneurship can help create new market entrants and prevent monopolies from dominating markets
- Support small and medium-sized enterprises through measures such as access to finance, training and mentoring
- Foster inter-County cooperation through measures such as trade agreements, intellectual property protection and international standards
- Empower consumers through consumer education, transparency, and access to information

v. Improve efficiency in the feed supply chain:

- Implementation of inventory management software technology, barcoding, and automated data collection improves inventory management and reduces delays in the supply chain
- Improving communication and information flow to ensure communication channels are transparent and open between stakeholders can help reduce supply chain inefficiency
- Negotiated feed supply contracts, including establishing quality standards and understanding the supplier's capabilities

vi. Enhance the availability of cheap and affordable credit:

- Establish credit history for individuals to take small loans and make payments on time to build a positive credit history
- Promote financial inclusion and support to help increase access to grants and microfinance for underserved populations, such as low-income households, small businesses, and rural communities
- Enhanced competition among financial institutions can lead to lower interest rates and better loan terms for borrowers. Incentives that encourage new entrants into the financial sector and promote innovations can help increase competition and drive down costs
- Credit guarantees can help reduce the risk for lenders, making it easier for them to provide credit to borrowers. Governments can give credit guarantees or insurance to lenders to encourage them to lend to underserved populations or to support specific sectors, such as small businesses or agriculture
- Financial education programs can help individuals and businesses make informed decisions about savings, borrowing and managing finances. By increasing financial literacy, borrowers will access credit responsibly and avoid over-indebtedness
- Promote Sharia-compliant credit products and village savings and loans

vii. Enhance access to market networks and information:

- Governments and community market scouts can provide market intelligence reports and analysis to help businesses and individuals make informed decisions about market opportunities and trends
- Modern technology has made accessing market networks and information more accessible than ever.
- Dispatch information on markets and performance in print, televised and audio media

- Collaboration with other businesses can provide access to new markets, customer bases, and valuable knowledge and expertise.

viii. Introduce favourable local government levies:

- Encourage stakeholder participation, and enhance collaboration and partnerships during the county government process of formulating finance bills.
- Counties should explore alternative funding sources such as public-private partnerships, grant funding, and crowdfunding to diversify revenue sources and reduce the over-reliance on county government levies.
- Engage in advocacy efforts, such as lobbying local officials, organising community forums, and engaging with the media to raise awareness of unfair local government levies and mobilise support for change.
- Promote unified local government levies to encourage feed trade across counties.

4.1.5 Intervention 5. Strategies to Improve the Feed Transport System

i. Improve road networks:

- Upgrade link road standards to all-weather status
- Upgrade main trunk roads to bituminous status
- Maintenance of roads to passable status
- Increase road network to production and utilisation centres
- Develop more alternatives to truck transport.
- Use rail transport where available and have connection points along the railway line.
- Establish transport groups for animal feeds along the main transport routes.
- Establish link points to the main trunk lines.
- Suitable transport trucks and other local means, e.g. customised donkey carts, tuk-tuk

ii. Encourage specialised modes of feed transportation and delivery:

- Suitable transport truck designs for different types of feeds
- Reduce distances by having many feed centres
- Pooling transport to reduce costs
- Operate at economies of scale- e.g. transport in bulk

iii. Enhance security and safety along the feed transportation corridors

- Provide community security on feed infrastructures and along transport routes
- Local community ownership of the feeds and feed infrastructures
- Install security gadgets, e.g. CCTVs and tracking systems along transport corridors
- Police escort and reinforcement along transport corridors

iv. Improve standardisation of feed packaging, transportation rates and code of regulation

- Lobby for the establishment of standard charges per unit of feed or feed ingredient package
- Develop standard packaging materials
- Develop standard materials for reusable packaging
- Establish standard package weight/size for different feed types
- Mapping stock routes to encourage efficient feed and water delivery

4.2 Pillar 2: Feed Access

Feed access to ruminants can be influenced by physical, social and economic factors. The following are the strategic interventions to address the challenges of feed access to ruminants.

4.2.1 Intervention 1: Enhance Physical Access to Feeds.

- Establishment of road networks to improve feed transportation and security

- Establishment of information and communication platforms for data and information sharing
- Establishment of feed centres in remote areas where farmers can access adequate feeds
- Improvement on feed contingency plans in case of disruption; and establish grazing plans
- Establishment of strategic water infrastructure
- Water trucking to enable the use of idle pastures in the rangelands
- Improvement of security to facilitate access to far-flung areas
- Establishment of conflict resolution mechanisms

4.2.2 Intervention 2: Consider Social Concerns in Feed Access.

i.Promote gender equity

- Promote gender mainstreaming and inclusivity in feed production, access and utilisation decision-making.
- Encourage gender-balanced participation in feed-related training
- Encourage gender balance in land ownership, access, utilisation
- Promote designing of gender-friendly feeding infrastructure

ii. Combat drug and substance abuse

- Implement rehabilitation programs for drug and substance addicts
- Sensitise the youth on feed-related income generation activities to reduce idleness
- Provide alternative livelihood opportunities for drug peddlers and illicit brew distillers

iii. Improve the skills and knowledge of farmers and other stakeholders

- Train farmers on modern technologies on feeds and feeding
- Translation of training materials, brochures, and fliers in local languages
- Use of local trainers to conduct the training
- Use of demonstration and model farms
- Use of vernacular print, TV and radio programs to upscale agricultural technologies
- Use of lead and champion farmers
- Use of ICT and social platforms for skills dissemination

iv. Address retrogressive cultural practices

- Sensitise the community against segregation and discrimination in accessing and utilising community feed resources.
- Elimination of cattle rustling practices and security restoration (beefing up security and peace-building initiatives)
- Encourage schooling for modern education and religious affiliation to minimise negative cultural beliefs (e.g., witchcraft).
- Sensitise the community against ethnic-based segregation and discrimination on access and utilisation of community resources.
- Discouragement of retrogressive community practices, such as the burning of pastures during a conflict
- Unplanned burning of pasture land for tick control
- Cutting of trees due to lack of ownership of community land- a tragedy of the commons
- Overdependence of the rangeland for pasture without alternative sources of feeds

4.2.3 Intervention 3. Strategies to Improve Economic Access to Feeds

i. Enhanced purchasing power and incomes:

- Collective purchasing: Farmers can come together to pool their resources and purchase feed in bulk, resulting in lower prices and increased bargaining power. The coming together is through cooperatives, farmer groups, or community-based organisations.
- Diversification of income: Farmers can diversify their income streams by engaging in other activities such as

agroforestry, beekeeping, or poultry keeping, which can provide additional income to purchase feed.

- Access to credit: Farmers may need access to credit to purchase the necessary feeds and other inputs. Sources may include government affirmative action funds (e.g. Women enterprise fund, Youth enterprise fund), cooperative loans facility, and private lenders.
- Subsidies and grants: Government subsidies and grants can be provided to farmers to offset the cost of feed and other inputs. These subsidies can target small-scale farmers in need and help improve their purchasing power.

ii. Improve access to market information.

- Encourage the use of market information systems for data and information sharing.
- (Packaging and labelling for enhanced phytosanitary requirements)- to delete
- Use of media, social gatherings, barazas, posters, brochures and other channels to share information on available market
- Establishment of farmers' service centres for increased access to market information
- Use of ICT to improve market information.

iii.Improve the feed supply chain.

- Promote ethical business practices
- Promote consumer protection through enforcement of feed standards by the Kenya Bureau of Standards (KEBS)

4.3. Pillar 3. Feed Utilisation

The factors influencing feed utilisation include its quality, safety, standards, processing, and value addition, among other factors. This section contains the strategic interventions to address the critical issues hindering feed utilisation.

4.3.1 Intervention 1. Strategies to Improve Feed Quality

i. Improve feed handling (harvesting, processing, conservation, storage, transportation, adulteration):

- Harvest pastures and fodder at optimal yield and quality (Timely feed harvesting to maintain optimum levels of ME, CP, CF and weight of the feed)
- Feed processing to increase palatability and utilisation (chopping, pulverising, grinding, roasting, decorticating/ dehulling, crumbling, dry rolling, flaking, pressure cooking, exploding, pelleting, reconstituting, extruding)
- Feed value-addition including crop residues (treatment, leaf meal, feed blocks, fortification, densification, supplements, probiotics, feed formulation)
- Train farmers and feed handlers on proper feed handling practices, including cleaning and disinfection of storage and transportation equipment and sound storage practices.
- Provide farmers with appropriate storage facilities and materials, such as moisture-proof bags and silos.
- Develop and enforce regulations on feed handling practices to ensure compliance with standards and reduce adulteration.

ii. Limited accredited laboratory services for feed quality standards and weak enforcement:

- Increased the number of accredited laboratories and improve their capacity to analyse a broader range of feed quality parameters.
- Reduce the analysis cost by subsidising laboratory services or establishing public-private partnerships to provide affordable laboratory services to small-scale farmers.
- Strengthen regulatory agencies to enhance monitoring and enforcement of feed quality standards.
- Facilitate capacity building and accreditation of existing feed testing laboratories.
- Establishment of more feed testing laboratories at the County level
- Create awareness of the need for feed testing
- Train more laboratory staff on feed testing

iii. Limited skills of the feed business operators:

- Develop and implement training programs for feed business operators on feed production, formulation, storage, and marketing.
- Provide access to technical assistance and mentorship to enhance skills and knowledge transfer.
- Establish business development services centres to provide support in business planning, financial management, and marketing

iv. Limited regulation of feed business operators:

- Develop and enforce feed quality and safety standards, including regulations on feed additives and processing practices.
- Establish a licensing system to regulate feed production and marketing, focusing on small-scale producers.
- Conduct regular inspections and monitoring of feed production facilities to ensure compliance with standards and regulations.
- Enforce feed operators' registration with KEBS and follow Good Manufacturing Practices (GMPs)
- Enforce feed regulations- labelling, ingredient standards, and manufacturing practices.
- Skill capacity building of the feed business operators
- Enforce operationalisation of feed quality standards
- Establish feed-quality surveillance systems

4.3.2 Intervention 2. Strategies to Improve Feed Standards

- Develop and operationalise feeds code of practice, especially for the forages.
- Harmonise and operationalise feed stuff standards and tariffs. Ongoing efforts are to harmonise feed standards for the East African region, mainly feed ingredients and forages. The process needs operationalisation, including awareness creation and broadening the standards to encompass other trading blocks, e.g. COMESA, SADC, and ECOWAS.
- Promote uniformity in units of packages and labelling for the different feed operators.
- Enhance surveillance systems and enforcement of feed quality standards
- Review existing policy and legislation on feed standardisation
- Fast-track the livestock bill to facilitate the formulation of the animal feed regulations
- Provide adequate information and communication (limited awareness) on feed quality standards since most rural users have low access to information. The importance of feed quality standards should be emphasised in local media -print, television and radio to reach the critical mass of farmers to improve feed quality standards.

4.3.3 Intervention 3. Strategies to Improve Feed Safety during Processing, Conservation, Storage and Transportation

- Preprocessing feed materials and allowing them to dry to the required moisture level (12-13%) before mixing and storing.
- Use improved methods of feed conservation (hay, silage, haylage, standing hay, water and air tight containers)
- Improve feed storage (Clean, well-ventilated and vermin-proof storage barns.
- Minimise levels of pesticide residues in feeds by following the recommended period for use after pesticide application
- Minimise mycotoxins (aflatoxin) levels and heavy metals (Lead, Mercury) in preserved and stored feeds. For example, the use of chemicals to manage aflatoxin. It is used mainly on maise (apply 30–35 days after planting, which is about 2–3 weeks before flowering, by side-dressing along the rows on the soil surface).
- Avoid feed adulteration and contamination with foreign objects that cause quality changes and lead to lower-quality feeds.
- Establish feed testing laboratories at the County level, create awareness of the need for feed testing, and train more laboratory staff on feed testing.

- Train and sensitise farmers and business operators on feed safety, standards, and associated changes.

4.3.4 Intervention 4. Strategies to Improve Feed Processing and Value Addition

- Use of modern and efficient feed processing technologies (high rate chopper, grass shredder, feed pelletiser, chaff /straw crusher, feed production line for feed centres) (Photos 4.5 and 4.6)
- Enhance access to quality feed and ingredients: inclusion of feed additives such as enzymes, probiotics, and organic acids; and fodder biofortification, for example, with trace elements (e.g. zinc, selenium, cobalt, copper, iron, manganese, boron)
- Organise farmers into groups and associations that buy feeds and feed ingredients, and distribute them to their members.
- Registration of feed operators, feed stockists and agro vets who trade on feed and feed ingredients
- Establishment and enhancement of feed analysis laboratories at the County level
- Reduced cost of modern feed technology, equipment and power by the use of alternative renewable energy (e.g. wind, solar, geothermal, biogas, bagasse)
- Enhance farmer skill and capacity building in good feed manufacturing practices, including feed formulation, processing and value addition -
- Encourage vulnerable and marginalised youth groups (VMGs) participation in feed production and processing business.
- Develop specific credit facilities for youths to engage in youth processing enterprises.

Photo 4 5. Animal feed shredder (Source: www.alibaba.com/showroom/animal-feed-shredder-machine.html)

Photo 4 6. Pelletizer (Source: www.alibaba.com/showroom/animal-feed-shredder-machine.html)

4.4 Pillar 4. Feed stability

The interventions to improve the stability of the feed industry include:

4.4.1. Intervention 1: Climate Change Mitigation and Adaptation:

- Use of climate information advisories for preparedness and disaster management
- Adoption of climate Smart Agriculture technologies, innovations and management practices, participatory rangeland management for increased forage production and sustainable land management
- Provision of water for livestock in strategic areas along migratory and livestock marketing routes

4.4.2. Intervention 2: Improved Economic Performance

- Increased investment in the feed resource sector, rural infrastructure and improved land tenure systems
- Enhanced research in feed technologies and agricultural extension services in feed production
- Develop technologies that reduce post-harvest losses
- Enhance feed value chain functionality through the proper producer-to-market linkages
- Improve financial inclusion and access for smallholder processors, feed developers and marketers through sensitisation to form/join SACCOs and cooperatives for collective bargaining
- Promote feed cottage industry for livestock feed value addition

4.4.3. Intervention 3: Market Stability

Market stability refers to the ability of the feed industry to provide reliable and affordable access to feed ingredients and finished feeds. The following strategies can promote market stability:

- Development of efficient and transparent market systems that connect feed producers with feed buyers
- Promotion of competition and fair-trade practices in the feed industry
- Establishment of feed price stabilisation mechanisms to reduce price volatility and protect farmers against sudden price fluctuations through the formation of cooperatives for easy access to cheaper inputs
- Investment in feed storage, transport, and distribution infrastructure to ensure timely and efficient delivery of feed products
- Improvement of market information systems to provide accurate and up-to-date information on feed prices, availability, and quality
- Encouragement of value addition and diversification in the feed industry to create new markets and products
- Promotion of exports to expand market opportunities for feed producers

4.4.4. Intervention 4: Institutional Stability:

Research and development are crucial for the feed industry to remain competitive and responsive to changing market demands. The following strategies can promote research and development:

- Investment in feed research and development to improve feed quality, safety, and nutrition
- Development of new and innovative feed products that meet the nutritional needs of different livestock species and production systems
- Adoption of new technologies and production methods that increase efficiency and reduce environmental impact
- Promotion of public-private partnerships to encourage collaboration and knowledge-sharing in feed research and development
- Development of training and capacity-building programs to enhance the knowledge and skills of feed producers and other stakeholders in the feed industry
- Establishment of research institutions and facilities to support feed research and development activities
- Promotion of private sector participation in the feed industry to encourage innovation and competition

4.4.5. Intervention 5: Enabling Policy and Regulatory Environment

Enabling policy and regulatory environments refer to the legal and policy frameworks that facilitate the operation of the feed industry. The following strategies can promote an enabling policy and regulatory environment.

- Development of clear and consistent feed regulations and standards that ensure the safety and quality of feed products

- Promotion of feed quality control and monitoring systems to detect and prevent feed contamination and adulteration
- Streamline feed import and export procedures to reduce trade barriers and increase market access. The strategic importation of feed ingredients to cover the feed industry's needs at crucial times while limiting the importation of finished feeds to safeguard our industry.
- Encouragement of investment in the feed industry through tax incentives and other policy measures
- Support services, such as credit, extension, and technical assistance, are provided to the feed industry to enhance its competitiveness and sustainability.

4.4.6. Intervention 6: Livelihoods Improvement

- Gender mainstreaming and inclusion in the feed subsector
- Livelihoods diversification and protection of livestock assets
- Continuous awareness creation using a participatory approach

4.4.7. Intervention 7: Community Conflict Management

- Create an enabling environment for improved community dialogues, resource sharing and political tolerance
- Empower community resource management committees

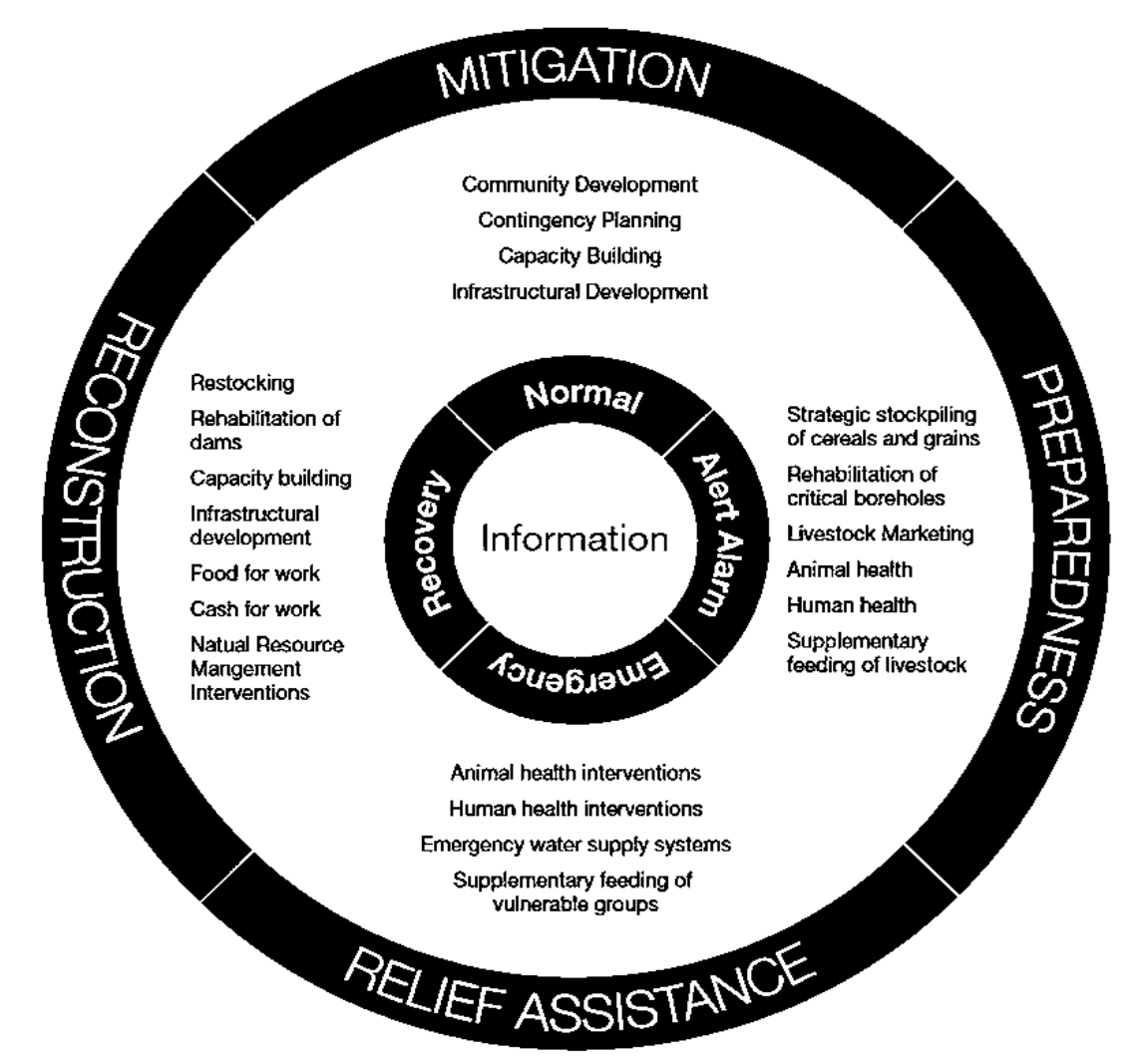
4.5 Summary of Strategic Livestock Feed Interventions and Management through the Drought Cycle

The summary guides stakeholders to plan for interventions at the correct cycle phase to curb the repetitive effects of drought in normal environmental conditions to worse drought situations. Interventions should be implemented in preparation for the next drought. Proper planning can reduce vulnerabilities, increase resilience, and transfer or share drought risks.

The global climate change crisis is causing an escalation in the frequency, duration, and intensity of droughts, impacting previously unaffected regions.
Addressing this issue requires a comprehensive approach that includes vulnerability assessments, early warning systems, adequate disaster relief, and long-term investments in drought mitigation and adaptation.

Drought interventions follow a four-phase cycle consisting of normal, alert, emergency, and recovery stages, as illustrated.

DROUGHT CYCLE ILLUSTRATION



Drought Cycle Illustration
Source: IRR 2004

4.5 .1 Strategic Livestock Feed Management through Phases of the Drought Cycle

This summarises the feed interventions at different phases of the drought cycle. These interventions aim to mitigate the impact of drought on livestock by ensuring sufficient feed supply, strategic planning, and emergency assistance during relief stages and promoting recovery and reconstruction in the aftermath of drought. The selection of appropriate interventions and feed options depends on factors such as the availability of local resources, the specific livestock species and production levels, management practices, production systems, and locality.

PHASE1. Mitigation - Normal Phase
Description; Weather conditions are good, adequate rainfall and available forage, natural grazing and existing feed sources meet nutritional needs

Interventions

- Opportunity to increase the area under pasture and fodder production for biomass yield and quality

- Contingency feed planning and budgeting with well-defined triggers for response
- Feed bulking, preservation and conservation, hay, silage haylage and reserved Standing hay.
- Feed Infrastructure development logistical planning, hay stores, feed centres and water at farm level and along stock routes in ASALs
- Producers and stakeholder capacity building on feed security
- Diversified options for feed production, including irrigation and adopted varieties for drought
- Best technologies in feed preparation and processing
- Grazing management and planning with grazing management committees to develop Wet and dry season grazing plans

PHASE 2 - Preparedness – Alert/Alarm Phase

Description: Early warning (KMD, NDMA, and other agencies) Signs of feed scarcity and reduced forage availability

Interventions:

- Assess available forage resources and estimate carrying capacity.
- Develop contingency plans for feed supplementation.
- Conduct soil and pasture assessments.
- Implement rotational or planned grazing management practices
- Educate livestock owners about drought management strategies
- Enhance livestock offtakes and destocking programmes
- Trigger community dialogues for resource sharing and conflict management
- Strategic stocking of feeds in feed centres and Supplementary feed supplies
- Commercial feed bulking, Subsidised feed business Credit availability for investment and marketing for the stable feed industry
- Improved feed utilisation also explores crop residue feeding and utilisation
- Fortification of stable straws and hays and enhanced feed block manufacturing
- Trigger grazing management plans, planned grazing and paddocking within demarcated range blocks

PHASE 3 – Relief Emergence Phase

Description: Drought impacts are more pronounced, forage resources are critically limited, and rangeland conditions are severely degraded. Interventions during this stage focus on survival and minimising the effect on livestock. Livestock market losses, Livestock body deterioration and deaths characterise this.

Interventions:

- Implement supplementary feeding programs, including conserved hay and silage feeding.
- Conduct feed analysis for strategic feeding as per animal requirements for Maintenance – strategic feeding.
- Explore alternative feed sources, Industrial wastes and Crop residue utilisation.
- Adjust stocking rates and implement destocking strategies.
- Prioritise feed resources based on animal condition and productivity.
- Provide emergency feed assistance; Emergency livestock feeding – Survival mash, UMMB, Range cubes, densified blocks
- Collaborate with local feed suppliers and farmers for linkages
- Offer technical support and guidance to livestock owners
- Herd segregation, migration, moving animals to feed camps and enhancing animal health interventions

PHASE 4: Reconstruction or Recovery Phase

Description: Conditions gradually returning to normal after the impact of drought

Interventions:

- Assess rangeland condition and implement rehabilitation measures.
- Develop long-term feed management plans.
- Promote sustainable grazing practices.
- Support restocking and herd rebuilding efforts.
- Continue education and training programs for livestock owners.
- Enhanced feed production using innovations, technologies, and improved farm practices
- Capacity building of livestock feed value chain actors
- Develop enabling policies
- Planned deliberate restocking of various livestock species
- Explore alternative pasture sources, and livestock feed TIMPs adoption
- Continuing education and training programs for livestock owners on sustainable feed and grazing management practices.

4.5.2 Key Recommendations

- Consult with local agricultural extension services, veterinarians, and livestock experts.
- Effective management of livestock during the drought cycle is crucial.
- Understanding the five stages and appropriate interventions is key.
- Collaboration with local experts ensures tailored solutions for specific conditions.
- All interventions can be tailored to sustainable feed supplies geared towards farmer resilience building.

Reference

Nair, P.K.R., Kumar, B.M., Nair, V.D. (2021). Multipurpose Trees (MPTs) and Other Agroforestry Species. In: An Introduction to Agroforestry. Springer, Cham. https://doi.org/10.1007/978-3-030-75358-0_13

CHAPTER 5

Feed and Nutrition Security Outcomes

5.1: Importance of Feed and Nutrition Security

Feed and nutrition security is becoming increasingly important to sustain animal production and productivity in face of increasing demand for animal source foods. Despite these upward trends in demand, whether feed production can continue to meet the requirements of an expanded livestock industry is uncertain as feed production faces challenges related to climate change and competition for water and land for agricultural, urban and other uses. Alternatively, climate change could also cause a reduction in crop quality, rendering those products unfit for human consumption, may be suitable as animal feed. Future feed security in livestock production could become more tenuous due to increased variability in climatic conditions, necessitating either the movement of livestock or the transport of feed over longer distances. This development could be particularly relevant to livestock production systems which rely on a combination of intensive crop and extensive rangelands to meet feed demands.

5.2. Outputs

- Improved animal growth: Higher feed productivity means animals receive better nutrition, resulting in enhanced growth rates. Animals can reach market weight faster, leading to increased efficiency in meat and milk.
- Enhanced feed conversion ratio (FCR): FCR is the ratio of feed consumed to weight gained by animals. Higher feed productivity often corresponds to a more favorable FCR, indicating that animals convert feed into body mass more efficiently. This leads to reduced feed costs per unit of output.
- Higher production output: Improved feed productivity leads to increased production of animal products such as meat and milk. This helps meet the growing demand for food and enhances the availability of nutritious animal-based protein sources.

5.3. Outcomes

- Cost savings: When animals are more efficient at converting feed into body mass, it reduces the amount of feed required per unit of output. This leads to cost savings for farmers and producers by lowering feed expenses, which can significantly impact their profitability.
- Improved profitability: Increased feed productivity can directly contribute to higher profitability in the livestock industry. By reducing production costs and maximizing output, farmers can enhance their financial performance and achieve better returns on their investments.
- Enhanced resource efficiency: Efficient feed utilization means fewer resources are required to produce the same amount of animal products. This includes land, water, energy, and feed ingredients. By optimizing resource efficiency, increased feed productivity promotes sustainability and reduces the environmental footprint of livestock production.
- Enhanced competitiveness: Improved feed productivity enhances the competitiveness of the livestock industry. By optimizing production efficiency, farmers can offer high-quality products at competitive prices, both in domestic and international markets. This can lead to increased market share and business opportunities.
- Animal welfare benefits: When animals receive better nutrition through increased feed productivity, it positively impacts their health and welfare (Appendices 6 and 7). Adequate and balanced diets promote optimal growth, reduce the risk of diseases, and contribute to overall well-being and quality of life for the animals.
- Reduced environmental impact: Higher feed productivity can lead to reduced environmental impact associated with livestock production. By minimizing resource inputs and waste generation, such as manure and greenhouse gas emissions, it supports more sustainable and eco-friendly farming practices.
- Improved resilience to climate change: Climate change can impact the availability and quality of natural forage, affecting livestock productivity. By diversifying feed sources and implementing climate-smart feeding practices, such as conservation agriculture and agroforestry, livestock farmers can enhance the resilience of their operations to climate change.
- Reduced overgrazing and land degradation: Insufficient livestock feed can lead to overgrazing as animals search for food, putting pressure on the available grazing lands. This can result in land degradation, soil erosion, and loss of biodiversity. Sufficient feed availability can help reduce the burden on grazing lands and promote sustainable land management practices

5.4. Impact

- Food security and availability: Increasing feed productivity contributes to addressing food security challenges by producing more food with fewer resources. It helps ensure a stable and sufficient supply of animal-based products to meet the nutritional needs of a growing global population.
- Sustainable resource utilization: Efficient feed utilization helps optimize the use of natural resources. With increased feed productivity, fewer resources such as land, water, and energy are required per unit of animal product, resulting in a more sustainable agricultural system.
- Reduced environmental impact: Higher feed productivity can lead to reduced environmental impact associated with livestock production. By minimizing resource inputs and waste generation, such as manure and greenhouse gas emissions, it supports more sustainable and eco-friendly farming practices.
- Reduced economic losses: Livestock resource-based conflicts can result in economic losses for livestock keepers. These losses may include the destruction or theft of livestock, damage to infrastructure, and disrupted market access. When conflicts are reduced, livestock keepers experience fewer economic losses, allowing them to invest in their herds, expand their operations, or diversify their income sources.
- Enhanced social cohesion: Conflict over limited resources can strain social relationships and community cohesion among livestock keepers. By reducing such conflicts, social cohesion can be restored or improved. This can foster cooperation, knowledge sharing, and collective action among livestock keepers, leading to stronger community networks and the potential for collaborative initiatives to address common challenges.

APPENDICES

Appendix 1. Per capita Demand and Supply of Animal Products			
Year	Human population		
2019	47, 584, 263		
2025	59, 981, 314		
2030	66, 449, 654		
Current and projected Per capita consumption of dairy food products			
	Dairy Cattle	Dairy Goats	Beef
Per capita consumption (WHO)	200	2	9
Demand of animal products			
Required 2019	5,234,268,930	95,168,526.00	408,000,000
Required 2025	8,997,197,100	119,962,628.00	514,295,579
Required 2030	9,967,448,100.00	132,899,308.00	797,395,848
Supply of animal products			
Produced 2019	4,200,000,000	34,312,500	408,000,000
Produced 2025	10,749,311,784	119,962,628	719,775,768
Produced 2030	16,109,310,125	132,899,308	877,135,433

Appendix 2. Feed Balance by County			
County	Actual feed availability and use as DM (MT	Livestock DM requirement as DM (MT)	Feed balance as DM based on actual feed availability and use (%)
Isiolo	681,759.90	934,303.00	-27
Tana River	1,302,760.20	1,126,815.20	15.6
Mandera	480,598.30	5,908,617.00	-92
Wajir	1,359,466.20	4,165,370.40	-67.4
Garissa	1,223,573.80	4,150,103.60	-70.5
Marsabit	1,269,229.00	2,683,134.80	-52.7
Samburu	559,140.80	656,448.90	-14.8
Turkana	1,498,228.90	85,43,141.2	-82.5
Narok	1,339,777.30	2,928,223.50	-54.2
Baringo	459,071.40	1,132,105.60	-59.4
Laikipia	286,584.90	542,852.00	-47.2
West Pokot	390,964.10	1,112,180.10	-64.8
Kajiado	905,438.80	1,381,552.80	-34.5
Nyeri	154,703.10	342,888.50	-55
Makueni	349,853.00	687,291.60	-49.1
Embu	253,843.90	384,577.70	-34
Tharaka Nithi	533,611.10	309,327.70	72.5
Meru	285,038.00	887,262.80	-68
Kitui	336,519.50	1,052,278.60	-68
Taita/Taveta	255.388.6	331,609.10	-23
Lamu	147,232.60	378,595.80	-61.1
Kilifi	340,251.70	476,591.50	-28.6
Kwale	253,903.70	412,929.80	-38.5

Appendix 2. Feed Balance by County			
Nairobi	40,567	66,641.90	-39.1
Mombasa	5,183.90	12,648.62	-59
Machakos	217,873.18	943,115.30	-76.9
Kiambu	527,835.40	574,317.40	-8
Muranga	306,834.10	496,101.20	-38.2
Nyandarua	309,998.00	726,350.00	-57.3
Kirinyanga	284,570.20	229,272.20	24.1
Nakuru	1,330,928.70	1,486,901	-10.5
Bomet	187,248.95	678,416	-72.4
Nandi	233,266.30	647,437.70	-177.6
Kericho	195,565.90	691,329.60	-71.7
Elgeyo Marakwet	531,106.60	751,678.50	-29
Uasin Gishu	820,216.80	678,502.40	20.8
Trans-Nzoia	555,599.80	366,758.80	51.5
Kisii	545,862.90	504,232.70	8.3
Nyamira	239,431.30	273,450.50	-12.4
Migori	426,223.00	810,158.90	-47.4
Kisumu	609,028.40	440,692.80	38.2
Siaya	259,368	727,412.83	-64.3
Homabay	1058563.8	1532695.7	-31
Kakamega	408,273.30	780,537.70	-47.7
Bungoma	464,415.50	683,339.40	-32
Vihiga	168,760.00	289,556.80	-41.7
Busia	118,325.60	369,700	-68

National Feed Balance for Kenya						
Country	**Feed balance**					
	Based on potential feed availability (%)			**Based on actual feed availability and use (%)**		
	Dry matter	**Metabolizable energy**	**Crude protein**	**Dry matter**	**Metabolizable energy**	**Crude protein**
ASAL	-28.9	-51.2	-9.7	-63.9	-75.3	-56.3
Non-ASAL	13	-36.6	-33.8	-33.3	-57.6	-60.8
National	**-17.7**	**-36.6**	**-33.9**	**-55.8**	**-57.4**	**-60.7**

Appendix 3. Livestock Mortalities due to Drought by County				
County	**Species**	**Livestock Population**	**Livestock Deaths**	**Livestock Mortalities (%)**
Marsabit	Sheep	1,052,437	511,054	49
Marsabit	Cattle	268,882	122,780	46
Marsabit	Goats	1,208,668	535, 972	44
Kajiado	Cattle	652,856	258,854	40
Isiolo	Cattle	285,210	112,500	39
Marsabit	Camels	283,327	82,841	29
Isiolo	Goats	850,000	212,500	25
Samburu	Cattle	369,399	73,879	20
Isiolo	Sheep	1198,000	179,700	15
Samburu	Sheep	651,787	97,768	15
Wajir	Sheep	2,231,725	265,286	12
Wajir	Cattle	893,032	89,942	10
Kajiado	Sheep	1,244,854	121,020	10
Wajir	Goats	3,190,511	237,777	7
Taita	Cattle	175,349	11,643	7
Laikipia	Sheep	364,951	20,000	5
Samburu	Goats	826,119	41,305	5
Wajir	Camels	1,184,033	44,079	4
Wajir	Donkeys	169,527	7,364	4
Total		**17,100,667**	**2,490,292**	**14.56**

Appendix 4. Livestock numbers and TLUs by County			
County	**Livestock Type**	**Livestock Numbers**	**Total TLUs**
Isiolo	Cattle	293162	205213.4
	Sheep	669354	66935.4
	Goat	738442	73844.2
	Donkey	28109	14054.5
	Camel	49510	49510
	Total	**1778577**	**409557.5**
Mandera	Cattle	863625	604537.5
	Sheep	1164238	116423.8
	Goat	3415484	341548.4
	Donkey	208126	104063
	Camel	1016790	1423506
	Total	**6668263**	**2590078.7**
Garissa	Cattle	982938	688056.6
	Sheep	994684	99468.4
	Goat	1916190	191619
	Donkey	196453	98226.5
	Camel	529895	741853
	Total	**4620160**	**1819223.5**
Marsabit	Cattle	286671	200669.7
	Sheep	2686049	268604.9
	Goat	1671737	167173.7
	Donkey	122642	61321
	Camel	317223	317223
	Total	**5084322**	**1014992.3**
Samburu	Cattle	168721	118104.7
	Sheep	413807	41380.7
	Goat	807805	80780.5
	Donkey	17893	8946.50
	Camel	38546	38546.00
	Total	**1446772**	**287758.40**
Turkana	Cattle	1932108	1352475.6
	Sheep	3968848	396884.8
	Goat	6033152	603315.2
	Donkey	748254	374127
	Camel	1018136	1018136
	Total	**13700498**	**3744938.6**
Baringo	Cattle	487155	341008.5
	Sheep	372635	37263.5
	Goat	901878	90187.8
	Donkey	9143	4571.5
	Camel	10192	10192
	Total	**1781003**	**483223.3**
Laikipia			

Appendix 4. Livestock numbers and TLUs by County			
West Pokot	Cattle	518,900.0	363,230.0
	Sheep	540,600.0	54,060.0
	Goat	570,960.0	57,096.0
	Donkey	14,010.0	7,005.0
	Camel	6,140.0	6,140.0
	Total	**1,650,610.0**	**487,531.0**
Nyeri	Cattle	181,982.00	127,387.40
	Sheep	125,899.00	12,589.90
	Goat	94,722.00	9,472.20
	Donkey	1,717.00	858.50
	Camel	0	0
	Total	**404,320.00**	**150,308.00**
Makueni	Cattle	265095	185566.5
	Sheep	118485	11848.5
	Goat	670885	67088.5
	Donkey	73550	36775
	Camel	0	0
	Total	**1128015**	**301278.5**
Embu	Cattle	194361	136052.7
	Sheep	59261	5926.1
	Goat	255112	25511.2
	Donkey	2178	1089
	Camel	3	3
	Total	**510915**	**168582**
Tharaka Nithi	Cattle	146451	102515.7
	Sheep	77970	7797
	Goat	223380	22338
	Donkey	5890	2945
	Camel	0	0
	Total	**453691**	**135595.7**
Kitui	Cattle	431389	
	Sheep	81585	
	Goat	906591.00	
	Donkey	121022	
	Camel	0	
	Total	**1540587**	
Taita/Taveta	Cattle	169536	118675.2
	Sheep	45450	4545
	Goat	179769	17976.9
	Donkey	2194	1097
	Camel	2192	3068.8
	Total	**399141**	**145362.9**

Appendix 4. Livestock numbers and TLUs by County			
Lamu	Cattle	251,516	176061.2
	Sheep	27,095	2709.5
	Goat	162,988	16298.8
	Donkey	6546	3273
	Camel	5	7
	Total	**448,150**	**198349.5**
Kilifi	Cattle	251,516	176061.2
	Sheep	48,284	4828.4
	Goat	274,205	27420.5
	Donkey	941	470.5
	Camel	33	46.2
	TOTAL	**574,979**	**208826.8**
Kwale	Cattle	196463	137524.1
	Sheep	54578	5457.8
	Goat	363061	36615.9
	Donkey	1145	572.5
	Camel	600	840
	Total	**615847**	**181010.3**
Nairobi	Cattle	32,855	22,998.50
	Sheep	15,303	1,530.30
	Goat	35,088	3,508.80
	Donkey	1,131	791.7
	Camel	274	383.6
	Total	**84,651**	**29,212.90**
Mombasa	Cattle	5,683	3,978.10
	Sheep	803	80.3
	Goat	14,462	1,446.20
	Donkey	20	14
	Camel	16	22.4
	Total	**20,984**	**5,541.00**
Machakos	Cattle	485,952	340,166.40
	Sheep	154,196	15,419.60
	Goat	412,108	41,210.80
	Donkey	23,348	16,343.60
	Camel	200	280
	Total	**1,075,804**	**413,420.40**
Kiambu	Cattle	314,036	219,825.20
	Sheep	137,772	13,777.20
	Goat	98,057	9,805.70
	Donkey	11,925	8,347.50
	Camel	0	-
	Total	561,790	251,755.60
Muranga	Cattle	283,436	198,405.20
	Sheep	46,055	4,605.50
	Goat	140,824	14,082.40
	Donkey	537	375.9
	Camel	0	-
	Total	**470,852**	**217,469.00**

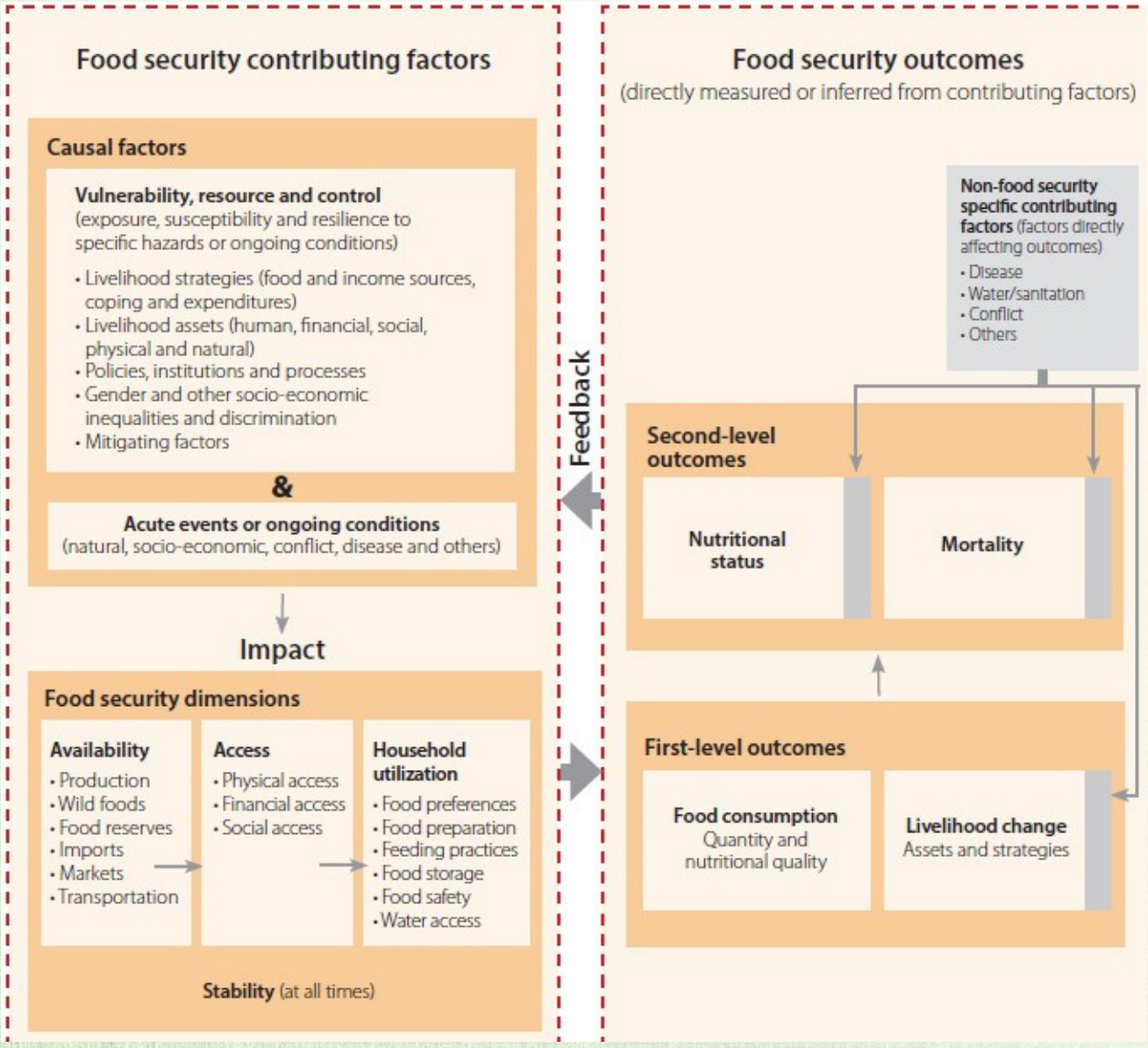
Appendix 4. Livestock numbers and TLUs by County			
Nyandarua	Cattle	374,685	262,280
	Sheep	376,215	37,622
	Goat	114,960	11,496
	Donkey	9,985	6,990
	Horses	15	14
	Total	**875,860**	**318,402**
Kirinyanga	Cattle	125,347	87,742.90
	Sheep	18,121	1,812.10
	Goat	74,500	7,450.00
	Donkey	4,997	3,497.90
	Camel	0	0
	Total	**222,965**	**100,502.90**
Nakuru	Cattle	758,916	531,241.20
	Sheep	554,044	55,404.40
	Goat	324,015	32,401.50
	Donkey	46,348	32,443.60
	Camel	0	0
	Total	**1,683,323**	**651,490.70**
Bomet	Cattle	370,955	259,668.50
	Sheep	105,970	10,597.00
	Goat	73,411	7,341.10
	Donkey	28,259	19,781.30
	Camel	0	0
	Total	**578,595**	**297,387.90**
Nandi	Cattle	325,320	227,724
	Sheep	267,924	26,792.40
	Goat	219,307	21,930.70
	Donkey	10,516	7,361.20
	Horses	0	0
	Total	**823,067**	**283,808**
Kericho	Cattle	394,749	276,324.30
	Sheep	62,683	6,268.30
	Goat	83,180	8,318
	Donkey	17,340	12,138
	Camel	0	0
	Total	**557,952**	**303,048.60**
Elgeyo Marakwet	Cattle	371,474	260,031.80
	Sheep	358,379	35,837.90
	Goat	302,221	30,222.10
	Donkey	4,673	3,271.10
	Camel	100	140
	Total	**1,036,847**	**329,502.90**
Uasin Gishu	Cattle	382,980	268,086
	Sheep	170,762	17,076.20
	Goat	86,963	8,696.30
	Donkey	5,081	3,556.70
	Camel	3	4.2
	Total	**645,789**	**297,419**

Appendix 4. Livestock numbers and TLUs by County			
Trans-Nzoia	Cattle	198,520	138,964
	Sheep	122,280	12,228
	Goat	33,210	3,321
	Donkey	8,940	6,258
	Camel	0	0
	Total	**362,950**	**160,771**
Kisii	Cattle	290,953	203,667.10
	Sheep	44,192	4,419.20
	Goat	108,521	10,852.10
	Donkey	2,993	2,095.10
	Camel	0	0
	Total	**446,659**	**221,033.50**
Nyamira	Cattle	159,262	111,483.40
	Sheep	19,227	1,922.70
	Goat	46,993	4,699.30
	Donkey	1,123	786.1
	Camel	0	0
	Total	**226,605**	**118,891.50**
Migori	Cattle	392,505	274,754
	Sheep	337,827	33,783
	Goat	404,294	40,429
	Donkey	4,682	3,277
	Camel	0	0
	Total	**1,139,308**	**352,243**
Kisumu	Cattle	224,610	157,227
	Sheep	181,490	18,149
	Goat	147,410	14,741
	Donkey	4,357	3,049.90
	Camel	0	0
	Total	**557,867**	**193,167**
Siaya	Cattle	379459	265621.3
	Sheep	165022	16502.2
	Goat	308442	30844.2
	Donkey	8426	5898.2
	Horses	0	0
	Total	**861349**	**318865.9**
Homabay	Cattle	801,349	560944.3
	Sheep	437,569	43756.9
	Goat	552,927	55292.7
	Donkey	16961	11872.7
	Camel	0	0
	Total	**1,808,806**	**671866.6**
Kakamega	Cattle	446,393	312,475.10
	Sheep	138,978	13,897.80
	Goat	117,479	11,747.90
	Donkey	5,761	4,032.70
	Camel	0	0
	Total	**708,611**	**342,153.50**

Appendix 4. Livestock numbers and TLUs by County			
Bungoma	Cattle	387,478	271,234.60
	Sheep	126,209	12,620.90
	Goat	122,942	12,294.20
	Donkey	4,852	3,396.40
	Camel	0	0
	Total	**641,481**	**299,546.10**
Vihiga	Cattle	1,78,470	124,929
	Sheep	4,800	480
	Goat	13,100	1,310.00
	Donkey	300	210
	Camel	0	0
	Total	**18200**	**126,929**
Busia	Cattle	446,393	312,475.10
	Sheep	138,978	13,897.80
	Goat	117,479	11,747.90
	Donkey	5,761	4,032.70
	Camel	0	0
	Total	**708,611**	**342,153.50**

Source: FAO (2021) Feed Balance Report

Appendix 5. Integrated Food Security Classification Food Security Analytical Framework



Appendix 6. Body condition scoring		
Body condition score	Description of condition	Weight change needed (ppounds) to reach optimal condition before calving
1	Emaciated	Gain 350
2	Very thin	Gain 300-350
3	Thin	Gain 200-300
4	Borderline	Gain 150-200
5	Moderate	Gain weight of fetus only (100 pounds)
6	Good	Gain weight of fetus only (100 pounds)
7	Fleshy	No weight gain needed
8	Fat	Can probably lose 100 pounds
9	Extremely fat	Can probably lose 150 pounds

Appendix 7 Pasture condition scoring	
Score	Description
Score 1: Poor	Sparse vegetation cover with significant bare ground.
	Weeds dominate the pasture.
	Grasses are stunted, weak, and lack vigor.
	Very low productivity and forage availability.
Score 2: Fair	Some vegetation cover, but still noticeable bare ground.
	Moderate weed presence.
	Grasses show moderate vigor and growth.
	Moderate productivity and forage availability
Score 3: Good	Adequate vegetation cover with minimal bare ground.
	Few weeds present.
	Grasses are healthy, vigorous, and actively growing.
	Good productivity and forage availability.
Score 4: Very Good	Dense vegetation cover with minimal bare ground.
	Negligible weed presence.
	Grasses exhibit excellent vigor, uniform growth, and high leaf density.
	Very high productivity and abundant forage availability.
Pasture condition scoring is a method used to assess the quality and health of pastureland. It involves evaluation of various factors such as grass species composition, density, height, vigour, and weed presence.	

REPUBLIC OF KENYA

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