IGAD

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PASTURE AND PASTURE SEED PRODUCTION IN THE IGAD REGION

Training of Trainers Technical Manual

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Foreword

Drought intensity coupled with climate change consequences, have adversely affected the livelihood of many pastoral and non-pastoral communities in the ASAL areas of the IGAD region (Matanó *et al.,* 2022; Alasow *et al.,* 2024). As a result, there are many communities who live below the poverty line (1-dollar day) and vulnerable to natural and manmade disasters. For example, it is reported that about 60% of undernourished persons and about 79% of stunted children are residing in the Horn of Africa (HoA) countries characterized by conflicts and are victims of climate change impacts (FAO et al., 2017; Abebe 2021). Notably, as reported by IGAD (2020), the prevalence of acute food insecurity in the region was 61% in South Sudan, 27 % in Ethiopia, 22% in Kenya, 17% in Somalia and 14% in the Sudan, all attributed to poverty driven forces as a result of climate change, with most pastoral communities being most hit and vulnerable. Past statistics from the HoA have shown that countries like, Ethiopia, Djibouti, Sudan, South Sudan, Eritrea, Kenya, Uganda, and Somalia have suffered from famine throughout their histories with more than 40% of the region's population living in areas prone to extreme food shortage with high poverty incidences, with households living on less than a dollar in a day (Markakis et al., 2021; Azadi *et al.*, 2022). The aforementioned challenges in the IGAD region put pressure on the current grazing resource governance system, and thus there is urgent need to come up with suitable plans to alleviate poverty as well as enhance the resilience of the pastoral communities. In the quest to address this need, strategic pasture and fodder production has proven to be an opportunity, with the potential to adapt and mitigate the impacts of climate variability, while building community resilience.

Investments in pasture production programmes have been on the rise in recent years, coupled with community training on pasture establishment, pasture agronomy, rangeland rehabilitation, and targeted pasture projects by partners among others. Most programmes are done by development partners and donors, with the aim of rehabilitating rangelands to increase feed and food supply to pastoral livelihoods. Despite the interventions, pastoralists are still struggling with pasture deficits, low productivity in the rangelands, low pasture production and use within the region. This could be attributed to the many challenges facing the production activities and the entire pasture value chain. Therefore, among the programmes, IGAD has supported projects in the region targeting governance, conflicts management and reseeding and rehabilitation of rangelands.

IGAD –ICPALD has supported this manual development to support the understanding of the regional pasture production and harmonize pasture and fodder production practices for the region with funding from GIZ - SCIDA III project, which works in supporting regional sustainable management of rangelands. This manual directly seeks to support the key resource 'feed' availability in quality and quantity that will support the livelihoods of pastoral communities. The manual was developed after a comprehensive scoping study and fact finding that supported developing a responsive and practical regional pasture and pasture seed production manual. This manual has been developed to present the regional perspective in pasture and pasture seed production for IGAD member states. The manual presents various production practices applicable in the region documenting the dominant production systems and practices. The manual also builds up on success cases to provide lessons for the region that could be replicated. The manual is designed to cover pasture production and conservation in the arid and semi-arid rangeland systems within the IGAD region. The manual provides topics that provide guidelines and technical knowledge to technical trainers and the community pasture and pasture seed producers.

It is anticipated that the finalized training manual on pasture and pasture seed production ultimately contributes towards Natural Resource Management and aims to enhance the sustainable management and use of transboundary rangeland resources for community resilience in the IGAD region.

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The manual has been developed with inputs from dedicated teams from the IGAD member states, with their **experiences and lessons being part of the manual presentation**. Special thanks goes to those individuals as presented in appendix 1.

We would like to highly acknowledge the German Government for the **funding** through Strengthening IGAD's Capacity to Increase Resilience in the Horn of Africa (SCIDA III) project implemented by ICPALD in close collaboration with GIZ.

About the Training manual

The pasture production manual for the IGAD region has been developed in a participatory manner with field data collection and analysis on production practices, challenges, opportunities and communities' aspirations in working towards increasing their resilience in livestock keeping sector. The manual has been developed to address the present and plan for the future livelihoods of the pastoral communities, who are the majority of the IGAD region landscapes. Pastoralism is and will still be the most adapted production system in the IGAD region, and thus, the need for modernization and revitalization of the sector following the global trends, as well as in response to the climate change and variability impacts.

IGAD Centre for Pastoral Areas and Livestock Development (ICPALD) has continued to work towards enhancing the regionals pastoral livelihoods, and one of the key areas being supported in capacity development and technologies adoption for communities' resilience. In this journey, this manual has been developed to feed a critical gap on providing the knowledge and practical practices and technologies that are applicable in the IGAD region for pasture production. The manual has been developed to bring together some of the best practices and technologies and innovations from the region that could be replicated, improved or customized by member states for increased rangelands productivity and sustainability. The manual has been developed to achieve the following objectives;

1. ***Provide an overview of IGAD's regional pasture production status, challenges and opportunities for the region.***
2. ***Present the regional practices and lessons in sustainable pasture and pasture seed production for learning and out scaling.***

3. ***Present the opportunities and lessons for IGAD regional livestock producers on increasing the sectors resilience to the impacts of climate change.***
4. ***Provide technical support to technical teams working in the livestock sector in the IGAD region for increased landscape management and enhanced adaptation to climate change.***
5. ***Provide recommendations for sustainable pasture and rangelands management in the IGAD region.***

The manual thus presents concrete support materials for the livestock professionals and practitioners in the region in support to pastoralism and livestock production.

1.1 Background on the Pasture Manual

1.1.1 About IGAD Centre for Pastoral Areas and Livestock Development (ICPALD)

The IGAD Centre for Pastoral Areas and Livestock Development (ICPALD) was established in July 2012 after the 45th IGAD Council of Ministers meeting that Mandated it to create the regional body with a special focus in supporting and advancing livestock development and rangelands management. This is from the identification of the critical role the livestock sector support in the regional economies, with significant contribution to communities' livelihoods and nationals GDP. The ICPALD advances the institutional provisions of the IGAD Animal Health Policy Framework in the context of trade and vulnerability support strategy development of the member states.

The IGAD region constitutes about 70% of rangeland ecosystems, predominantly inhabited by Pastoral and agro-pastoral communities. The inhabitants mostly rely on rangeland resources for a living. These drylands have been increasingly exposed to the impacts of extreme climatic events, chiefly the frequent droughts and in some regions devastating flash floods leading to displacement and losses. Many of the communities in the region have developed adaptation strategies to climatic anomalies and their subsequent impacts on their livelihoods. The pastoral and agro-pastoral producers have continued to adopt pasture and fodder production as one of the climate adaptation strategies to avert feed deficits. Within the IGAD region, many development partners and governments have continued to promote pasture

production and management, However, being pastoral communities, who have continued to rely on natural pasture vegetation for decades, some of the pasture production interventions and practices has continued to be a new venture, for the example the established pastures, and thus, the levels of adoption have been low and varying scales among countries.

Pasture production from the natural environments within the vast rangeland ecosystems in the IGAD countries has been greatly affected by the increasing frequency of droughts, with high variability of rainfall events, greatly impacting on pastoral livelihoods. Notably, the vast country's land mass support over 70% of the livestock and wildlife populations. Unfortunately, the integrity of these critical ecosystems is under threat from climate variability and change, particularly recurrent droughts (Tierney *et al.,* 2025; Han *et al.,* 2022). The IGAD region has continued to experience droughts every two to three years and major ones every decade (Marthews *et al.,* 2019; Adloff *et al* 2022). This is with the exception to the arid parts of the Horn of Africa like Northern Kenya, Sudan, Ethiopian, Djibouti arid lands which have continued to experience droughts after every year with increasing recurrence (Nicholson, 2014; Adloff *et al.,* 2022; Alasow *et al.,* 2024). These droughts usually result in immense losses in pasture resources and affect the livelihoods of many pastoralists (Agutu *et al.,* 2020; Alasow, *et al.,* 2024). The impacts of these droughts on the population have been increasing exponentially from 1970s to date (Muller 2014; Masih *et al.,* 2014).

1.1.2 Drought and its impacts in the IGAD Region rangelands and livestock sector

Drought intensity coupled with climate change consequences, have adversely affected the livelihood of many pastoral and non-pastoral communities in the ASAL areas of the IGAD region (Matanó *et al.,* 2022; Alasow *et al.,* 2024). As a result, there are many communities who live below the poverty line (1-dollar day) and vulnerable to natural and manmade disasters. For example, it is reported that about 60% of undernourished persons and about 79% of stunted children are residing in the Horn of Africa (HoA) countries characterized by conflicts and are victims of climate change impacts (FAO et al., 2017; Abebe 2021). Notably, as reported by IGAD (2020), the prevalence of acute food insecurity in the region was 61% in South Sudan, 27 % in Ethiopia, 22% in Kenya, 17% in Somalia and 14% in the Sudan, all attributed to poverty driven forces as a result of climate change, with most pastoral communities being most hit and vulnerable. Past statistics from the HoA have shown that countries like, Ethiopia, Djibouti, Sudan, South Sudan, Eritrea, Kenya, Uganda, and Somalia have suffered from famine throughout their histories with more than 40% of the region's population living in areas prone to extreme food shortage with high poverty incidences, with households living on less than a dollar in a day (Markakis et al., 2021; Azadi *et al*., 2022).

The aforementioned challenges in the IGAD region put pressure on the current grazing resource governance system, and thus there is urgent need to come up with suitable plans to alleviate poverty as well as enhance the resilience of the pastoral communities. In the quest to address this need, strategic pasture and fodder production has proven to be an opportunity, with the potential to adapt and mitigate the impacts of climate variability, while building community resilience.

1.1.3 Present and future of pasture production and rangelands ecosystems in the IGAD Region

Many development organizations are working with pastoral communities in the IGAD region in areas of pasture production and management, natural resource management and governance, diversification of incomes, conservation of biodiversity among others. However, for the past decade, pasture production has been identified as the main opportunity to bridge the gap between feed deficit and surplus within the years. Therefore, investments in pasture production programmes have been on the rise in recent years, coupled with community training on pasture establishment, pasture agronomy, rangeland rehabilitation, and targeted pasture projects by partners among others. Most programmes are done by development partners and donors, with the aim of rehabilitating rangelands to increase feed and food supply to pastoral livelihoods.

Despite the interventions, pastoralists are still struggling with pasture deficits, low productivity in the rangelands, low pasture production and use within the region. This could be attributed to the many challenges facing the production activities and the entire pasture value chain. Therefore, among the programmes, IGAD has supported projects in the region targeting governance, conflicts management and reseeding and rehabilitation of rangelands. From the field assessments on communities' livelihood options, it is still evident that pastoralism and agro-pastoralism, will still be the main activity in the IGAD region, and thus, the need to put in strategies to sustain the communities' choices is recommended.

1.1.4 IGAD -ICPALD support to regional pasture and rangeland management in the region for sustainable livelihoods

IGAD Centre for Pastoral Areas and Livestock Development (ICPALD) was established with a mission to complement the effort of the IGAD member States to sustainably generate wealth and employment through livestock and complementary rangeland resources in arid and semi-arid areas of the region. Its overall objective is to promote, facilitate and advocate for people-cantered and gender-responsive sustainable development in Arid and Semi-Arid Lands (ASALs) and livestock in the IGAD region. ICPALD thrusts in the improvement of animal health, production, and marketing;

enhanced dryland production and pastoralism, including value-added rangeland products with the aim of bringing positive impacts on food and economic security, especially in rural pastoral populations. IGAD has continued to provide cooperation and coordination of actions based on evidence of risks to shared resources remain the principal means of achieving these benefits.

IGAD –ICPALD has supported this manual development to support the understanding of the regional pasture production and harmonize pasture and fodder production practices for the region with funding from GIZ - SCIDA III project, which works in supporting regional sustainable management of rangelands. This manual directly seeks to support the key resource 'feed' availability in quality and quantity that will support the livelihoods of pastoral communities. The manual was developed after a comprehensive scoping study and fact finding that supported developing a responsive and practical regional pasture and pasture seed production manual. This manual will contribute towards Natural Resource Management and aims to enhance the sustainable management and use of transboundary rangeland resources for community resilience in the IGAD region.

1.2 Guideline on the Training Manual Use

1.2.1 Training Preliminaries and Process

This manual has been developed to present the regional perspective in pasture and pasture seed production for IGAD member states. The manual presents various production practices applicable in the region documenting the dominant production systems and practices. The manual also builds up on success cases to provide lessons for the region that could be replicated. The manual is designed to cover pasture production and conservation in the arid and semi-arid rangeland systems within the IGAD region. The manual provides topics that provide guidelines and technical knowledge to technical trainers and the community pasture and pasture seed producers.

1.2.2 Training Preparation and the Training Norms to Be Followed

The use of these manuals will need proper planning for ToTs capacity development in the region. The training provides for class learning and field practical sessions and thus has some financial implications that will be dependent on training location, number of participants and topics of interest for trainees. It is assumed that not all topics may be relevant to different teams depending on region, needs, and background of the trainees, and thus, for practical use of the manual, the planners need to do training needs assessment and capacity gaps and then use the specific section of the manual to deliver. During the trainings, the following Norms and requirements should be considered for effective delivery of the content, in the form that will be useful to the team and support in making a difference to communities' livelihoods in the pastoral and agro-pastoral areas;

- *The participants should commit to taking the whole course when planned to depend on needs assessment.*
- *Active engagement in a participatory manner during delivery by all trainees is mandatory*
- *Ensure there is cooperation between trainees and trainers and flexibility of translation to most understandable language by trainers is important*
- *Trainees should focus on knowledge acquisition during lessons and commit to applying it with commitments*
- *Trainees and trainers should strictly keep to the agreed training times and period, with participatory selection of appropriate training venue by all parties.*
- *Respect for other people's opinions or views will be critical for all the training sessions*
- *We expect all trainings will be coordinated discussions- One speaker at a time facilitated by the trainer*
- *All trainees and trainers will adhere to training decorum by avoiding unnecessary movements during training.*
- *All mobile phones to remain on silent mode/vibration during training sessions for limited disruptions*
- *All training courses held will have gender considerations in trainees' selection and special consideration to people differently abled in the society, youth and the vulnerable member's support.*

1.2.3 Expectations from Participants

Class discussion on what are the trainee's expectations after the training? - 20 Minutes

The trainees should be able to clearly explain why they need the training, how the training will benefit them, how they intend implement the knowledge and skills gained and highlight of the community/societal challenges they would want to address after the training.

The master trainers will always seek to discuss with the trainees before the training begins. There will be a need for self-introductions to set up a free expression mood, with trainees' background information sharing. Thereafter, the master trainers should seek to receive the trainees' expectations using participatory approaches like pin cards shared to all, and collected, arranged thematically on the wall, or stick board and then participatory read and agree with the participants. Below are some of

the expected responses from the trainees, but not limited to, of which it is what is expected to be achieved from the training manual.

- *To learn on how to improve on pasture and fodder production*
- *To learn how to know planting methods, harvesting, storage and conservation*
- *To be provided with pasture production technologies so that more pastures for our animals can be produced*
- *To learn on pasture seed harvesting, storage, utilization*
- *To learn on land management for pasture production/Reseeding in natural rangeland landscape/ecosystem*
- *To learn on commercial fodder production*

1.2.4 Expected Learning Outcome from the Manual

By the end of the Pasture and pasture seed production training, the learners should be able to:

1. Explain the different pasture production practices in the IGAD Region and from the trainee's specific country/ region
2. Explain the specific pasture production challenges in their countries and specific regions
3. Demonstrate understanding of the different pasture reseeding technologies and applicable regions/areas/ range sites with reasons
4. Describe the different pasture preservation and conservation technologies and their applicable regions and situations
5. Demonstrate ability to support pasture value addition and understasdning of pasture value chain for different regions

1.2.5 Proposed Training Schedule

This manual has been designed in modules of about 7 days' delivery, but this may be modified based on time available and target topics depending on trainee's interest and time available. The time can be more if trainees' knowledge is low and from training needs assessment, and when practical hours are extended to allow effective learning. Thus, master trainers and planner are free to customize the schedule to best fit the need and situations. Below is a schedule of the topics.

Day	Time	Sections	Content
Day 1	8.00am - 5.00pm	Module 1:	1. Introduction 2. Training objectives 3. Training Preliminaries and Process 4. Introduction to pasture and pasture seed production 5. Pasture and rangeland management 6. Challenges to pasture production 7. Opportunities for pasture production 8. Land degradation and loss of natural pastures
Day 2	8.00am - 5.00pm	Module 2:	9. Pasture Production and Reseeding 10. Selection of pasture and pasture seed production areas/ reseeding areas 11. Types of important pasture types in rangelands 12. Planning Process for pasture production 13. Timing for pasture establishment/Reseeding 14. Selection of pasture/Fodder type for reseeding and /or pasture establishment
Day 3	8.00am - 5.00pm	Module 3:	1. Common rangelands grass species used in reseeding and pasture establishment 2. Legumes plants as Forage 3. Fodder trees that support Silvo-pastoralism 4. Land Preparation for pasture establishment

Day 4	8.00am - 5.00pm	Module 4:	1. Pasture Establishment technologies/practices 2. Pasture management practices for Established pastures and their sustainability
Day 5	8.00am - 5.00pm	Module 5:	1. Rangeland Forage Seed Multiplication 2. Pasture seed production and Multiplication 3. Pasture seed production process and management strategies 4. Pasture seed storage 5. Fodder Storage and Conservation
Day 6	8.00am - 5.00pm		1. Management of natural pastures 2. Pasture Preservation and conservation methods 3. Pasture preservation, conservation, value addition and storage 4. 4Pasture biodiversity conservation and Research for Sustainability 5. Research on pasture production and utilization 6. Grazing management for sustainable rangelands 7. Pasture/Fodder Processing and Value Addition
Day 7	8.00am - 5.00pm		1. Pasture/Fodder value chain development and management 2. Pasture Production as a business opportunity 3. SWOT Analysis of pasture/ fodder value chain 4. Trainees self-test assessment on pasture training

1.3 Introduction to pasture and pasture seed production in the IGAD region

Pasture has become the most critical resource supporting the main pastoral livelihoods in the IGAD region. The need for sustainable pasture production is becoming increasingly important. For quality pastures, there is need for proper establishment and management. The region faces many challenges to the production systems, and thus, need for strategic plan in pasture activities, including the need for seed bulking for enhanced reseeding and rehabilitation efforts within the man y degraded areas.

1.3.1 Rangeland and terminologies in their management and use

Training discussion under the moderation of Master Trainer
30-45 Minutes Max

The master trainer to lead the discussion by asking trainees on their understanding of what are rangelands? Arid and semi-arid lands? Their uses and benefits?

The discussion should also bring out what pastures are. What are the pasture production challenges from their regions? What are pastures? Forages? Feeds? As per their understanding. Do they produce pasture seeds? Which ones? What are the opportunities in pasture and pasture seed production from their regions?

The trainer may also try to get a discussion from the team on regional pasture production challenges to have their understanding and explore how they see the opportunities to address the regional challenges while relating to their local challenges. The discussion points should be noted down in flip charts.

Master trainer to enhance free discussion, sharing of information and create a free environment for contributions by all trainees, with moderated focus and cope by trainees keeping time. Key focus to set up the stage is; why do we need to produce pastures? Benefits must be highlighted from environmental to socio-economic perspective.

From the discussion; it should come out clear that;

Rangelands are uncultivated grasslands, shrublands, woodlands, wetlands, and savannas suitable for grazing and browsing domestic and wild animals. In the IGAD region and training purpose, we will note that they are lands within Arid and Semi-Arid areas (ASALs) dominated by natural or semi-natural vegetation suitable for extensive livestock production and wildlife conservation, as known within the IGAD region. Region context: IGAD Region has about 70% of land mass being rangelands in the following countries (Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan and Uganda). Kenya over 80%, Ethiopia 70%, South Sudan 70%, Somalia about 87%, Djibouti 83%).

Arid and semi-arid lands: This includes the tropical grassland and savannah/ woodland savannah, the warm desert and semi-desert, temperate grasslands, tundra communities, and cold deserts biomes. The Regional ASALs are classified as below, with all the IGAD countries having representation in different proportions;

Table 1: IGAD region Rangelands categorization based on amount of rainfall received

AEZ	r/E0 (%)	r (mm)	E0 (mm)	Climatic Designation
IV	40-50	750-900	1800-1880	Semi-humid to semi-arid
V	25-40	525-750	1880-2095	Semi-arid
VI	15-25	520-525	2095-2150	Arid
VII	<1	170-320	2150-2280	Very

Source: *Regional rangeland management strategic framework: 2019, IGAD Centre for Pastoral Areas and Livestock Development (ICPALD)*

Notably, it should be noted that these lands cover over one third of the earth's land surface and are home to over 900 million people.

Pastures: Pasture lands in the narrow sense are enclosed tracts of farmland, grazed by domesticated livestock, such as horses, cattle, sheep, or goats. The vegetation of tended pasture, forage, consists of grasses, with an interspersion of legumes and other forbs (non-grass herbaceous plants). Pastures can also refer to naturally occurring grass fields managed and utilized by livestock, found in almost all the agro-ecological zones, but majorly within the arid and semi aroid zones as natural grazing pastures.

Fodder: Coarse food for livestock, composed of entire plants, including leaves, stalks, and grain, of such forages as corn and sorghum.

Feed: hay, straw, silage, compressed and pelleted feeds, oils and mixed rations, and sprouted grains and legumes. Grass and crop residues are the most important source of animal feed globally

The discussion on Roles of Rangelands should highlight on the following benefits, with regional and country specific example depending on sessions and audience;

(Mater trainer to enhance free discussion, sharing of information on Rangelands and their benefits)

Rangelands play a significant role within the IGAD region.

- *They provide habitats for a diversity of flora and fauna-birds, wildlife*
- *Support socio-cultural communities-traditional uses, houses*
- *Environmental and economic significance-clean air, gaseous cycles*
- *Home to pastoralists and agro-pastoralist communities*
- *Pasture for livestock and wildlife*
- *Next frontiers of development*
- *Industry raw materials-gums and resins, honey, medicinal products etc.*
- *Employment opportunities for communities*
- *Recreation services and biodiversity conservation*
- *Resources for export, minerals/oil/gas*

1.3.2 Pasture and rangeland management in the IGAD Region

Training discussion under the moderation of Master Trainer

(These notes to support the master trainer and TOTs on regional issues on pasture and rangeland and their sustainability opportunities)

30-45 Minutes

The impacts of droughts on the population have been increasing exponentially from 1970s to date. Drought intensity coupled with climate change, have adversely affected the livelihood of many pastoral and non-pastoral communities in the Horn of Africa, IGAD Region being among the most hit part of the regions. This has affected forage and pasture supply for livestock, the main livelihood option.

The community's actions have also contributed much to the increasing frequency of droughts which threaten their livelihoods. Main activities by communities that have worked against them include; over grazing, deforestation and unplanned

settlement and water development. As a result, many communities are vulnerable to natural and human-caused disasters and continue to live below the poverty line. This, however, puts pressure on the current resource governance system, with much need to produce suitable plans to alleviate poverty and build the resilience of pastoral communities.

Pasture production and reseeding is among the interventions that will contribute to building resilience of pastoral households in these areas, besides the critical need for proper grazing plans and rangeland management practices. This manual provides insights on pasture agronomy, management, and utilization in the context of pastoral production systems. The need for sustainable production systems is important since we need to meet the nutritional demands of cattle and small stock (shoats) and camel in extreme drought situations. Importantly also, we need to protect our grazing lands from degradation.

The need to increase livestock production is critical for the IGAD Region, being the main livelihood option for the communities. The production systems have been facing many challenges related to environmental degradation, reduced land productivity, increased vulnerability due to climate change and variability as well as social-economic challenges from the many complex interactions within the fragile ecosystem.

There have been tremendous efforts to improve the welfare and well-being of the vulnerable communities, with major focus on livestock value chain support even within the humanitarian support context. Sadly, with the vastness of the IGAD countries, and the much-entrenched needs of the many vulnerable households, these efforts do not fully build the resilience of the communities.

Despite these challenges, the countries and the communities have valuable resources with potential to support sustainable and resilient livestock production for food and nutritional security. To achieve this, there is a need to plan and implement sustainable pasture production and livestock husbandry practices.

This training seeks to support the extension staff as ToTs, and the community pasture producers and rangeland manager in reseeding and establishment of pasture for better feed production and land rehabilitation.

The knowledge and skill provided seeks to build on the past activities support to communities by various organizations on resilience support and development of pastures and livestock sector for enhanced adaptation of communities to climate change, while increasing environmental protection and conservation through sustainable livelihoods and income generating activities.

This is in line with the ICPALD mission in the region, working towards supporting and improving livestock productions as a key economic activity for communities. The training manual and sessions seek support from IGAD member states in enhancing our rangeland productivity and reducing the impacts of climate change. These efforts will contribute to the support of the vulnerable communities in the IGAD region.

1.3.3 Challenges to pasture production in the IGAD region

Training discussion under the moderation of Master Trainer

(Plenary discussion on what the trainees think are the challenges to pasture production in the region/their countries/local regions)

All the challenges be listed and a discussion on each on why they are a challenge and how this can be addressed)

30-45 Minutes

(Master trainer to enhance free discussion, sharing of information on regional challenges. Local challenges both from ecological, social, environmental, climatic, biotic, and abiotic related)

Delivery Approach

(Depending on number of participants, do in groups or as a plenary discussion the following activity)

(Create a participatory populated table of the Challenges, causes and Solutions, including who can support to achieving the solutions from the discussions)

Below is the Expected table to populate, depending on region of trainees and the context in which the discussion will be focused. The table created will also provide trainees with some kind of action plan to implement based on the solutions provided.

CHALLENGES TO PASTURE PRODUCTION	***CAUSES OF THE CHALLENGES***	***SOLUTIONS TO THE CHALLENGES***	***RESPONSIBLE/SUPPORT TEAM***
Land degradation			
Loss of natural pastures			
Overgrazing and under grazing			
Droughts			
Floods			
Termites			
Invasive weeds			
Pest (Locust) and diseases			
Wild fires			
Climate change			
Illegal grazing			
Insecurity			
Land use changes			
Lack of market access			
Lack of pasture seeds			

Training discussion under the moderation of Master Trainer
(These notes to support the master trainer and TOTs on challenges and the management of pasture production as identified)

30-45 Minutes

1.3.3.1 Land degradation

Land degradation is one of the major threats to pasture and pasture seed production in IGAD states. This refers to the reduction or loss of biological or economic productivity of cropland, pastures, forests, and woodlands.

Main causes of land degradation

The main causes include;

- ✓ Climate changes resulting to frequent droughts and occasional floods
- ✓ Land use changes in the ecosystem and landscapes, increase in crop farming with soil disturbance in marginal landscapes
- ✓ Overgrazing
- ✓ Deforestation
- ✓ Invasive plants encroachment

All these results in deterioration and erosion of soil properties resulting to loss of ground cover. The losses of soil also reducing or completely removing soil seed gene bank affecting ecosystem regeneration. Droughts occur naturally every one out of five years or less in IGAD region rangelands, but in the recent past, the frequencies of drought events spells have become yearly with rainfall becoming increasingly scarce.

Plate 1: Charcoal Burning in rangelands causing deforestation: Location - Moroto district, Uganda

Plate 2: Fuel wood and construction wood cut causing deforestation: Location - Moroto district, Uganda

Plate 3: Parthenium Hystorophorus weed invading pasture lands inKenya, Kajiado County.

Plate 4: Ipomoea Hildebradndtii weed invading pasture lands in Kenya, Kajiado County.

Plate 5: Selected identified invasive species found in the IGAD region; Parthenium hysterophorus, Opuntia stricta, Solanum incanum (Sodom Apple), Ipomea spp

Plate 6: Invasive Xanthiam strumarium

Plate 7: Serious threats from Parthenium hysterophorus

Plate 8: Land use changes with deforestation in Kajiado County.

Plate 9: Land degradation and erosion threats to the landscapes within the Masai mara ecosystem

Impacts of rangelands degradation to ecosystems and livelihood of communities in the IGAD Region

The IGAD region states are affected by the impacts of land degradation within the dominant grasslands supporting grazing for both wildlife and livestock. Grazing lands' degradation is associated with loss of primary productivity, mostly due to overgrazing and frequent droughts. Below are some direct effects of degradation;

- ✓ Increase in invasive species within the rangelands. The IGAD region has experienced an increase in weeds, the most dangerous and widespread weed is *Prosopis juliflora*. This has affected all the IGAD countries, with spreading getting to alarming status in Kenya, Ethiopia, Somalia, Uganda and Djibouti. Other emerging problematic weeds in the rangelands are *Parthenium hysterophorus, Solanaum incunum, Ipomoea hildebrandtii* in Kenya, Ethiopia, and Uganda.

- ✓ Decreasing forage resources in rangelands as a results of land degradation from soil erosion which has increased livestock losses, increase in production costs from purchasing feeds, loss of soil gene bank and exacerbated impacts of droughts to pastoral dependent livelihoods.

- ✓ Loss of beneficial biodiversity of forage plants and other important medicinal and wild food plants that benefited the pastoral communities. Rangelands of Kenya, Ethiopia have seen a decline in palatable species such as *Cenchrus ciliaris, Chloris roxibhurghiana, Digitaria macroblephara, Enteropogon macrostachyus, Eragrostis Superba, sporobolus pellucidus* among others. The reducing plants are replaced with many upcoming unpalatable species within grazing lands.

- ✓ Changes of vegetation structure from land degradation has also been observed with reduced land productivity, with bush encroachment into

previously useful savanna grazing ecosystems, example is the *Acacia reficiens*, *Lanatana Camara* and *Prosopis juliflora* species that have spread unprecedentedly thus worsening availability of forages for livestock.

- ✓ Reduced land productivity has affected livestock productivity hence impacting on human livelihoods directly, directly from reduced carrying capacity and reduced productivity per head and per unit of land.
- ✓ The Conservation of wildlife biodiversity has also been seen because of land degradation, with increasing human wildlife conflicts experienced in Kenya, Tanzania.
- ✓ The rangelands of the IGAD region have become expensive to manage for livelihoods support due to land degradation, with costs of reseeding becoming high.
- ✓ The landscapes degraded in the region also face reduced ecosystem services (poor water quality, decline in water table, loss of climate regulation ability) affecting community livelihoods and quality of life.

Measures to reduce and address rangeland degradation in the IGAD region

- ✓ Land rehabilitation efforts are urgently needed in the many areas degraded within the rangelands of IGAD region, with promising practices and technology interventions available.
- ✓ There is need to practice sustainable farming systems with grazing lands being maintained and managed with reduced or avoided farming in marginal rangeland ecosystems.
- ✓ There is need to control the carrying capacity with variable strategies depending on seasonality and forage availability to avoid over grazing in the rangeland ecosystems.
- ✓ The IGAD countries should work towards reducing deforestation from charcoal and fuel wood and thus need for clean energy support like solar and gas to reduce pressure on wood as well as use of energy efficient stoves for wood energy.
- ✓ There is an urgent need to support control and management with removal of introduced invasive species like *Prosopis juliflora in* the IGAD region, with also other species like *Ipomea hildebradtii* and *Parthenium hysterophorus*. Community invasive species control strategies are urgently needed in all the rangelands affected in the region.
- ✓ Restoration of degraded sites through removal of unwanted weeds and reseeding with native species is also an opportunity to be considered.

Pasture reseeding provides potential for environmental protection from impacts of degradation and increase in forage supply for livestock. The biggest challenge facing pasture reseeding efforts is availability of seeds in terms of good quality and quantity.

Plate 10: Degraded bare land in West Pokot County, Kenya

Plate 11: Reseeded areas in Makueni county, Kenya

1.3.3.2 Sporadic and frequent Floods

Sporadic floods are some of the challenges that have been reported in the IGAD regions, especially in areas where pastures and rangeland restorations are being done within river flows, flood plains and lowland run in areas. Ethiopia areas of Afar and Oromia have immense potential areas for pasture production, but floods have limited some areas from Omo River and other dry river, with some incidences of infrastructure destruction. This has also been reported on pasture production areas in Kenya along Tana River on Sothern and Turkana from Turkwel River. Somali regions of Shebelle, Jowhar region and Xaaxi have also been affected by intense floods which sometimes reduce pasture productivity, with the expected loss of soil gene bank and initiated land degradation for sheet erosion.

To reduce flood problems, vegetation cover must be increased to slow water flows, soil infiltration supporting underground water recharge and support natural regeneration. Onsite Rainwater harvesting using applicable technologies will also reduce flood challenges, including riverine ecosystems revegetation to manage flow intensities.

Plate 12: Floods affecting farms and pastureland in Somalia, Jowhar region, Shebelle River. Photo credits: mustaqbalmedia.net

Plate 13: Scale of floods from Shebelle River in Somalia. Photo Credit: FAO-SWALIM

1.3.3.3 Termites

Termites have been identified as one of the major threats affecting pasture productivity within natural standing hay or bales not well stored with increasing effects during dry seasons. Even though termites have positive ecological roles, they consume a significant amount of biomass within the rangelands. To reduce losses from termites, timely grazing with a good grazing plan can limit losses. Other ways to reduce this challenge are pasture harvesting and storage as hay or value added though processing.

Plate 14: Termites in the Karamoja, Moroto District, Uganda

Plate 15: Termite mounts in West Pokot County, Kenya

1.3.3.4 Pasture pests and diseases

Pasture pests and diseases have also become other threats to sustainable pasture production in the IGAD region. Locust pests have been identified as the major threat

to pastures with a recent increase in invasions leaving pastoralists more devastated.

To reduce the locust threat, timely grazing, pasture harvest and storage are recommended. Other strategies are timely control from the breeding zones, more so into the source countries along the red seas. Countries most affected by Locust is Djibouti, Kenya, Ethiopia, Somalia, and Tanzania. Pasture diseases like leaf rust, st8unting have also been reported in specie like Bracharia and Nappier grass pastures. However, most native pastures have disease resistance abilities.

Plate 16: Locust's infestation in rangelands. Photo Source: https://www.actionagainsthunger.org

1.3.3.5 Wildfires

The IGAD regions have also seen challenges of wildfires from natural lightning or at times human-caused fire disasters affecting vast rangeland ecosystem, reducing forage and feed for livestock and even wildlife. Kenyan rangelands have seen a series of wildfires in southern rangelands of Taita Taveta, Rift counties of Pokot, Turkana, among others. Ethiopian rangelands and Tanzania have also some sporadic wildfires. The fires reduce biodiversity, lead to soil seed gene banks loss and forage biomass loss impacting community livelihoods.

To reduce wild fire effects, there is need for timely emergency responses when incidences happen. There is also need for fire breaks planning, especially when fire risks are detected or when biomass is high with risk of fires to prevent wider ecosystem impacts. The need to also train pastoral herders and wild honey harvesters on fire risks management and reduction is important for the region states. Among pasture rangeland and community enclosures, fire breaks are mandatory to protect devastation from wildfires.

Plate 17: Wildfires in Tsavo Rangelands, Taita Taveta county, Kenya

Plate 18: Wildfires in the rangelands of Moroto district, Uganda

1.3.3.6 Illegal grazing and encroachments

Illegal grazing is reported as one of the challenges within the IGAD region, more so in the reseeded and rehabilitated areas. The most driving force is the breakdown of traditional rangeland management customary regulations, with increasing violations of grazing plan strategies including encroachments into set out dry season grazing areas for pastoral communities.

The need to strengthen customary regulations and rules that work in the IGAD region will be important to the reduction of the illegal grazing challenges. There is also a need to have legal protection mechanisms to safeguard protected areas and rehabilitated areas until deemed ready for use by the communities. The need to develop effective grazing management plans at pastoral grazing areas with regulatory frameworks will go a long way in reducing the illegal grazing challenges.

1.3.3.7 Insecurity and conflicts over grazing resources

Regional insecurity has been reported to be among the threats to pasture production and utilization in some member states of IGAD. Insecurity has limited access to some grazing areas, example is Kenya North Rift, West Pokot, Turkana, Samburu Counties, and this has resulted to underutilization of insecure areas at the cost of over grazing to limited secure areas thus causing land degradation and loss of feed resources. Somalia also reports inter clan conflicts to sometimes limiting sustainable grazing strategies and thus affecting pasture production. The Kenya-Uganda Karamoja cluster areas has also some cases of sporadic conflicts, but with the Kenyan and Ugandan governments having some efforts that has seen decline of conflicts, cattle rustling and reduced weapons by the communities.

The need for peace building initiatives and community dialogue opportunities in support of transboundary resource sharing is a starting point to addressing the challenge. Community security support by the governments is also important.

When rangelands are protected and managed well, when insecurity happens, loss of access, control and utilization plans usually return effort backwards, with more degradation happening.

Box 1: Summary of Rangeland Challenges in the IGAD Region

From the regional perspective and situation analysis, it is evident that the challenges are common but vary from one region to another depending on agro-ecological zone and livelihood options. However, it is notable that land degradation is the major threat in the IGAD region, coupled with the impacts of climate change and variability to community livelihood. The most critical impacts of rangeland degradation loss of feed/forage for both livestock and wildlife, and thus, these manual support the need for protection of available forage resources, with promotion of strategies on fodder production and conservation. From the module lessons, below are recommended capacity gaps that need to addressed for the identified challenges;

- Community Capacity development on Rangeland management for invasive species
- Community natural resource governance using participatory rangeland management (PRM) approaches
- Community preparedness training for disasters like wild fires, droughts and floods for ecosystems stability and safeguarded livelihoods
- Youth and women and the elderly are affected different by the identified challenges based on their roles, and thus strategies that have gender considerations are needed in addressing the regional rangeland management challenges.

1.4 Pasture Production in the IGAD Region

The IGAD countries have diverse agro-climatic regions that determine the pasture and fodder production practices and the strategies employed by the communities. However, the main production systems are pastoralism and agro-pastoralism. Notably, there is an increasing modernization of the production system with peri-urban livestock keeping bringing in some form of intensive livestock system, courtesy of increasing urbanization and development with population increases.

1.4.1 Extensive rainfed system

The extensive pasture and livestock production system takes three forms within the region. The key characteristic is production under the highly variable climatic

conditions, with seasonality playing a significant role in exploitation patterns. The high variable rainfall patterns across spatial-temporal scales have made the system complex with increasing vulnerability to communities, especially in the arid and very arid climatic zones.

a) Free range system

Free range system can be looked at from two perspectives, free range pastoral and free range agro-pastoral system, both depending on rained systems for pasture production and utilization. The free-range pastoral system has continued to rely on nomadism, with mobility being an imprint strategy for grazing resources extraction. The communities move with their stock to access pasture and water, with strategic information sharing on where to move and when to move. The system has sustained livelihoods for centuries, however, with the increasing population and breakdown of the traditional management strategies of resource sharing based on customary agreements, the system has been declining in practice. The transnational communities in the region, for example Borana, Oromo, Somali, Karamoja, Turkana, Pokot have benefitted from this system for centuries, and is still beneficial for Kenya, Ethiopia, Somalia, South Sudan, and Uganda among the transboundary area.

The free range agro-pastoral system is also an important feed/fodder production system in the region, with agro-pastoralists who practice seasonal farming and livestock keeping exploiting season for livestock feeding strategies with natural pastures or crop residues by free grazing. Agro pastoralists also explore the fallow period under this system to allow natural grasses to grow and provide animal feeds. Some of the agropastoral communities also deliberately have adapted to the climate and seasonality challenges by practicing pasture planting within the agro-pastoral system. For example, the Akamba and Taita agro-pastoralist in Kenya have shown strategic pasture production, with utilization of research knowledge in range pasture and pasture seed production, thanks to regional and national research support institutions like Kenya Agricultural and Livestock Research Organization (KALRO) in Kenya. This practice has also been seen to be embraced by the Maasai Agro-pastoralist in Kenya who have been planting pasture as over sown pastures or massive pasture farm through rehabilitation efforts. The Oromo and Afar communities in Ethiopia have also embraced pasture production as a practice within the free-range grazing system, with timely reseeding and planned grazing.

Pasture production under free range system greatly depends on rangeland management strategies that reduce overgrazing, chiefly mobility strategies. This also depends on the existing customary relationships among communities, with elders being central to supporting harmonious exploitation as in the past.

b) Rangeland Pasture enclosures

Pasture enclosures has also been a kind of pasture production and management system in the IGAD region, with communities using the strategy to control access and utilization as well as prevention of over grazing or as strategy to regenerate the

land or as strategic fodder reserves for their livestock. This practice seems to move away from free open grazing to a controlled system, and more supported by some form of private or communal ownership of defined landscapes. The practice has shown some satisfactory results in regenerating lands in Kenya (West Pokot, Baringo) and in Taita Taveta County. Also, Within the Oromia and Afar regions of Ethiopia, the practice has shown enormous potential for pasture regeneration within community enclosures. The other examples that has shown success is in Somalia Toghdheer region, Oodwayne district, with the combination of Farmer Managed Natural Regeneration (FMNR) practices. The Enclosure system has also proven to be a sustainable concept with the Karamoja rangeland in Uganda, with one success case in Moroto, Muruita community where 30-acre land has been successfully rehabilitated with increased land cover, increased biodiversity and improved livelihoods of the communities being reported. In Turkana County, Lorgum site under SCIDA III, communities have also been practicing rangeland pasture enclosure, with half-moon bands for water retention that has supported natural enclosures regeneration.

c) Paddocking pasture production systems

The system is close to enclosure but has been widely adopted to private land ownerships like ranches with fencing done to divide grazing areas into paddocks, for controlled grazing and pasture protection from the illegal grazers. The system has been widely applied within grazing ranches in Kenya Laikipia county, Narok county and Kajiado county. Some of the paddocks are also used for pasture production bailing as a conservation method or as a commercial business, whilst others use the paddocks for direct grazing, especially grass-fed beef systems.

1.4.2 Intensive pasture and livestock systems

a) Intensive rain fed pasture/Livestock production systems in IGAD region

The intensive rain-fed pasture and fodder system in IGAD region is mostly practiced in the highlands with some significant rainfall amounts (300-500mm pa), mostly benefiting from the wet periods among the two bimodal rainfalls in most rangelands. The communities have practiced pasture systems with established pasture of some improved grasses like *Chloris gayana*, Sudan grass, *Cynodon dactylon* natural swards among other grasses, or with some fodder crop like Desmodium spp, Lucerne, alfalfa, among others. The system is mostly practiced by commercial fodder producers or intensive livestock keeper like dairying systems.

b) Irrigated pasture/livestock systems in IGAD region

Irrigated pasture production within the IGAD region is characterized into two, extensive irrigated pasture livestock systems and Intensive irrigated pasture livestock system, all depending on water harvesting and application practices.

Intensive systems have high capital needs with water harvesting structures like dams and bore holes being investments, while extensive systems being depended on natural water sources and strategies or practices of water distribution to the farms like river floods and diversions.

Intensive irrigated pasture/livestock production systems

The increasing impact of climate change has also made the communities consider irrigated pastures production in the arid and semi-arid lands within the IGAD region. The availability of irrigation technologies like sprinklers and pivot have seen high value pasture and fodder crops done, like legume fodder crops (Lucerne, desmodium, Alfalfa), especially under intensive livestock systems. Boreholes or earth dams have become some water development sources for irrigated pasture production in Somalia, Ethiopia, and Kenya.

Plate 19: Intensive large scale irrigated pasture production system in Turkana County using electric Pivot irrigation and Solar powered borehole water to reservoir at KVDA farm (Cenchrus ciliaris grass).

Extensive irrigated pasture/livestock production system

The other common irrigated systems include extensive river irrigation, with use of river water through simple furrow irrigation system with examples along the Tana River in Tana River county, Perkerra river in Baringo county, Dawa river in Mandera county, Tarkwel river in Turkana County within Kenya. We also have Omo River in Ethiopia, Shebelle River in Somalia, being some case examples of flood and furrow irrigated pasture production practices within extensive irrigation system. Spate irrigation systems also fall under extensive irrigation with river floods being used to support pastures. Other practices include road runoff harvest and spreading to pasture farms for production. Extensive irrigated fodder has high potential for commercialization as already seen with the increasing peri-urban livestock keeping in the IGAD countries. The peri-urban livestock farmers have high demand for fodder and hence access from own production or market from traders or fellow farmers doing fodder under irrigation.

Plate 20: Extensive irrigated pasture production from River Turkwel in Turkana County Kenya, Canal irrigation system for Juncao Napier grass through Public Private partnership.

Pate 21: Production of fodder under extensive river flood irrigation and Marketing in Somaliland. Photo Source FAO

Plate 22: Production of fodder under extensive River Turkwel canal flood irrigation in Turkana County

There is also potential for high value fodder crops from sweet potatoes or Bracharia species under irrigation. This could also be applied to produce protein source crops like Lucerne, Alfalfa, Desmodium and Dolichos lab.

Plate 23: Irrigated sweet potatoes- These tolerate drought and provide excellent quality fodder from the leaves during dry periods. Photo Source FAO

Box 2: Summary of Regional Pasture Production practices and the opportunities

The region major livestock production and fodder utilization system in natural free range system under pastoral livestock production strategies. This highlights on the importance of the natural vast pasture lands that support the regional herds, with the observed thr4ats from land use changes, climate change impacts on their sustainability. To sustain natural pastures, it is important that the following support be provided to communities;

- Natural grazing lands should be well managed, with the need for grazing management plans at community level.
- There is need for community grazing resource sharing arrangements that is legally binding and enforced by community in support to transboundary resource sharing
- There is need to support ecosystems rehabilitation and natural regeneration enhancement for the natural grazing lands to enhance feed/fodder availability.

The increasing climatic uncertainty for natural pasture also calls for innovative production and conservation strategies in the region. Strategic irrigation within the niche areas offers he opportunities for community adaptation to climate change impacts as well as utilization of strategic water sources. Thus, sustainable irrigation systems are recommended, including water saving technologies like drip, smart irrigation as well as opportunistic spate irrigation systems for flood prone areas in support to pasture production within the region.

1.5 Opportunities for pasture production in the IGAD region

The IGAD region has great potential for pasture and pasture seed production in support of pastoral and agro-pastoral livelihoods as well as with benefits to the IGAD countries economy. From the IGAD –ICPALD desk, it is noted that livestock constitutes a major economic activity, with greater roles in social and cultural support for over 250 million people within IGAD region. The region also provides the bulk of small ruminants traded globally, with an estimated 242 million shoats, with a total of about 520 million heads of livestock. More important, it should be noted that these stocks are reared under extensive systems in the region, relying on natural pastures and rangeland feed resources, of which, the current trends show even further increase in demand amidst declining productivity due to climate change impacts. The production systems within the IGAD being extensive pastoralism with transhumance being a major practice that has been reported to account for about 6-10% of the nation's GDP in the region. The estimated exports account for about 60MT of ruminant meat every year, estimated at about 13m heads of shoats (IGAD fact files; https://igad.int/livestock-development-at-igad-in-a-nutshell/)

For this manual use in support to livestock sector in the IGAD region, we present a SWOT Analysis of the pasture and pasture seed production in the region, which should guide the use and support to our regional communities for the benefits of humankind. Below is the Strengths, Weakness, Opportunities and Threats (SWOT) based on regional analysis and information synthesis within the IGAD member states.

Figure 1 Strengths, Weakness, Opportunities and Threats (SWOT) to pasture and pasture seed production in IGAD region

1.6 Pasture Establishment and Management in the IGAD Region

1.6.1 Planning Process for pasture production

The planning process for pasture and pasture seed production should always follow the participatory planning guidelines. Community engagements are paramount, with gender inclusivity consideration.

Training discussion under the moderation of Master Trainer

(Plenary discussion on what the trainees think are the planning processes for pasture production in the region/their countries/local regions)

(All the planning process identified be listed and a discussion on each facilitated)

10-30 Minutes

(Master trainer to enhance free discussion, sharing of information on why participatory planning process is critical including site selections, what problems need to be addressed, consideration of ecological, social, environmental, climatic, biotic, and abiotic factor in planning for pasture and pasture seed production)

Delivery Approach

(Depending on number of participants, do in groups or as a plenary discussion)

(Below notes to support the master trainer and TOTs on participatory planning process discussion or training slides for learning)

1.6.2 Selection of pasture and pasture seed production areas/ reseeding areas

The first step in pasture establishment and reseeding is the selection of appropriate sites by the community and/or households. The choice of sites should be able to support quick establishment, areas that have good soil. After the community discuss and agree on what problem they want to solve, such as soil erosion? Loss of soil gene bank? Loss of biodiversity? Improvement of pasture sward density? Stabilization of riverbanks? Reclamation of gulleys? Among other challenges as identified.

The participatory process should not be a one-time event, can include some time for more community engagements on their own, identify and give reasons of where and why from their consultations, with need to ensure majority buy in idea from the final resort.

Factors to consider and guide the community as they do participatory planning are;

- ✓ Site suitability in location, security, access, and agreed/favorable ownership arrangements that may not bring conflicts for successful project/activity. (Guiding principle for communal project sites should be fully owned and controlled by the community).

- ✓ Considerations of whether the site requires active reseeding or managing existing pastures and allow natural regeneration to occur. This depends on the percentage of existing desirable species, chances of soil gene bank presence etc., a factor that will also need community engagements for decision making based on the present status, building on their knowledge and past experiences.

- ✓ The ecological consideration for enhanced success is; areas with good soils, potential for soil water harvesting for enhanced establishment, land topography to reduce losses or need for land preparation based on topography etc. Please note that flat areas to reduce possibility of seeds being washed away by runoff. Also, communities should be guided to select areas of enormous potential from historical knowledge and experiences.

1.6.3 Timing for pasture establishment/Reseeding

Lessons from the region clearly show the need for timely planning and implementation of any pasture production activities. The high climate variability due to climate change has presented the need for adaptive strategies with precision in timing and execution of pasture projects. Notably, the IGAD region has strong climate information platform and support system to the nations, including at local scale potential based on strategic partner organization support, and this is the greatest opportunity for timely planning for reduced losses and wastage of efforts. There is need for proper timing for pasture reseeding to allow successful establishment. Below are some of the considerations and benefits accrued when deciding on proper time to reseed pastures;

- ✓ Provide proper timing for planting when the implementers have high confidence of sufficient soil moisture for germination.

- ✓ Planting should be done just before the rains to increase germination and to allow undisrupted preparation and planning for successful establishment.

- ✓ Timely planting ensures reduced losses of inputs and labour, with reduced failures, with the following benefits;

    - o This increase germination rates
    - o High chances of establishment
    - o Increase in biomass yields and seed yields.

1.7 Selection of pasture/Fodder type for reseeding and /or pasture establishment in the IGAD region

Training discussion under the moderation of Master Trainer

(Plenary discussion on what the trainees consider as the factor to consider when choosing pasture type/species/variety for establishment)

(All the considerations listed should be noted and a discussion on each facilitated)

10-30 Minutes

(Master trainer to enhance free discussion, sharing of selection criteria for pasture species for target region/ landscape/country)

(The discuss should bring out clearly factors of local germplasm consideration, the need for local adaptability for selected species, factors to productivity and preference, tolerability to situations like droughts, salinity, value for community/use values, economics, and practicability of establishment)

Delivery Approach

(Depending on number of participants, do in groups or as a plenary discussion, have the teams identify list of things to consider and supporting facts)

(Below notes to support the master trainer and TOTs on what the community should be consideration during the selection process, based on regional differences, local contexts, and desired outcomes by the communities)

The process of which species to reseed/plant is dependent on community selected sites. We note that reconnaissance visits play a significant role before actual decisions on which pastures to establish or produce. This allows the community to select species that once existed or that exist but with threats of decline and therefore adapted to local conditions. We note that participatory process for species of interest be allowed, with community dialogue and planning, of course this will also be guided by their region understanding, local knowledge, past status and with their future aspiration to the choice of species process. There is also need to appreciate that there is increasing knowledge and science that can also support the community on their choice options, of course this should be backed by evidence and support to sustainability factors, rather than outside economic focus from some species/varieties as experienced in the region. We thus strongly encourage the TOT to have ecosystem stability and

community land sustainability when supporting choice of species. For species with both limited communities' understanding and the experts little understanding, then such species choices should first pass through research screening and should be a research partners role and not straight to community implementation in large scale, despite any driving for or short-term benefits presented.

Box 3: Considerations for choosing pasture species for community establishment

The choice of species to use and promote among communities should have the following consideration;

- At least proven adaptability to the regions/locations/ecosystems eco-climatic zones (rainfall, temperature, radiation etc.). This can be supported by the proposed reconnaissance visits.
- Checks for adaptation to prevailing soil types, best if local available species are considered, if new, then there is need to match to its known soil requirements from source or from known scale of its habitats.
- The selected species growth attributes such as growth rate, productivity, and resistance to herbivory, palatability should be considered.
- Native plants are usually preferable to non-native plants. Nonnative species often become invasive weeds that compete with native plants. This is critical if there is limited knowledge on the introduced species of choice.
- The ToTs/experts should consider Available knowledge (scientific or indigenous) about the species
- During planning at native rangeland ecosystems, mimicking nature is recommended, that is, multiple species/multiple functional traits establishment is preferred than monocultures, with consideration of native diversity. This increases diversity of diets to livestock, habitat for biodiversity, increase resilience to environmental shocks etc., thus at times, the need for local plant seed bulking to enhance this is recommended.

1.8 Types of important Feed/Forage Resources in IGAD rangelands

Training discussion under the moderation of Master Trainer

(Plenary discussion on what are the important pasture and other forage species in the region/location/landscape)

(All the considerations listed pasture and forage types should be noted and a discussion on them facilitated)

(The expected list will range from grasses, forbs, threes, shrubs depending on locations/region, production systems and cultural systems)

10-30 Minutes Max

(Master trainer to enhance free discussion, sharing of known important species and varieties of pasture and forage plants in their locality/region/landscape)

(The discuss should bring out clearly which are grasses or grass-like plants, shrubs and trees, which species do livestock utilize and what community values/benefits, provide for their identification as critical components of forage types)

Delivery Approach

(Depending on number of participants, this be done in groups or as a plenary discussion)

(Field collections of the available materials if training is done within field sites will also help in bringing the understanding, with trainees/community collection and display during the training)

(Below notes to support the master trainer and TOTs on the categories of pastures and forage species the community may identify as important within their landscape/region)

The rangelands of the IGAD region have many feed resources with diverse plant species ranging from grasses, grass-like plants, legume shrubs and trees, which are admirably adapted to different rangeland sites. The array of this vegetation growing in different agro-ecological zones is determined by climatic and soil types, with their evolution within their space. The trees, shrubs, grasses, and forbs are all adapted differently to these conditions, with varying adaptation strategies known, from deep rooting, fast growing, rooting adaptation-tubers, seeding strategies-fast

seeder, and seed dormancy, among others. Therefore, during selection of fodder/pasture species for reseeding, knowledge of species adaptation is important for the region. This determines the success of any project intervention in rehabilitation, and the end productivity of biomass and seeds. Thus, matching and knowing some common plants is critical for the regional capacity development. Below is a broad classification of the forage classes with their unique characteristics making them important for livestock production in the IGAD region.

1.8.1 Grasses

Grasses are the largest biomes of vegetation globally, and within the IGAD region, grasses are the dominant vegetation in the vast rangelands. They are herbaceous monocots and are found everywhere in the world, forming the critical forage/feed for both livestock and wild ungulates, with other Gramineae family being critical for land stability like Bamboo grass. Grasses in the region are either perennial (live more than two years), with most rangeland grasses in the IGAD forming this proportion, while still others are annuals (lifespan less than one year), and are also critical forage resources owing to this adaptation strategy within the rangeland ecosystems, especially in the very arid zones. Most rangeland grasses are efficient in water use and fast growing, with significant quality of both dietary needs to ruminants and micro and macro nutrients supplies. Notably, one of the advantages with rangeland grasses is that they have a confounding adaptation to water stress, salinity, sodicity, water logging, and grazing pressure as well as to pests and diseases. Some of the attributes making them critical plants in the rangelands of IGAD region is that they are fast growing, have strong rooting systems that stabilize the soils and reduce erosions, have high feed value with high palatability, are tolerant to dry condition successfully surviving droughts, and also with divers species providing large primary portion for livestock and wildlife biomass.

Common rangeland grasses in ASALS of IGAD Region

This section presents selected grass species that are dominant in the IGAD region, but not limited to, the training sessions should produce a list which are found within the regions/localities and in a participatory manner during the sessions. A collection of species during practicals for identification is also recommended. This section builds on the past common pasture species for Kenya published by Oscar, K., & Kibet, S. (2021). Pasture production and conservation training manual, Under the Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/legalcode), (https://www.studocu.com/row/document/egerton-university/introduction-to-laboratory-animal-science/19-pasture-production-and-conservation/82424378) which permits unrestricted use, distribution, and reproduction, provided the original work is properly credited). This form part of reference training material for this IGAD Manual)

The most dominant grass species that are always found growing in association are;

1 Sporobolus pyramidalis

The species is native to Africa and some parts of Yemen. It does not have a distinct established English name, but it is one of the two species of giant rat's tail grasses. It has become a weed in eastern Australia. The species has seen an increase in rangeland of IGAD region, more into degraded landscapes, reported to be a salinity tolerant species, these versatile growing environments. The quality declines rapidly with increasing growth, becoming less palatable to stock.

Plate 24: Photos of Sporobolus pyramidalis growing in rangelands

2 Heteropogon contortus

This is a native tropical grass in Africa, reported to be a natural weed in most farmlands, but also in pastures, the species is an increaser plant due to low palatability with maturity. The species is fire tolerant and thus has seen to be more adapted in East African savanna rangelands shaped by wildfires. The plant grows tall to about 1.5 metres. The grass has dark seeds with a single long awn at one end and a sharp spike at the other. The awn becomes twisted when dry and straightens when moistened, and in combination with the spike can drill the seed into the soil.

Plate 25: Heteropogon contortus growing in rangelands

3 Chrysopogon aucheri

The grass is native in rangelands of tropical Africa, including Eastern Africa and one of the key forage species. The plant has significant values as a perennial grass that grows primarily in the desert or dry shrubland biome. The species has proven to be a great drought tolerant in the region, with good feed value in dry periods. The plant can grow in harsh habitats, including inhospitable habitats such as rocky slopes and rock fissures. A most recognized as critical fodder plant in these places, especially in highland and mountainous ecosystems in the IGAD region.

Plate 26 Chrysopogon aucheri species

4 Setaria barbata (Lam.)

The species is also known as bristly foxtail grass, corn grass, Mary grass, and East Indian bristle grass. The species is native to tropical Africa and tropical Asia, and is known to be found in some habitats with periodic flooding, seasonal water areas with alternating dry periods. The species is very palatable and most liked by livestock when young but becomes less liked with maturity to flowering.

Plate 27: Setaria barbata (Lam.) species

5 Hyparrhenia hirta (L.) Stapf

This is a common grass to the regional rangelands, more in areas with black cotton soils, and is known to be a tough grass, commonly known as thatching grass. *Hyparrhenia hirta* it is quite common and one of the most widely used thatching grasses in African pastoral communities, being hardy with tough steams. The grazing value is good in early growing stages but quickly decline in maturity. However, the grass has an immense potential in stabilizing degraded areas, with many gulleys' rehabilitation support ability due to extensive rooting system. Other value chains in mats weaving have also been seen in Africa.

Plate 28: Hyparrhenia hirta (L.) Stapf

6 Sorghum arundinaceum

This is the common wild sorghum species with high drought tolerant potential in the region, native to Sub-Saharan Africa, and very prolific, thus liked by many pastoral and agropastoral farmers in the IGAD region. The species has been part of dryland fodder crop, with spate irrigation being used for many centuries in Sudan, Ethiopia, Somalia, and Kenya. The species has good flowering and seeding among the family Poaceae, and it is highly spread due to birds, ease of seed harvest and sharing by communities as well as formal seed trade. It is the known wild progenitor of cultivated sorghum, Sorghum bicolor, with some authorities considering it to be a mere variety or subspecies; Sorghum bicolor var. arundinaceum, or Sorghum bicolor subsp. Verticilliflorum.

The species has provided immense potential for livestock feed under rain fed or irrigated system in the IGAD region, widely used as feed stock by communities under traditional stacking storage methods.

Plate: 29 Sorghum arundinaceum species

7 Digitaria ternata

This is a native species in Tropical Africa, and a known drought tolerant species, with habitats of sessional dry wet favoring its spread and existences. It offers feed value drying critical periods but can be an invader/increaser species due to its hardiness.

Plate 30: Digitaria ternata species

8 Pennisetum pedicellatum

This is among the important grass species in the IGAD region, with Ethiopia providing some enormous potential as animal feed resource through establishment and reseeding. *Pennisetum pedicellatum,* known simply as Desho or as Desho grass, is an indigenous grass of Ethiopia of the monocot angiosperm plant family Poaceae. It is also known as annual kyasuwa grass in Nigeria, bare in Mauritania, and deenanath grass in India. It grows in its native geographic location, naturally spreading across the escarpment of the Ethiopian highlands. Widely available in this location, it is ideal for livestock feed and can be sustainably cultivated on small plots of land. Thus, desho is becoming increasingly utilized, along with various soil and water conservation techniques, as a local method of improving grazing land management and combating a growing productivity problem of the local region, with lots of success stories in Ethiopia Afar, Oromia and Tigray Regions.

Plate 31: Pennisetum pedicellatum

9 Brachiaria humidicola

The species is also known as Koronivia grass (*Brachiaria humidicola* (Rendle) Schweick), which is a tropical grass from East and South-East Africa. The species is admirably adapted to grazing and has great feed value being leafy, procumbent, creeping, stoloniferous perennial grass. Notably, its creeping habit and stolons are different from those of other bracharia spp. The species is known to form dense sods increasing biomass yields. The palatability is high in young vegetative stage, but declines with maturity, though very much consumed by livestock as forage.

Plate 32: Brachiaria humidicola species

10 Pennisetum clandestinum

This has been one of the tradition fodder grasses in Kenya and the region. The tropical grass species *Cenchrus clandestinus* (previously *Pennisetum clandestinum*), common name is Kikuyu grass. It is native to the highland regions of East Africa that is home to the Kikuyu people. Because of its rapid growth and aggressive nature, it is categorised as a noxious weed in some regions. The species has been known to be garden; awns with good ground cover, including in sports fields. The graze value is excellent, forming a mat like ground cover, thus resisting grazing. In addition, it is useful as pasture for livestock grazing and serves as a food source for many avian species, including the widowbird.

Plate 33: Pennisetum clandestinum

11 Penniseturn sphacelaturn

This is one of the hardy grass species that inhabits the rangelands in the region, always evergreen to semi-evergreen grass with a clumping growth habit, offering useful feed value to livestock in dry seasons. It produces a clump of fine-textured, medium-green foliage that mounds to around 18 inches tall and 18-24 inches wide. The species offer great roles in soil stabilization, reducing erosion effects within the habits it grows.

Plate 34: Penniseturn sphacelaturn

12 Eragrostis tenuifolia

This is one of the important perennial grasses in Africa, with good drought tolerant properties, and resistant to erosion from the extensive rooting system, thus a critical land rehabilitation property. The communities are also used as a medicine, while it also offers good feed value during dry seasons.

Plate 35: Eragrostis tenuifolia

13 Pennisetum mezianum

This is a perennial grass, mostly not well appreciated as a potential drought and dryland feed resource, but owing to its hardiness and prolific nature, the species is a potential feed resource that can help increase communities' resilience. The grass has a short stout woody rhizome clothed with ovate coriaceous glabrous cataphylls. The feed value is great, very palatable when in vegetative state, but as it matures with flowing, the quality goes down just like many other grasses.

Plate 36: Pennisetum mezianum

14 Setaria verticillata

The species of grass also known as bristle grass, due to its rough bristles and bristly foxtail. It is native to Europe, but it is known on most continents as an introduced species and often a noxious weed, with presence in Africa. It is a hardy bunchgrass which grows in many types of urban, cultivated, and disturbed habitats. It is a weed of many types of agricultural crops and irrigated pasture lands or dryland crop farms in IGAD region, growing in vineyards and fields. The species is also known to be herbicide-resistant strains have been noted.

Plate 37: Setaria verticillata

15 Dactyloctenium aegyptium

The grass is also known as Egyptian crowfoot grass native to Africa and Asia. The plant mostly grows in heavy soils at damp sites, and within the rangeland of IGAD often associated with run in areas or water points within the grazing lands. This grass creeps and has a straight shoot which are usually about 30 centimeters tall. The species is also reported to be used as food during droughts in Africa when famines occur, greatly supporting nutrition, and boosting food security, foster rural development and support sustainable landscapes. The species is very palatable and has great digestibility to ruminants, thus a good feed.


Plate 38: Dactyloctenium aegyptium

16 Chloris roxburghiana

Common name: Horsetail grass, Local names: Goro (Borana)

Grass widely found in IGAD region countries. This is a tufted perennial 30-120 cm high that grows in arid and semiarid areas, often as a pioneer grass in areas abandoned from cultivation or desert woodland. The grass is highly palatable with digestibility between 80-89%). The species is highly prolific and tolerate grazing pressure.


Plate 39: Chloris roxburghiana

17 Eragrostis superba

Common name: Maasai love grass

Eragrostis superba is a species of perennial tufted grass and a very palatable grass species to livestock. The species is found in all the rangelands in Eastern Africa, forming varied ecotypes. They are very prolific and have high seeding capacity and very drought tolerant.

Plate 40: Eragrostis superba

18 Enteropogon macrostachyus

Common name: bush rye; Local names: Gedi (Borana);

This is a Tufted annual or perennial found in many areas of Eastern Africa Rangelands, about 90 cm high, the grass is very palatable when young and may grow tough when over grown. Leaves are scattered along the Culm and the leaf-blades fold readily when dry, and are very finely pointed. The grass has very good seeding ability and provides highly viable seeds in n Rangelands.

Plate 41: Enteropogon macrostachyus

19 Cenchrus ciliaris

Common name: Buffel-grass or African foxtail, Local names: Matguthes (Borana);

The grass is native to the rangelands just like with Africa, southern Asia. This species is prolific in seed yields and vegetative spread through splits. The species is also very palatable especially when young and maintains quality long into the growing season.

Plate 42: Cenchrus ciliaris

20 Panicum maximum (Common name: True guinea grass).

Native of Africa and widely distributed in Eastern Africa rangelands. The grass has been introduced to all tropical countries as a source of animal fodder. Its seeds are still sold commercially today for this purpose. The species leaves are fine and soft and contain good levels of protein (13-21%). It is an ideal forage plant as it grows well on a wide variety of soils and even under the light shade of trees and bushes (and thus can be grown with other crops). It can survive long dry spells and quick-moving fires which does not harm the underground roots. The seeds are dispersed by birds.

Plate 43: Panicum maximum

21 Cynodon dactylon

Common name: Star grass, Bermuda grass or couch grass; Local Names: *Emurua in Maasai*

This is a creeping perennial grass that has stolons and rhizomes. It can be a serious weed where it is not cultivated, especially in arable farming or pastures. It is usually unsuitable for crop/pasture rotation but a valuable permanent pasture which can resist animal trampling.

Plate 44: Cynodon dactylon

22 Digitaria Macroblephara

Local names: Ilmagor (Borana)

This is a perennial grass that grows up to 90 cm high in the arid and semiarid areas. The grass can exceed 1m when in good soils and water supply. The species has also been known to be drought-resistant among the species of Digitaria, where it remains green long into the dry seasons. The grass is relatively very palatable when young and in vegetative stage.

Plate 45: Digitaria Macroblephara

23 Themeda trianda

Common name: ***Red oatgrass, kangaroo grass*** **Local names: Gedi in Borana**

Themeda triandra is a tufted perennial grass of highly variable size, 30-180 cm tall with tussocks up to 0.5 m wide. The species is highly fire and drought tolerant in the arid rangelands. It is erect and branched and very palatable when young and vegetative. Red oat grass has been used as fodder in pastoral areas but also as human food during famine. The species provided very high dry matter and crude protein yields when green and vigorously growing.

Plate 46: Themeda triandra

24 Bothriochloa insculpta

Common name: ***sweet pitted***

This is a perennial grass that tends to be stoloniferous. This species of average grazing grass potential. It has good leaf production, but its aromatic smell deters animals. Useful grass for combating soil erosion by providing a good stable ground cover on hill slopes because of its higher ability to withstand frosts and sends out runners that root well. The species has moderate palatability and becomes useful during dry seasons.

Plate 47: Bothriochloa insculpta

25 Sudan grass and Sorghum-Sudan grass

Local names: **Bododi (Borana)**

Sudan grass and sorghum-sudan grass are midsummer grasses suitable for short, 8-10 week plantings. These grasses are the most heat and drought- tolerant cover crops. Sudan grass grows faster and easier to manage since it weed tolerant. These crops provide abundant root biomass, which is useful for increasing soil organic matter. Cut and carry encourages fast regrowth and root growth. The plant also suppresses root knot nematodes and inhibit weed germination if densely sown. The species is high in biomass yield and drought tolerant. The plant is not affected by flooding/ponding. The palatability is good in early vegetative stages, but declines with maturity.

Plate 48: Sudan grass and Sorghum-Sudan grass

1.8.2 Legumes plants as Forage in IGAD Region

The legumes have proven to be among the critical feed and forage resources in the IGAD region, owing to the identified significant contribution of goats as small stock and the camels that are very hardy to the harsh climatic conditions. The legume plant species, ranging from legume shrubs and trees, can fix nitrogen in the soils, thus providing ecosystem services of rangelands soil fertility management. Legumes are an important livestock feed resource in the drylands as the main source of proteins. Providing free supplementation of the much expensive animal dietary requirement. The legumes in the IGAD region occur in the form of trees, shrubs, lianas, climbers, and forbs. Leguminous trees/shrubs provide forage to livestock in form of leaves and/or pods, however for forbs and climbers, the whole plant is consumed and most liked by livestock species. Legumes can be evergreen, semi-deciduous or deciduous. Shedding of leaves is an adaptation to regions with erratic and unreliable rainfall, and the shade materials are consumed by the livestock or if not, become the important source of soil organic carbon, that makes our regional rangelands healthy and stable. The legume plants are an important rangeland vegetation adapted to many climatic zones from humid to hyper-arid within the IGAD Landscapes.

1.8.3 Fodder trees that support Silvo-pastoralism in the IGAD region

The IGAD region rangelands have a wide array of trees that have continued to support the pastoral livelihoods for centuries. The trees have become the savior to huge populations of livestock during the major droughts, and thus they cannot be ignored as critical components of ecosystems that have increased communities' resilience. When we plan for pasture and pasture seed production and rangelands rehabilitation for increased productivity, forage trees must be part of the plants for consideration. The many forage trees found in the rangelands are known to tolerate low amounts of rainfall owing to their deep rooting habit and have proven to be successful in revegetating our ecosystems.

The need to promote pasture and pasture seed production in the region with the consideration of silvo-pastoralisms by including forage trees is to provide the following benefits;

- ✓ Legume Fodder trees provide cheap protein source that reduce the need for animal supplementation. It is noted that, protein is one of the most limiting and expensive in ruminant nutrition.
- ✓ Fodder trees in rangelands are a critical forage resource during dry periods, supporting even the grazers, and have contributed immensely to survival and livelihood support.
- ✓ Fodder trees provide dry season feed supplement and can also be used in feed formulation especially for the pod producing species.
- ✓ The fodder trees provide other ecosystem services such as animal shade, controlling soil erosion, nitrogen fixation and improving soil fertility, firewood, construction materials etc.
- ✓ Fodder trees support livestock within the cut and carry or allow them to browse the trees directly. In rangeland pollarding (*Cutting of branches to feed animals*) during dry season is done to supplement livestock.

Plate 49: Pastoralists utilizing tree for livestock feed during droughts

Plate 50: Acacia pods a good source of animal feed in dry seasons

Box 4: Considerations for choosing fodder trees for communities' establishment

The choice of fodder tree species to use and promote among communities during land rehabilitation and pasture establishment in the IGAD region should consider the following;

- The trees should not have invasive traits or characteristics or known to be invasive like Prosopis juliflora
- The tree leaves and pods should be palatable and have a high nutritive value, and utilizable by livestock
- The trees should be prolific, ability to tolerate dry conditions and seasonality, and enough leaves even after coppicing for forage
- The tree should have no nonnutritive properties or toxicity effects to animals
- The trees should support utilization by wide array of livestock species with high palatability and digestibility.
- Most importantly, the tree should be identified by communities with traits of tolerant to drought, pests and diseases resistance, less competition with pasture and crops,
- They should be deep-rooted to avoid competition with shallow rooted pasture or crops for water and act as nutrient pumps from leached elements.

The need to have strategic programming within the IGAD region with the consideration of the critical legume and fodder trees is to support the need to increased climate change adaptation, increase community resilience to climate change impacts, increase carbon sinks and to support the ecological services. The choice of legume trees should be well done, with care not to introduce problematic trees. Also, during the rangeland projects programming, local and important species should be considered first before any introductions. The need to support legume for feed is to explore the need for strategic feed value addition, especially the legume pod trees.

Below are few selected regional known common fodder trees (Table 2) used as forage resources, but not limited to the list, and the countries can expand and develop more list and photos during the implementation of this trainings for local adoption;

Table 2: Important multipurpose trees growing in IGAD region

Botanical name	Importance and uses
Ziziphus Mauritiana	*Particularly important fruit tree, feed for animals, provides shade to animals and humans, source of timber and poles*
Cordia Africana	*Feed, fruits, shade, construction, treatment of measles, soil*
Tamarindus indica	*Fruits, medicinal, poles, shade, feed, food, juice, spices, feed, soil conservation*
Hyphaene compressa	*Fruit, medicine, beer, teeth cleaning*
Acacia nilotica	*Medicine for stomach, poles, shade, gum, feed, soil*
Acacia bussei	*Feed/fodder, bark for medicine in treatment of cholera, shade, soil*
Juniperus procera	*Construction, mosquito repellent, religious uses, shade*
Terminalia prunioide	*Shade, fodder, poles, soil*
Acacia Senegal	*Gum arabic, Quran writing ink, feed/fodder, fencing, medicine for back pain and tonsils, food processing gum*
Salvadora persica	*Toothbrush, medicine for teeth, feed/fodder, shade, anti-Helminthes for animals, camel feed, drought feed*
Terminalia spinose	*Shade, soil*
Azadirachta indica	*Medicine for malaria and many diseases, insecticides, insect repellent, feed for droughts, good shade*
Schinus molle	*Shade, medicine for tooth ache, soils*
Prosopis chilensis	*(An aggressive tree that a lot of Somalis complain about).*
Casuarina equisetifolia	*Poles, ornamental, shade, soil*
Carica papaya	*Fruits, insecticides-mixed with neem and aloe vera, soil*
Citrus aurantifolia	*Lime fruit, medicinet, juice, food, shade*
Citrus paradise	*/Grapefruit*
Mangifera indica	*Mangoe fruits, shade, soil stabilization*
Psidium guajava	*Guava fruit, shade, poles, soil stabilization*
Cocos nucifera	*Coconut oil, cooking, fruits, juice, shade*
Dracaena cinnabari	*Dragon Blood Tree, it grows in Daalo forest, Somaliland, threatened by extinction, used in making ropes.*
Boswellia carteri	*Frankincense Tree (Grows in the mountainous areas of Daalo forest, Somaliland, gum, shade, soil*

Cordeauxia edulis	*Quality oil than American variety, raw material for food industry*
Faidherbia albida/ Acacia albida	*Fodder, they say has best shade in the world, soil, poles,*
Ficus carica	*The common fig/ Fig Tree, fruits, seeds have dormancy, easily propagated by cuttings, fodder tree*
Boscia minimifolia	*Fodder/feed, shade, drought resistant, cleaning traditional milk containers, insect repellent, crops preservation*
Acacia mellifera	*Fencing, honey, bees forage, making ropes from bark to construct houses and making mats, feed for livestock, shade, soil*
Phoenix dactylifera	*Date palm, mostly on offshore areas, shade*
Boswellia frereana	*Gum, soil, religious/cultural*
Moringa Oleifera	*Medicinal, fodder/feed, shade, vegetable, soil, food*

2.0 Pasture Production in IGAD Region

2.1 Land Preparation methods for pasture establishment

Training discussion under the moderation of Master Trainer ***(Plenary discussion on what are the major land preparation methods/practices for pasture establishment in the region/location/landscape)*** ***(All the methods used by the communities be listed for a discussion)*** ***10-45 Minutes***	
	**(Master trainer to enhance free discussion on all the land preparation methods used by the communities in pastureland preparation)** **(The discuss should bring out clearly which are the land preparation methods, tilling practices, water harvesting practices for pasture establishment)** **Delivery Approach** **(Depending on number of participants, this be done in groups or as a plenary discussion)** **(Field photos printed on A3 of the different methods can be shared later for discussion, or members asked to draw sketches of some of the methods used during the explanations)**

	Practical Exercise **The practical aspect of the sessions is the trainees be taken out for practical learning on land preparation methods, using a hoe/jembe, panga/ Machete, the team should demonstrate the Zai-pits, Semicircular bands, tied ridges, half-moon structure, terraces, and if rippers available be demonstrated etc.)**
(Below notes to support the master trainer and TOTs on the land preparation methods for pasture establishment in the region)	

2.1.1 Land Preparation Methods for pasture establishment

There are several land preparation methods in IGAD region, which are a critical process for successful pasture establishment. The method could be land preparation before sowing, like tractor disc or mold board ploughing and landscape improvement without complete land destruction, followed by water harvesting for establishment. The type of land preparation will be dependent on production objectives, scale of production, availability of financial resources and technologies for the purpose and location for planting. Not all preparation methods are suitable for all landscapes, some could be a threat to sustainability, for example slope areas should have no or limited preparation to avoid erosion enhancement. However, improvements for water harvesting using applicable Technologies are recommended. Land preparation for reseeding or pasture establishment is critical for its success. The timing and sitting of reseeding areas should be well done. Pasture establishment under rainfed systems requires timing where land preparation and planting are done on time before the rains. This is an even more thoughtful consideration in arid environments where planting should be done early to capitalize on the first rains.

In IGAD region rangelands that receive bimodal rainfall, the short rains of September to December are the best for most rangeland grass species. For the long rain targets land preparation should be done during the long dry seasons and ready for planting just before onset of rains (Mar-April). The only challenge is the high variability of rainfall periods in ASALs, where variation between years and within seasons makes predicting a big challenge. However, getting timely meteorological information that is reliable can help in making appropriate timings.

Land preparation can be low cost or prohibitive cost depending on scale and technology to be employed. When mechanization is involved, the process needs significant resources. However, at community level, this can be low cost if local labor and local available implements are used, or technologies that are low-cost power like oxen, donkey, or horsepower instead of tractor or mortised technologies. The choice of applicable method and technology will always depend on availability, scale, and resources available.

Box 5: Benefits of Timely land preparation for pasture establishment

Timely land preparation offered many benefits to pastures establishment, this includes;

- Breaking the soil crusts in degraded areas for increased water infiltration
- Creation of micro catchment to hold pasture seeds and water
- Provide soil stability by reducing the rate of runoff hence support to control of soil erosion
- Support plant establishment by providing quick and easy root establishment and penetration into the soil
- Protect the light grass seeds from losses through wind erosion.
- Support preparation with removal of unwanted/invasive or unpalatable plants for preferred species
- Provides opportunities for onsite water harvesting through applicable technologies

2.1.2 Land preparation methods

Bush Clearing: This is usually the first step if reseeding or rehabilitation is done in bushland or unwanted species invaded areas. Bush clearing can be done manually for small shrubs and non woody species but also can be done in woodlands but with time consuming process. We also note that sometimes, when the available vegetation is not bush, and the need is to just improve the cover/density or pasture sward, especially when the desired plants are part of the vegetation, clearing may not apply**.** The decision on where to do bush clearing or not should be carefully done to avoid exposing the land to agents of erosion

Plate 51: Bush clearing using hand tools by community

Plate 52: Mechanised bused control for pasture establishment, Prosopis Juliflora invasive

Tiling/Ploughing: This could include both mechanical/motorized means like the use of a tractor or oxen drawn tools as well as human labor with handheld tools or traditional animals' draught power from donkey, oxen or horses as applied in the IGAD region. This is recommended when the soil has crust/unwanted plants or invasive species and when there is need to create micro catchments for easy grass establishment. For faster land preparation, the use a tractor can be employed, but thereafter harrowing may be needed to get the fine tilt, with immediate planting, and thus timing is critical for this to happen close to rains to avoid long wait period that may lead to wind erosion. Land preparation at small scale farms can be done by use of ox plough or hand tools like jembes/hoe, forks etc.

Plate 53: Tractor ploughing for pasture establishment in large scale projects: Photos credit, Dr. Koech, Aroori Livestock centre of excellence in Somalia

2.1.3 Water harvesting land preparation for pasture establishment

The rangelands of IGAD region as presented have serious challenges of getting enough moisture/weather for pasture establishment or in support to natural regeneration through rehabilitations efforts. This necessitates the need for water harvesting technologies to maximize the low amounts of precipitations received. There are various technologies developed for both support to new pasture establishment, support to natural regeneration, and support to tree growing in silvo-pastoral and agro-pastoral system or agroforestry systems in the region. The decisions on which method to use depend on producers' objectives or farmers' objectives, availability of the technology and needed resources, land topography and the presented land need for ease of achieving the desired outcomes. Below are the methods applicable through mechanization, traditional animal or manual human labour water harvesting as part of land preparation.

2.1.3.1 Mechanized land preparation and onsite water harvest for reseeding

Ripping

This can be done by tractor or grader using a tine ripper to create deep lines along contour for increased water infiltration on and reduced water run off on natural

pastures. The land can be ripped and left for natural regeneration if soil gene bank is good. But in areas that need reseeding, this can be combined with other land water harvesting done manually as will be discussed later.

Plate 54: Tractor ripper from with three tines ripper

Plate 55: Tractor subsoiler for increased water infiltration/sinking water for rehabilitation and pasture establishment. Photos Source: https://kibbleeq.com/farmers/tillage/rippers

Pasture contour plough for increased infiltration

This is done using tractor one disc to make contour that will reduce runoff and increase infiltration in pasture farms within slopping lands. Tractors make contours of deep plough across the land and leave about 5-10 m distance between each contour depending on slopes. This increasing soil water recharge and traps the grass/pasture seeds for establishment and avoiding soil gene bank loss. The same disc plough can also be used for the entire land preparation in large scale where complete ploughing is done for new pasture sward establishment and removal of unwanted weeds or plants.

Plater 56: Tractor making soil contours for increased infiltration, reduced run off

Grader Contour belt using grader board plate

Just like the grader, a grader can also be used to make the land contours for water retention and reduced flooding and overflow. This may be slightly costly compared to tractor use but can be useful in areas that need larger contours for increased benefits and in larger areas with rough terrain where tractors can have challenges in doing so.

Plate 57 Grader plate used in contour terracing for reduced rub off and increased water infiltration

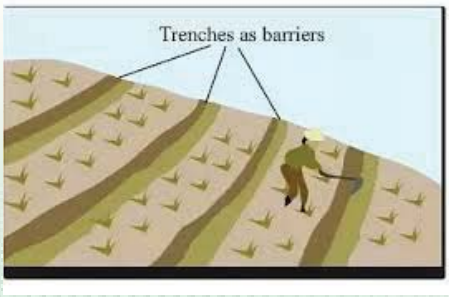

Plate 58: Contour design and interval that can be done in slopping land by grader

Tractor Chisel plough

The tractor can also be mounted with a chisel plough, close to ripper, but this is smaller and may not go deep like a ripper. Most suitable in areas with slightly not hard pan but need loose water lines for increased infiltration.

Plate 50: Tractor Chisel Plough for rainwater harvesting and creation of micro catchment and seeding lines for pasture

Plate 60: Chisel plough preparation of land for pasture reseeding

Tractor Furrow/ridge lines

This uses the ridging or furrow equipment and supports water harvesting and micro catchment for ploughed land or in good open softer soils within the range and supports reduce erosions, increases infiltration and thus easy pasture establishment.

Plate 61: Tractor furrow line for pasture reseeding micro catchments preparation

Plate 62: Ready furrows lines for row pasture establishment

2.1.3.2 Traditional animal water harvest/ land preparation

Oxen/donkey or horse ripping

This uses animal draught power to pull a simple riper and create the same lines along contours in support to increasing water harvest through sinking for underground recharge and reduce runoff.

Plate 63: Animal drawn ripper

Plate 64: Donkey pulling ripper for pasture farm preparation water harvesting/braking soil crust.

Oxen/donkey/horse board plough contour ploughing

The normal animal plough board can also be used for entire land ploughing for pasture establishment or also strategic interval contour water retention along slopping and for increased infiltration and reduces erosion and runoff.

Plate 65: Animal drawn board plough for pastureland preparation

Plate 66: Oxen land preparation for pasture establishment using animal board plough

2.1.3.3 Human labour water harvest land preparation for pasture establishment

This is the most common in the region, low cost but time consuming and slow water harvesting and land preparation practice in the IGAD region. The use of simple fork jembe, normal jembe and other hand tools like muttock to make water structure. Very applicable in community projects and possible in sloppy and rough terrains where mechanization may not be possible.

The other way this may be done is use of rock contours by human collection and lining along sloppy area to reduce water flow, increase infiltration, and increase soil seed bank traps. The human labour can be used to make water harvesting techniques like contours, semi-circular band, zai pits, nega rims, tied ridges as illustrated below;

Plate 67: Contour Terracing for rangeland rehabilitation and reseeding

Plate 68: Stone contour placement for increased soil and water conservation in pasture farms.

Plate 69: Design of semi-circular bands for water harvesting to support rangeland rehabilitation

Plate 70: Water Retention ditches developed for reduced runoff and increased soil and water conservation for pasture establishment and rangeland rehabilitation

Plate 71: Tied ridges for water harvesting and soil conservation in pasture establishment

Plate 72: Zai pits for soil and water harvesting for rehabilitation and pasture establishment

Plate 73: Circular Tied ridges for water harvesting and soil conservation in pasture establishment

Plate 74: Mega Tumbukiza holes for water harvesting and soil conservation in pasture establishment

Plate 75: Jembe scratching and twig use for water harvesting and soil conservation in pasture establishment

2.2 Pasture Establishment/Management technologies/practices in the IGAD Rangelands

Training discussion under the moderation of Master Trainer

(Plenary discussion on what are the pasture production technologies from the different regions/countries/locations/landscape as applied by the communities).

(All the pasture establishment technologies/ practices/ methods used by the communities be listed for a discussion)

30-40 Minutes

	**(Master trainer to enhance free discussion on all the traditional/ modern and existing pasture establishment technologies and practices by participants.)** ***(N/B -The discussion should bring out clearly the pasture establishment practices/planting methods and technologies used, and the rationale for choice of the methods and practices)*** **Delivery Approach** **(Depending on number of participants, should be done in groups or as a plenary discussion)** **(Field photos printed on A3 of the different methods can be shared later for discussion, or photos and video presentation for visual learning)**
	Practical Exercise **Where possible, the practical aspect of the sessions the trainees should be taken out for practical sessions on reseeding/planting and establishment, very practical when at community training sites with prior arrangements)**
(Below notes to support the master trainer and TOTs on the technologies and practices for pasture planting and establishment in the region)	

The regional pasture species are diverse with varying seed types, sizes and also adaptability to different regions. The choices of planting method will be determined by the species selected, which also is determined by land preparation methods. For very small seeds, care must be taken not to place the seeds too deep to inhibit successful germination and emergence. For pasture species or varieties with bigger seeds, seed placement may not be a big problem. The seeding process is also determined by the risks associated with it, for example animals eating like birds and rodents, wind blowing from bare areas or unprepared fields to hold the seeds. Thus, the previous topic on land preparation informs the seeding methods and practices for successful pasture establishment in the rangelands. It is important to appreciate that there are several methods of seed placement to the prepared land, where the choice will depend on land size, land preparation made and scale of production.

2.2.1 Broadcasting by hand

This is the simplest method commonly used by communities for small scale production. The most important consideration is making sure that the land being broadcasted is well prepared to hold the seed for establishment. The timing should also be good to avoid wind effects, especially when doing for lighter seeds like the most grown *Cenchrus ciliaris* grass among others. After reseeding, it is important to protect the seeds by ensuring some light coverage of soil, at least to avoid birds, rodents, pests and insects from eating. The simplest way is using a light raker or use of tree twigs with branches pulled over the farm strategically just behind the person's broadcastings. This process ensures successful establishment, especially when done at proper timing just before the rains.

Some consideration during the process of broadcasting is;

- Plan to have a uniform spreading of seeds on a prepared soil surface following the recommended seeding rate of the species, most are 3-5kgs per Ha, depending on species.
- Proper timing on seeing times and ways to avoid windy season and early morning or late evening reduces disturbance from birds/insects.
- Ensure seed are placed in soils prepared to avoid erosions and seed loses
- Do proper timing using weather information to plant just before the rains and not long wait after seed placement.
- When reseeding with very light seed species, you can use carrier materials like sand or saw dusts for even distribution and delivery to the soil without wind blowing
- Ensure proper seed coverage after placement with twigs or rake after placement

Plate 76: Broadcasting of pasture seeds in ploughed land in the rangeland of Kenya, Marsabit County.

2.2.2 Broadcasting by Machine/Seeders

This is the most used method when pasture establishment is being done on large scale levels, with availability of machines like tractors used to do seeding. The seed spreaders are mounted on a tractor, calibrated to the recommended seeding rates. Another modification used is the fertilizer spreaders. Immediately after seed broadcasting, it should be lightly covered with soil, and rakers set on like scratch pulled by tractor also used to achieve this. The main principle still remains on proper timing of seeding, as well as ensuring cover is done well to avoid erosion and seed losses. While in the large, mechanized farms where erosion can occur, rollers are used. The use of homemade harrows can also be used in small farms under mechanization when doing large seed pasture types, after spreading for coverage. Other ways we have used to do large scale seeding for fodder crops with large seed like Sudan grass is hand broadcast in large areas and then disc plough immediate at light depth, and this has seen a lot of success in Somalia, Aroori Livestock Centre of Excellence.

Pate 77: Hand-pushed broadcast spreader. Source: https://en.wikipedia.org/wiki/Broadcast_spreader

Plate 78: Tractor seed broadcaster for large scale production use. https://www.deere.com

2.2.3 Seeding using seed drill

Modern seed drills are available for use, and this method is most suited since the seeds are covered immediately after placement. However, the process is not suitable for many light grass seeds or hairy types like *Cenchrus ciliaris* since they will not flow well from the driller. There are methods to counter this, maybe mixed with other foreign degradable material like saw dust or rice husks. The advantage is that the depth of seeding can be set on the driller based on seed type. The use of the seed drill is best for large scale reseeding.

Plate 79: Tractor pulled seed drill. Photo Source: Farmers weekly, UK https://www.fwi.co.uk

Plate 80: Mini tractor fabricated seed drill: Photos Source: https://farmhack.org/tools/home-built-no-till-seed-drillSunny Slope Orchard o

2.2.4 Oversowing or sod seeding

This method has proven successful in rangelands that are in process of degradation or have lost some desired pasture species that need to be increased or reintroduced. The methods work well where no invasive plants are present, and can be useful with limited land preparation, sometime only seed holding preparation like high spaced harrowing can be done or chisel or ripper to increase seed holding and water harvesting as discussed earlier. Over sowing can also be done on large scale pasture to either to increase pasture sward or a strategy to introduce a high value forage pasture or legume fodder in the sward. Thus, it is an establishment technique that involves improving an existing pasture sward by seeding it over with an adapted, improved or better forage material. The process demands utilization of existing pastures to a lower level before seeding to reduce completion for resources like water and light for the new seeds. Burning can also be done for fire tolerant species, and the method is good since no land preparation disturbs the soil and existing vegetation, hence reduced erosion.

Plate 81: Tractor oversowing for sward increase and improvement. https://www.cotswoldseeds.com

Plate 82: Hand seed over sowing on existing pasture field.

2.2.5 Under sowing

This pastured establishment technique supports the process of intercropping or mixed cropping to increase land productivity, as well as enhanced soil and water conservation. The practices carefully select pasture cover crops that increase soil cover, offering cover crop potential. This may also involve other fodder crops like legume fodder like lucerne, disodium or sweet potato for vines. But also, some non-competitive grass varieties like Boma Rhodes *(Chloris gayana*) have been sued to do over sowing. This system integrates other crops in the farm, which are compatible with pasture species either as intercrop or cover crop. This system may not be common in the tropics, but there is high potential, especially for leguminous forages. The process reduces the need for repeated farm operations and also increasing productivity per unit of land. This system may work well under maize systems, where the late sown pasture will be harvested after the main crop, before the next season.

Plate 83: Under sown pasture in corn farms to increase cover after main crop and provide forage resources. https://www.aaf-armer.co.uk/agronomy/soils/under-sowing-maize-has-soil-health-benefits.html

Plate 84: Undersowing-maize-with-grass-Arnolds-Hill-Source: Farm-c-Debbie-James. https://www.fwi.co.uk/livestock/grassland-management

2.2.6 Vegetative establishment of pastures/fodder

This method is most common on pasture varieties that are low seeders or difficult to propagate via seeds. There are many grasses that are low seeders or produce unviable seeds such as Napier grass, kikuyu grass, Improved Bracharia spp and star grass *(Cynodon dactylon)*. These species are mostly established vegetative by use of stem or root cuttings or splits. When using cuttings, it is important to ensure at least 2-3 nodes are buried in soil. The practice has become more prominent with the latest introduction of Napier varieties from China in the region, like the super Napier and Packchong grass. This practice is widely spread from farmer to farmer sharing of planting materials among the communities in the region. Other fodder spies that utilize this vegetative propagation are like the fodder vines from sweet potatoes, a critical feed within intensive systems under irrigation or seasonal irrigation. Depending on the planting system, this system may require good land

preparation, fine till by ploughing and the planting done in rows, or random spread for grassland forming varieties/species.

Plate 85: Splits used for vegetative pasture establishment, mostly for species with no or limited seeding abilities

Plate 86: Cuttings for vegetation propagation, mostly used for Napier grass

2.2.7 Furrow line sowing

The furrowing line planting can be from seed or vegetative species but requires proper land preparation for ease of seedling placement or seed placement carefully. The furrows are done to provide water harvesting for ease of establishment as well as to allow fertilization for intensive systems, as well to remove the unwanted plant species. The furrows are done by manual hand tools or tractor driven Ridger for large scale farms, and planting done by light seeding along the furrow lines covering with light soils.

Plate 87: Furrow grass sowing for better establishment through better soil and water harvesting micro catchment support. Photos source: Dr. Oscar Koech

Plate 88: Established pasture under furrow lines with furrow irrigation system for support. Photos source: Dr. Oscar Koech

2.2.8 Enclosures establishment and management for natural regeneration

Enclosures have become an important low cost and effective method for land regeneration and rehabilitation/restoration in the IGAD rangelands, at times supported by reseeding for increased establishment or pasture improvements. It is more of management practice that supports pasture establishment among the pastoral communities. A selected area, is picked in a participatory way, with set up of improvements objectives, and then strategies for protection from utilization to allow time (Rest period) for either natural regeneration if soil seed bank is good, or reseeded with desired plant seeds/pasture seeds for areas with low or degraded and lack of soil gene bank. The enclosure protection can easily be done using natural plant twigs/thorns and branches to prevent grazing or live fences as observed to provide results in the region. Enclosures allow natural regeneration with cases providing successful grass and trees regeneration, increased soil seed banks as well as protect the soils to allow natural regeneration to occur due to increased soil moisture and fertility/organic matter. But also, in large scale enclosure, fencing

is done using barbed wire or chain link as deemed useful, but at higher cost mostly beyond the community reach. The main success of enclosure is putting in place a strategy for protection and management, with communities being central for any success. Enclosures have continued to form part of strategic dry season grazing or fodder harvest for strategic feeds, as observed within pastoral communities in Kenya (West Pokot, Laikipia, Borana and Afar regions of Ethiopia, and Even many other areas in Somalia (Oodawyne, Burao, Shebelle and Dollow), Karamoja Region in Uganda (Moroto, Kotido, Napak regions). The community traditional structures of protecting identified and established pasture enclosures are very critical for the region, with customary protection strategies yielding results, more so in the quest to adapt communities to the climate change and variability impacts. The lessons from the practice success is that communities should be central to the establishment and also take lead in the management and protection of enclosures. A success story from the enclosures assessed in terms of governance structure is having a community Enclosure management committee, as observed in Karamoja Moroto, which is independent from the rangeland management committee, this assures close and focused management of the for assured success.

Guiding steps in establishing a successful enclosure are;

Community willingness: This is one of the critical stages to ensure the communities are willing to get support and also participate in the enclosure establishment. This may start with capacity development, awareness creation on what it is, what it intends to achieve, what are the benefits and if possible, some exposure visit to see and learn from existing communities.

Box 6: Potential reasons and Benefits of Enclosures establishment at community level

Enclosures can be set up to achieve different objectives, and thus, a community should be clear or what they intent to achieve, for example, the benefits achieved by enclosures include;

- To reclaim degraded landscape's
- To increase feed resources
- To provide pasture seed bulking opportunity
- To protect biodiversity losses e.g. medicinal plants, forage plants etc.
- To support other NTFP livelihoods like apiculture, gums and resins etc.
- To reclaim land mines and other loosed land from pasture/pastoralism units e.g. farmlands to grazing lands
- To control and reclaim invades areas
- To protect shrines and cultural sites/heritage sites
- To protect dry season grazing areas/planned grazing

Land Identification: The need to have a participatory process for enclosure site identification is critical, based on the intended need and potential to address the problems as prioritized by the communities. This should be done in a more participatory way, with the voices and inclusivity of all in society. The process should result in a more communal supported area for communal projects. However, for individual or private enclosures, this should also be guided by the objectives and appropriate location identified for the purposes.

Community fencing/protection: For enclosures to provide the desired outcomes, protection is always important as a consideration. Most of the enclosures in the region use fencing, either traditional fence from the use of branches, twigs, natural stones and life fences, as cheaper options or use of barbed wire, chain links as modern and expensive options. However, we do note that some communities also have enclosures without a physical fence, but use of natural barriers like roads/rivers, streams as demarcating indicators and use of community agreed grazing strategy to protect the area from use, with community structures and bylaws governing the protection.

Enclosure sites establishment: This may require some support from community, governments support, Partners and development agencies to do the manual; fencing, reseeding if needed, water harvesting and reclamation infrastructure like erosion control if part of the needed support for quick and ease of establishment.

Enclosure sites management: For the success of the practices, post establishment management is important. The need to have a management body/support for control use and also repairs and enforcement of community agreement. The management also monitors and guides use periods, modes of use and ensures sustainable decision making on use and management. The management should also be responsible for measuring and detecting impacts and challenges created by the process as well. The communal enclosures within the IGAD region, most are under the grazing management committees within the rangelands, but also other interesting models where an enclosure has its specific management committee for close protection and management is noted, as a good example for increased sustainability.

Enclosures utilization: The enclosure management team in consultation with community members have to agree on utilization strategies, which mostly depend on the establishment objectives as well as the size of the land under protection. Most community enclosures that are not big serve as source of feed during droughts or prolonged periods of dry seasons, mostly for cutting and carrying lactating and weak animals, while the other herds migrate. Some community enclosures are for the purpose of seed bulking and feed used only after seed harvest and then pasture biomass harvested for their animals. Only in large enclosures is it when animals can graze for the community ones with control over numbers and period of use. However, we note that in private and smaller agro pastoral individual household's enclosures, some have direct grazing as utilization strategy but with controlled stocking rates.

NOTE: The success of enclosure will depend on original state of the chosen sites in terms of ecology, soil seed bank and water harvest for regeneration/or precipitation to be received as well as soil health, successful implementation of the management plan. Thus, the period taken has been different in the region, with good site having only one season and land regenerates, other several years and seasons of management without utilization. But most enclosure in the IGHAD region take about two years and desired results are achieved.

Plate 89: Pasture enclosures protected using traditional twigs methods for establishment. Photos source: Dr. Oscar Koech

Plate 90: Established pasture enclosure pasture in Turkana West, Nariemeto pasture group, good established sward for seed bulking. Photos source: Dr. Oscar Koech

2.2.9 Planned Grazing management for pasture production and utilization in the IGAD Region

2.2.9.1 Free range pastoral grazing management

Free range grazing has been and will continue to be the major grazing system within the pastoral and agro-pastoral communities in the IGAD region. Thus, the system has been facing many challenges from the loss of tradition planned systems/strategies due to breakdown of traditional grazing strategies and governance, chiefly from increased development, urbanization, shift in economies and cultural changes in lifestyles from exposure as well as contributions from factors like climate change impacts on communities, and political development and strategies from states that have reduced mobility as a way of exploiting transient and variable resources. The IGAD rangelands has a wide array of diverse ecosystems that support a great biodiversity of flora and fauna. The region has critical rangeland ecosystem supporting the conservation of the natural environment and promoting sustainable development for the benefits of the IGAD countries. IGAD and its partners working

with member states have been committed to sustainable management of natural resources, continuing to support practices that ensure long-term healthy grazing rangeland ecosystems. The organization has continued to collaborate closely with local communities, empowering them to manage natural resources in a way that enhances their livelihoods while preserving the environment, and thus, among the support is the present pasture production and management plan development, which identified free grazing as one of the regions land use strategies.

Grazing management in the region rangeland are needed to be developed to address the myriad of observed challenges, ranging from land degradation, loss of biodiversity, invasive species encroachment, and the declining ability of the ecosystems to offer services, among others, and of which have continued to be exacerbated by the climate change impacts and the increasing human activities precipitating land use changes. Other challenges that need to be addressed by planned grazing are working to have strategies that reduce the impacts of climate changes resulting in famine, increased unsustainable livelihood options, increased human conflicts, and negative societal change among communities. The grazing management plans also seeks to scale up ecosystem conservation measures, support pastoralism as a sustainable livelihood option, and increase land productivity through the development region grazing resources use with consideration of transboundary grazing and natural resource sharing strategies and plans.

Grazing Planning: The plan has to be developed through a participatory process to enhance land ecological health and make grazing sustainable and economically viable land use option within the rangelands in the region. The grazing strategy provides guidance to the leadership of grazing committees and rangeland management committees and enhance the benefits of implementing the desired activities that will see the key grazing and conservation areas and livestock and wildlife corridors for the countries are being protected for the benefit of the nations and the communities at large. Thus, we propose development of grazing plans for the entire pastoral rangelands, with assure potential positive impact to livelihoods and benefit to the environment. The IGAD member states need to support pastoral and agro pastoral communities to develop grazing plans that support the vision of working towards minimizing land use conflicts and enhancing community livelihoods. The grazing plans will promote the conservation of viable grazing biodiversity and reduce land degradation through such initiatives.

Holistic Rangeland Management (HRM): This is another support strategy to planned grazing which utilizes animals for support to land rehabilitation. The practices capitalize on animal's ability to impact on land through hooves action in breaking soil crust, increasing soil water infiltration, the animal nutrient cycling from dung and urine and also animal seeding from dung seeds of grasses and trees. The main strategy is bunched grazing to have maximum impact on the land, efficient grazing to reduce animal selectivity and reduce challenges of increaser specie's as well as manage invasion in grazing fields. The plan also considers mobile animal Bomas/Kraals for support to animal reseeding/rehabilitation of ecosystems.

Framer Managed Natural Regeneration (FMNR): This strategy works to support tree development in degraded areas by allowing natural trees establishment from care in tree water harvesting, tendering and utilization with care to avoid over exploitation through proper coppicing/pruning and loping. The practice also works to promote fodder trees for rangeland rehabilitation, naturally healing the lands. It also benefits from providing care from animal planted trees from HRM fields.

2.2.9.2 Benefits of planned grazing management in the IGAD region

a. Reduced Loss of plant biodiversity: *During the consultation, meeting, it was noted that there is and increasing threats from loss of important grass species that provided quality animal forages/feeds, due to increasing droughts, land degradation and over grazing from a high number of herds with feed shortage during dry seasons. Grazing plan supports ecosystem stability, reduced over grazing and over exploitation of grazing lands and thus, community benefits from a healthy ecosystem.*

b. Reduced Climate Change and variability impacts on Livestock production*: The IGAD countries Landscapes have witnessed increasing climate change impacts that has reduced feed availability, with increasing human wildlife conflicts from overlapping resource use. Climate change has also increased resource use overlaps and thus inter and intra community conflicts in the region. Planned grazing is a tool that assure co-planning among communities, with the goal of addressing the many challenges of climate change, including feed availability as well as conflicts management through planned resource sharing agreements that increase coexistence and harmony in land utilization.*

c. Reduced community conflicts and insecurity: *Community conflicts has been seen to increase from increasing mobility to other countries/region with also encroachment into key conservation areas by other communities/illegal grazers, especially during droughts in the IGAD region. The results have been resources use and land-based conflicts, and at times access barriers leading to conflicts. Human wildlife conflicts have also been on the rise within the region's conservation areas, mostly triggered by resource access, use and management as well because of land use changes from the noted increase in farmlands/settlement among other land use changes. Planed grazing management works towards reducing resource and land-based conflicts in the region, with success cases within transboundary resources in the IGAD regions, like the Mandera triangle between Kenya, Ethiopia and Somalia, Karamoja landscape for Kenya and Uganda.*

d. Management of Invasive and alien plant species: *The IGAD region landscapes have seen plant invasions that have made a bad situation worse as they have started taking over large swaths of grazing areas, reducing available forage significantly. This has been partly due to the climate change and variability impacts, leading to a shift in niches and ecological balance. Other invasion treats are from land use changes and over utilized ecosystems from over grazing and land degradation. This has affected natural grasslands regeneration and loss of soil seed bank in the many identified regions rangeland with the observed Prosopis juliflora, ipomoea spp, Parthenium hysterophorus, Solanum incunum, Cissus rotundifolia, Lanatana camara, and Xanthium strumarium species being the notorious species. Thus, with planned grazing, grazing management with sustainable implementation strategies, these challenges can be reduced from use of biological tactics like multi species grazing as well as Holistic Grazing Management (HGM) tactic to give pressure on invasive within grazing lands.*

e. Reduce Land use change*: IGAD region has seen an increasing immigration and people taking over rangelands for farming activities, mostly bringing along land use change with the application of inappropriate farming technologies and practices. This has continued to deplete grazing lands. The changes have also increased land degradation, resulting in erosion that has resulted in overgrazing. Sale of land-by-land owners has also encouraged land use changes from new owners, most often leading to conflicts or access challenges by grazers and loss of wildlife habitats and home range. Other land use changes have been large scale government investment projects, most bringing in destructive production systems like mono-cropping, mining among others. However, with consultative and participatory grazing management plan and legal documentation of regions grazing lands by state and support to planned grazing management, this could be well addressed for sustainability of our ecosystems. Grazing strategy through proper land management increases sustainable resource exploitation increasing land productivity with reduced degradation, especially on supporting overgrazing and promotion of rehabilitation of degraded land in the wider grazing lands.*

f. Strengthened traditional/indigenous technical knowledge on rangeland management *Traditionally, the wider rangelands of the IGAD region have been pastoralists as inhabitants, whom have been using their traditional resource governance structure and customary regulations, but with increasing intermarriage and immigration, there has been a breakdown of traditional rangeland and grassland management institutions by pastoral communities in the region. This loss has continued to negatively affect the management and utilization of the grazing ecosystem in the rangeland. But with community driven grazing planning, the recognition and revitalization of tradition strategies and customary regulation institutions, there is hope in making the rangelands sustainable again. The already establish and supported*

efforts on strengthening traditional grazing systems through planned grazing have proven working, with communities' engagement enhancing success, case observation within Karamoja Cluster between Kenya and Uganda among Turkana, Karamoja and Pokot communities, who are implementing and developing a mutual benefit sharing in grazing management. The same has also been developed for Mandera triangle between Kenya, Somalia and Ethiopia pastoralists, employing g their ITK and resource governance system for common benefits.

***g. Reduced Soil erosion from road tracks and mining**: Increasingly, there has been a trend of new roads within the rangelands that create a source of truck lanes which initiate gulleys. Overgrazing has also brought in bare lands extending from loss of topsoil and plant seed banks, affecting productivity. Planned grazing systems support control of erosion agents and predisposing factors, and this is enforced by the rangeland management committees and grazing committees within the regions rangelands, and thus, a strong benefit for the implementation within the regions rangelands.*

***h. Promotion of appropriate farming and land exploitation technologies in the wider IGAD regions grazing ecosystem:** The IGAD region rangelands have seen increasing use and adoption of inappropriate farming technologies and strategies around the community areas that have cleared land and left bare soil, leading to erosion from the high areas leading to gullies formation. Also, lack of forage production and conservation technologies has affected the resilience of the pastoral communities in the region, ending up putting pressure on the rangeland resources during the stressful periods. Planned grazing with communities' implementation provides solution to protect critical grazing lands from encroachment and unsustainable developments, with promotion of sustainable solution in pasture and fodder conservation, like the dry season protection and water catchment areas protection.*

***i. Support investment in land management:** IGAD regions rangelands have had no substantive resource investment in the past, and efforts to combat land degradation have been limited. The investment into supporting the livestock sector has also been limited, and thus access to feed technologies, production support and rangelands health has been very low. The regions rangelands have had low support to grasslands and rangelands feed resources value chain development, despite the immense potential. However, with well-planned grazing management, there is great potential for sustainable investments in both pasture/fodder and livestock value chains and thus an opportunity that is created.*

j. Reduced impacts of emerging pests and diseases: *Pest and diseases of animals and grasslands has been a major challenge in IGAD rangeland. With occasional outbreaks of animal diseases, plant pests like desert locust have continued to affect productivity of our grasslands. These challenges have reduced productivity, negatively affecting the livelihoods of communities. The planned grazing management plans address these challenges with the goal of improving the livelihoods of the communities and sustainably managing the multiple use of the ecosystem, building resilience and adoption of resource exploitation strategies that reduce their impacts. For example, planned grazing if well planned supports breaking down life cycle of pests and pathogens through rotation or HGM tactics, as well as timely grazing for reduced losses from termites and locusts.*

2.2.9.3 Steps in Development of Community grazing/rangeland Resource Sharing and Management Agreement

For an effective community rangeland resource sharing and management agreement among communities, participatory approaches must be employed. Below are the 10 steps that support participatory engagements in the grazing/rangeland management within shared resource areas. The steps are useful for both community local boundary and national transboundary scales planning process, all speared towards community engagements and participatory planning process.

Figure 2: Steps in Development of Community grazing/rangeland Resource Sharing and Management Agreement

Step 1: Mobilization and sensitization of communities within the shared transboundary resource areas

This is the first step where all the communities living within transboundary areas are engaged differently to identify all their problems in rangeland resource management following community participatory approaches. The community thereafter chats the way forward for sustainable solutions to managing their resources, including identifying transboundary resource use and management challenges and solutions to the challenges.

Step 2: Identify and bring together all the community representatives to support community agreement processes in rangeland resource use / Grazing resource use and management

This process is very critical, and the support team should ensure the communities select the accepted and true spoken persons to represent their views. The selected team should be done in a participatory manner, with care to include the known and accepted opinion leaders within the community. During the community mobilization and sensitization, the representatives can be identified by the community in a participatory manner. Most of the time, the local authority, religious leaders, and local elders are part of the selected by the communities. Note that the process should also be gender sensitive for the selected teams, with inclusion of all gender groups' representatives. The team should also have community blessing and a clear understanding of the community boundaries, existing resources and historical information. The selected team should be well informed of their clear roles as expected by the community.

Step 3: Development of community rangeland resource maps within the shared ecosystem/landscape

This is a noble process where the selected community representatives sit down together and draw/develop a community resource maps in a participatory manner. The maps should show clear and agreed boundaries, consider historical boundaries, devoid of political boundaries. The maps should clearly show the boundaries and neighboring communities, different existing resources, dry, wet and reserve grazing areas, migration routes to markets and grazing areas (water & pastures), conflict prone zone and existing institutions. For grazing resources, the communities identify critical grazing zones, with mapping of seasonality effects and status with season of all the grazing lands. Among the grazing consideration resources water points, natural salt licks and other animal support infrastructure like dips/spay races markets etc. The developed maps are thereafter critically analyzed by the communities through brainstorming on the implications and planning for sustainable

resource use, sharing and management. The community representatives also reflect on climatic events and adaptation strategies that could be employed looking at the resources, available adaptation and coping strategies to the changes. The team also reflects on conflicts related to the identified resources, hotspot areas, causes, suggested solutions and the areas of need for inter community negotiations to avert and manage the conflict threats.

Step 4: Community participation in validation of the developed rangeland resource maps and use plans suggested

The maps developed by the community representatives are thereafter shared with the wider community for validation and improvement on the issues and resources identified. The community keenly looks and provides inputs with consideration of working historical information and knowledge that the team needs to consider. During this process, the community discussion engagements is done and making awareness and clear that they can't live in isolation, especially with sharing of transboundary shared resources, the importance and need to agree with other neighboring communities on the sharing modalities. In these meetings, it is made clear for the community to agree and have consensus for an inter community meeting and engagements about the resource use, sharing and management, with agreements on their proposal for discussions with the other neighbors. The negotiating representatives are given the mandate to represent the views and interests of the communities with clear tradeoffs and goodwill for a win-win situation among all the parties to be engaged. For rangeland management, the grazing resources are looked at keenly, from pastures, browse and other grazing support resources and mutual agreements made for their sustainable use and management.

Step 5: Inter-community meetings on transboundary resource use, sharing and management plan for common benefits

The intercommunity meetings and discussions on transboundary resources, issues affecting their sustainable management and utilization as well as the shared resources status, challenges and opportunities is critical. These meetings should be held in a neutral agreed place where each community will be free to air their concerns and provide a platform for healthy discussion in a free and participative manner. The representatives within this meeting should be true representatives *of the communities* with the blessing and goodwill of their communities. As much as possible, the meeting should be neutral with no political influence but mutual community views and agreements that are genuine and of mutual importance. The meeting should not focus more on boundaries for the communities, but as much as possible on community perceptions on shared resources, status, challenges, proposed solutions, interventions and way forward to ensure sustainability of resource with improvement of livelihoods for all the communities. In case any political and boundary issue

arises, the facilitators should be tactical and resolve amicably with communities being the center of getting the solution and best way forward, with adherence to ***'do no harm principles***.

During the meeting, the key transboundary shared resource forms the basis for engagements and negotiations, where focus to grazing lands, access, status, management, seasonal uses, migration routes; water resources, locations, challenges, sharing need, season of use, management and maintenance; conflict areas over transboundary resources, causes, mitigation and management, solutions and way forward; resource hotspot areas, seasons of use, challenges, management and sustainable use a agreements; important tree resources, challenges, opportunities, sharing and management; other resources shared with the transboundary areas, challenges, opportunities for sustainable use and management and way forward.

Please note that this could be a series of meetings, and not a one-time event, at times communities may fail to agree and create need for consultations with their wider community before coming back on the consultative meetings for negotiations on the resource, use and sharing, this may repeat until all parties agree and are in one page of the resource sharing and management agreement.

The final stage of this stage is when the negotiating teams have fully agreed, then there is need for the inter-community representatives sharing the outcomes with their wider community, create awareness and buy in good will by the general community leading to community approvals and if any need for amendments done, and the process is followed to completion.

The facilitating team should have these consultative meetings processes well documented with the following sections well captured in the Minutes/Report

a) *Venue of the meeting*
b) *Communities in consultation meeting*
c) *Date of the meeting*
d) *Convener of the meeting*
e) *Participants lists with signatures/fingerprint*
f) *Issues discussed in thematic areas*
    i. *Grazing management/pasture management*
    ii. *Rangeland management*
    iii. *Soil and water management*
    iv. *Settlement and infrastructure*
    v. *Plant resources management etc.*
g) *Agreements on the issues discussed*
h) *Signing by community representatives*

Step 6: Inter-community resource use, sharing and management strategic planning

This stage comes after intercommunity meetings on the resource, sharing and management meeting. At this stage, the community representatives thereafter come together and develop a strategic plan of use, sharing and management with considerations of earlier agreements for implementation. The process involves the creation of a systematic framework plan that can be easily followed, implemented and monitored. The framework plan also provides for the terms and conditions on how the agreement will be operationalized, specific use agreements agreed upon with seasonality implications if any, the agreed enforcement plans, responsible persons, and community agreed enforcement/penalties/fines etc.

This process should also develop an implementation modality from the communities, including identification of committees to oversee the implementation at community and transboundary community coordinating mechanism. For grazing rangeland management, the meeting should consider the establishment of Rangeland Management Committees, Grazing management committees, Enclosure management committee if any at this stage. The roles and responsibilities and the membership are also agreed upon at this stage. The proposed committee should also have gender consideration in memberships.

Step 7: Ratification and validation of the proposed resource use, sharing and management plan elements

This step allows the agreed resource use, sharing and management plan to be shared with the communities within the agreement areas/region and seek for their endorsement for the implementation of the plans. This process allows the whole partnering communities to be aware and support the agreements for implementation with ownership.

Step 8: Final signing of the resource use, sharing and management Agreement

This stage is important where all the authorized and identified community representatives to legalize the agreements are allowed to sign as a sign of commitment and legal binding of the agreement. This step is done when all parties have agreed, build consensus, and are ready to implement the agreed items. The signing is crucial step and should be witnessed by local opinion leaders, local community leaders, local administrations, community political leaders, local or regional security team for support in enforcement as well as other community members in witness. For the cross border/trans-border resource sharing agreements, all representing parties should be in witness from the countries/regions. The whole process involved to the signing stage should be well documented in the process report and filed with the signed agreements, deposited with all the relevant authorities with communities having their own copy kept by their leaders in the agreement negotiating team.

Step 9: Implementation of the transboundary resource use, sharing and management Agreement

The most relevant and critical stage is effective implementation of the agreed plans by the communities. The agreed implementation modalities should be adhered to, with an effective plan of implementation by all the community members. The implementation committees, leaders, and general community are responsible for ensuring that the agreements are implemented accordingly. During the implementation process, there should be effective communication among all the inter community teams and timely exchange of progress, status and any concerns addressed on time. There should also be continuous awareness during implementation with communities understanding of the process, benefits and implications as agreed by the communities. The community committees tasked with the implementation like the RMC/GMC should be up to the task with a clear communication and community engagement and feedback mechanism to ensure smooth implementation for the desired results achievement.

Step 10 Monitoring of the transboundary resource use, sharing and management Agreement implementation

There should be a monitoring plan among the implementing committee's where progress, challenges, arising opportunities, adherence, etc. should be discussed on timely manner and where adjustments are needed, effectively agreed upon in a participatory manner with the teams for smooth implementation. The local authorities should also be updated on the implementation process, impacts, failures and success and community discussion should be allowed to keep on improving on the agreed resource use, sharing and management system as well.

2.2.9.4 Technical considerations for transboundary resource use, sharing and management Agreement development and Implementation

Sustainable transboundary rangeland resource use, sharing and management is an iterative process based on the dialogue amongst all stakeholders aiming at the negotiation and decision for a sustainability. The process should ensure decisions that are sustainable, socially acceptable, environmentally compatible, and socially desirable and economically sound to the end users of the resources. It sets in motion social processes of decision making and consensus building concerning the use, management and protection of rangeland resources by the community. It is therefore important that when preparing sustainable management, use ad sharing of rangeland resources in transboundary areas, the local community who depend wholly or partly on natural resources should actively participate in the process. The results of planning and the implementation of any measures agreed upon can only be sustainable if plans are made with and by the local community, not behind them or even against them, with the consideration of supporting resources, climatic conditions, human activities that foster sustainability or vulnerable in the planning process (Fig 3). Sustainable planning is therefore not just a matter for experts but should be carried

out together with those affected by it. To ensure a feeling of ownership concerning self-help activities, the local community who are affected must be involved in the planning process from the beginning. The planning process considers cultural viewpoints and builds up on local environmental knowledge. Rural communities can often provide complex indigenous knowledge of the environment and therefore local knowledge should be part of the basis for planning and implementing a sustainable transboundary resource use, sharing and management plan. Proper planning will therefore enhance the resilience of communities within transboundary areas. Figure below shows how the land resources interact with climate and human activities, and this forms the basis for proper planning with cause-effect considerations by the communities.

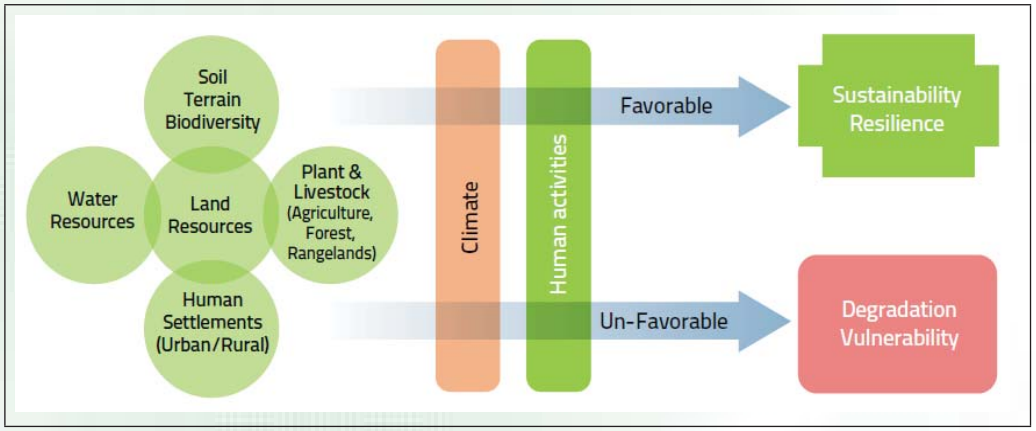

Figure 3: The linkages between resources, climate, and human activities. Source: FAO 2017

2.2.9.5 Attributes of a successful transboundary resource use, sharing and management pan

Rangeland resource management is considered sustainable when it is socially and environmentally compatible, desired by society, technically viable and when it makes economic sense. This means that when considering the effects of planning measures, attention should be paid to the distribution and kind of benefits to the community and society. Those should be spread in such a way that even the socially weak parties, the vulnerable, are allowed to participate in the process. The following should be attributes to consider;

a) **Consider long-term sustainability of natural rangeland resources**. The rangeland planning and utilization must be designed to ensure that the natural basis of living is sustained in the long-term. This should ensure that the use of the land corresponds to its natural potential, like grazing plan should ensure regeneration ability of plants after use, reduced and avoid degradation from grazing impacts. Existing environmental damage processes

of land use systems should be minimized and damaging developments avoided by supporting and adapted and proven suitable approaches. Thus, in sustainable grazing land management, enough rest period with protection from deforestation and over grazing are factors to be considered in the planning process.

b) **Community acceptance and social compatibility**. The rangeland resource use, sharing and management plans process should be desired, accepted, supported, and carried out by those who directly use the land. The effects of such measures can only be sustainable if they are socially compatible and culturally suitable and if they consider local knowledge and capacities. Integrating local knowledge and traditional management structures and institutions, helps to understand the challenges and demands on the ground that are related to livestock keeping, grazing, and browsing resources, water supply for humans and livestock, the utilization of wild fruits and fodder trees, among others. For transboundary areas, the communities have a long history of resource sharing and management, this should be revised, strengthened, and planned to respond to the recent changes with time.

c) **Economically efficient.** The measures planned should be designed to contribute to the long-term security of the economic basis of the IGAD member states communities. Therefore, the measures should be self-financing and thereby economically justified. In this way, they contribute to the improvement of the living conditions and to the overall economic development. Thus, when doing a participatory planned grazing in the region rangelands, strategies that increase economic benefits are desired, like access to markets for pasture and livestock as well as livelihood support by the governments, with favorable policies that support economic development.

2.2.9.6 Building the capacity of the transboundary resource management support working group

Capacity building is increasingly seen as a key component of developing a sustainable rangeland resource use, sharing and management. The community transboundary resources support working groups will require special skills, knowledge, tools, and equipment for coordinating the transboundary rangeland use planning process and seeing it through to implementation. The need for communities and community leadership capacity development will enable members of the working group to obtain, improve, and retain the skills, knowledge, tools, equipment and other resources needed to do their jobs competently into the future for sustainability. Even if the key focus may be on education and training to meet short- and medium-term needs for developing the transboundary rangeland use plan, capacity building measures should be addressed in the wider context of developing institutional infrastructures

for developing and implementing a rangeland use plan in a sustainable way.

In this case, capacity building measures for the support working group must be addressed. For proper capacity development of the community working group, the members must:

- Evaluate the external environment and their organizational composition: The external assessment should include: an evaluation of their strengths, and weaknesses, the political environment, funding outlook, trends, and demand for the planning process. The internal assessment should include an evaluation of the number of, and skill sets of, members, internal trends such as continuing staff turnover and quality issues.

- Identify and discuss the strengths, weakness, opportunities and threats facing the community groups: From there, the leadership should identify and prioritize the actions they need to take to address their weakness, shore up their strengths and take advantage of the opportunities.

Rangeland use, sharing and management plans for transboundary areas should be dynamic and allow for the frequent assessment of implementation and results and which can be adjusted and updated to meet goals and address emerging issues. The capacity of the community working groups to prepare and revise community rangeland use plans must therefore be developed to ensure the continuous fine-tuning of plans in response to challenges and uncertainties in a participatory manner.

Recognizing the interdependence of community well-being and ecosystem health strengthens the capacity of communities to have a voice in decisions about land use planning process. Capacity building is valuable and important because of the long-term impacts which include:

- Minimizing an over-reliance on outside experts as sources of knowledge, resources, and solutions to community issues. By preventing a dependency relationship on outsiders from forming, capacity building encourages local people to take action on local issues themselves.

- Capacity building fosters a sense of ownership and empowerment, so that community partners gain greater control over their own future rangeland use.

- Strengthened confidence, skills, knowledge, and resources that increase from capacity building efforts may enhance a community partner's ability to envision and take action on various rangeland management projects.

- Capacity building efforts are sensitive to the particularities of local culture and context, and, as a result, often lead to more feasible and appropriate community solutions than approaches that lack a capacity building focus.

2.2.9.7 Peace support for transboundary Rangeland resource use, sharing and management in IGAD Region

Conflicts is one of the challenges affecting grazing resource management and utilization in the rangeland in the Horn of Africa. IGAD region has many transboundary rangeland resource areas, which have suffered periodic conflicts mainly associated with resources such as pasture, water and livestock among the pastoral communities. The exploitation of natural resources, including grazing areas, fuel wood, farmlands, water are the key factors in triggering, escalating or sustaining community conflicts within and outside the region. Furthermore, increasing competition over diminishing renewable resources, such as land and water, are on the rise, coupled by increasing drought events. This is being further aggravated by environmental degradation, population growth and climate change impacts. In order to develop a sustainable rangeland use, sharing and management plan for the transboundary area, the technical support group must organize peace forums together with the regional/ national/country governments in the borders, together with all the key development stakeholders, CBOs, and village councils in all the village units. Peace forums are community-driven dialogues aimed at analyzing and understanding the root causes of conflict; acknowledging the abuses and crimes perpetrated by community members against each other; facilitating healing; undertaking negotiations to secure formal commitments for durable peaceful cohabitation; and working towards community-based recovery. The peace forums should provide an opportunity for the community to understand the essence of collective management and sharing of resources without unnecessary conflicts. The support working group must ensure that the affected communities take leadership in the process of dialogue and negotiation to come up with agreed social commitments for sustainable peace and recovery, and this then will enhance pasture and rehabilitation efforts for sustainable grazing ecosystems.

Box 7: Guidelines for a successful community peace building support

For a successful community peace building support, the following guideline should be considered;

- Community assessments to better understand the structural issues underlying the conflict in the community so that the interventions do not just respond to the triggers of conflicts. The assessment will allow the technical support group to assess the community's willingness to go through the reconciliation forums.
- Facilitate community conversations or dialogue sessions to:
  - Manage emotions
  - Conduct a participatory problem analysis to agree on the root causes and effects of the conflict, and on the issues that need to be addressed;

- Facilitate healing, truth and reconciliation and/or acknowledgement of what happened;
  - Constructing a vision for the future with the community and developing respective roles in achieving their goals.
  - Guiding the negotiation and signing of the social commitments and agreements
  - Setting up community mechanisms to oversee the adherence to the social commitments of members of the community.

2.3 Pasture management practices for Established pastures and their sustainability in the IGAD Region

Training discussion under the moderation of Master Trainer

(Plenary discussion on what are the pasture management post planting and establishment and as applied by the communities.

(All the pasture management/ practices/ methods used by the communities be listed for a discussion)

20-30 Minutes

(Master trainer to enhance free discussion on all the traditional/ modern pasture management after and post establishment)

(N/B -The discussions should bring how successful productivity is achieved by communities to reduced threats of weeds and invasive, water stress and use planning to avoid over utilization)

Delivery Approach

(Depending on number of participants, should be done in groups or as a plenary discussion)

(Field photos printed on A3 of the different methods can be shared later for discussion, or photos and video presentation for visual learning)

Practical Exercise

Where possible, the practical aspect of the sessions should on weed removal, weeds identification, watering regimes assessment and community engagements for control on access and utilization)

(Below notes to support the master trainer and TOTs on management strategies post pasture planting and establishment in the region)

2.3.1 Proper watering/water harvesting for pasture establishment

Watering of pasture fields or water harvesting of pasture before establishment is critical for successful establishment. The earlier session land preparation provides the onsite water harvesting for establishment. But also, in some cases, under irrigated farms, proper watering is good. Some technologies like water spreading through canals, furrow is useful, and this could be from water sources like dams, boreholes, rivers or even eater spreading from natural flows like road run off, hill run off just to increase water capture and use for pasture growth. Some water irrigation technics are also positively used to increase sustainability like springer, overhead systems as well as simple spate irrigation techniques. The mode of delivery from water source can also take advantage of clean energy like solar systems. Some of the known technologies used to irrigate the pastures are;

Solar powered or Gasoline powered Basin irrigation

The need for sustainable farming systems demands the adoption of climate smart technologies, like solar power irrigation system in the IGAD region. Basin irrigation has proven to be a suitable for small scale high value fodder like legume crops or fodder crops for households. The technology uses water supply technologies like water pumps during diesel or solar powered systems from water sources (Dams, shallow well, river) to the farms. Some basin system uses petrol or diesel water pumps, which has been shown to be high cost in the region, and in most cases not suitable as well as being environmental unfriendly. The only producers reporting benefits is those doing high value crops that give residue for animal feeds, or for those doing pastures, targeting high value legume fodder crops for any economic sense.

Plate 91: Solar-powered water pump- drawing water from a borehole enough to irrigate fodder. Photo Source FAO Pasture production Manual

Plate 92. Farmer in Gebilley with a shallow well is assured of green fodder even during dry season, which he can mix with harvested dry maize stalks (see background) for his livestock. Photo Source FAO Manual

Plate 93: Preparation of basins using hoes along riverine areas. Photo Source FAO Manual

Plate 94: Directing water to the basins- a good fodder crop is assured as seen above. Photo Source FAO Manual

Spate Irrigation -cultivated flooded plains in IGAD Region

Traditionally, agro-pastoralists in the IGAD region who have been doing dual purpose crop and fodder production have the experience of using spate system of water delivery to their farms. Spate irrigation is a technology that is used to manage flush floods from ephemeral rivers to the farmlands or command areas through simple and economical ways. Technology allows converting disasters into blessings. Spate irrigation has potential for production of pasture after land preparation and effective spreading of water within the prepared land. Mechanization (Tractor Ploughing) can be used to plough and establish water spreading plans within the prepared spate land. The technology implores use of overflowing water from rivers or deliberately directed from seasonal rivers through feeder canals after flash floods. The technology has great potential in IGAD like the reported success in Somalia (Toghdheer regions of Burao District, along the Beer seasonal river, Shebelle River in Jowhar region, Oromo region, Tigray region in Ethiopia and Tana River and Turkwel river regions in Kenya, with systems used for both crop and fodder production showing great potential. The practice yields more beneficial results when planned weirs are done for assured water spread and flow to wiser farmlands.

Plate 95: Water floods that can be harvested for spate irrigation in Somaliland: Photo Source FAO Manual

Plate 96: Land ploughed by tractor for spate irrigation of grass seeds (Beer village): Photo Source FAO Manual

Plate 97: Established pasture field within the flood plains in Beer village, Togdheer region of Somalia: Photo Source FAO Manual

Plate 98: Potential yields from flood plains at Beer village, Togdheer region of Somalia: Photo Source FAO Manual

Challenge to Spate Irrigation in the Region

The Spate irrigation technology has great potential in IGAD region, however, not fully exploited due to low capacity in flood water utilization and spreading to the farmlands in an economic and safe ways. Most often, the flush floods destroy the infrastructure, and also poor spreading increasing impact on concentrated flow areas. The flush gates from the main river to primary and secondary canals need to be well constructed to resist flush floods and also allow for easy control of flow and distribution to fodder growing areas. Notably also, it is reported that the biggest challenge is maintain the intake Weirs from the sedimentation through desilting, which at times is expensive to the communities.

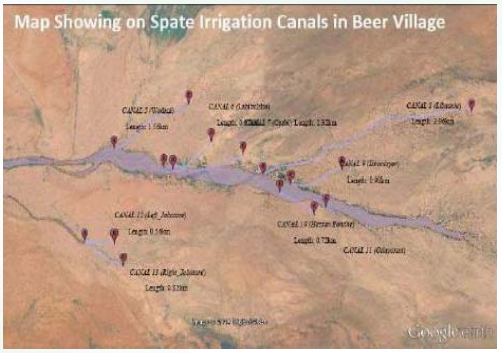

Plate 99: Map image showing the secondary canals along Beer River in Burao. Photo Source FAO Manual

Plate 100: The sluice gates at Beer River should be continuously maintained. Photo Source FAO Manual

2.3.2 Weed control in pasture /reseeded fields

Fore successful pasture establishment and increased productivity, pasture weeds must be managed. Many times, the pasture weeds are less palatable and invasive. However, we need to note that weeds in pasture may only be considered as plants not useful to animals as feed, not like the crop farms, since in many cases some other plants within pastures are actually beneficially and add value as part of it, kike edible and palatable legumes and shrubs, forbs such us Commelina etc. Thus, when deciding which weed to control, producers must be careful only to identify only what is unwanted. Some desired plants species may be weeds when growing in unwanted places. Weed management in established pastures is very critical for good pasture sward. Weeds are known to bring competition both for nutrients, light, space and water. This may result to reduced productivity and even the final quality of the products. Some weeds are invasive and may end up outcompeting the planted pasture species as a result of inter-specific competition. However, not all weeds are bad to animals; some are actually very nutritious especially when they are leguminous. Others could be conferring benefits to the established swards such as nitrogen fixation.

As a range manager, one needs to understand the botanical composition of the swards and weigh the negative or positive impacts before clearing. Some weeds could also be of negative contribution to sward productivity or quality but still important for soil erosion control, biodiversity contribution e.g. nesting place or cover for wildlife. Weeds could be a challenge in many ways such as:

- ✓ Allelopathic properties making other species not to grow
- ✓ Alternative hosts for pests and diseases
- ✓ Shading other plants among others

The weeds can be annuals, biennials, or perennials. Some weeds could be grasses, forbs, or legumes. Knowledge of weed science in pasture management is critical especially when producing pasture seeds for the market.

Selected Applicable Methods of weed control in pastures in the IGAD Region;

For effective weed control, selecting the most appropriate and cost-effective method is critical with the consideration of environmental safety and animal's safety as well. There are several methods employed in pasture weed control worldwide. Depending on the level of mechanization, resource capacity and size of land, the following technologies are applicable.

a) Biological control methods

This has been one of the most common methods especially in IGADs region grazing rangelands. The method uses biological understanding of the grazing environments

and puts in a stagey that best exploits land with strategic process of managing weeds and invasive. The most practical biological method is planned grazing, to reduce over or underutilization of grazing fields. Holistic grazing strategies have worked wonders in reducing weeds, unwanted species or increaser species, as well as managing invasive through multi species grazing tactics. The use of natural enemies such as pests/insects etc. to manage weeds has also been useful when dealing with alien weeds. Not commonly used in developing countries. Crop competition also offer the opportunities where the most dominant and best fit takes over, and if it's the desired species, then weeds are suppressed, such as what we achieve with over sowing or reseeding to increase competition from the desired species.

b) Mechanical Control

This is a method that can be achieved either manually or mechanized depending on scale and availability of resources and equipment. Manual control is easily achieved with human labour, where communities have been useful in controlling trough uprooting, stumps removal or weeding using simple handheld tools. Under mechanization, machinery like tractors/graders with implements like rotavators or chain slashers may be used to control the weeds. This method is effective in annual weeds management and can be cost effective system for annuals. Effective on annual weeds, it's also cost effective, system of weeds. Annual weeds are usually mowed to prevent seed production and to allow the crop a better competitive advantage. The method can use simple tools e.g. hand hoes etc. Hand weeding is also ideal in small farms. The method is effective if weeds are controlled at the earliest, before they set seed. Best weed control is usually achieved by a combination of two or more of these methods.

Plate 101: Weed control in reseeded areas for better establishment/ Photo source: Dr. Oscar Koech, Xaaxi, Somaliland

c) Chemical weed Control methods

The use of chemical weed controls should be the last resort in the regional rangelands owing to the known or unknown long-term effects on the environment, more so on soil and water bodies or aquifers. This can be done by use of systemic chemicals, which at time can be selective depending on the weeds to be controlled. Notably, if it must be used, then safe herbicides are available and have been used mostly which can be applied at pre-plant, pre-emergence, and post-emergence

d) Crop and pasture Rotation system

This method works well within the agro-pastoral areas where rotation of crops and pasture with fallow periods allows for weed management and control in a biological way. This is a biological and environmentally friendly way to control weeds. Rotating crops with different types of pastures can't act as alternative hosts to pests and diseases, as well can help in soil fertility and structure improvement especially when legumes are part of the cycles.

e) Prescribed fires within the rangelands of the IGAD region

Historically, the rangelands in ten IGAD regions have co-evolved with some places getting natural fires or prescribed fires, as one of the tools for rangeland management. Pastoral communities have been doing planned fires to reduce fuel load and kill weeds and pests, with proper timing on just before the rain periods, as well as with care on extent of the fires to avoid undesired burns. Fire as a tool also needs professional use on timing period and start point to ensure head or backfires which have different impacts on ecosystem. Although it may be also a threat to ecosystems biodiversity but can be useful when dealing with a serious problematic weed infected area sand there is need kills the seed bank. This has been used to maintain the savannas. Plants vary in their resistance to fire, and intensities will impact differently to varied plant species. Fires can help control invasion of shrubs and trees in grasslands.

The region recognizes the need for weed problems to be managed on time. The most identified problematic weeds being *Parthenium hysterophorus* and *Xanthium stramenium*. The other observed weeds are *Crotolaria lebrunii* and *Sesbania keniensis which* seem to reduced with pasture crop maturity, but was also noted to be palatable to goats and sheep, a chance that the farmers can harvest as feed. The region notes weeds challenges will be a big problem in the region with increasing intesification of farming and land use changes, since most most farmers leave weeds to seeding stateg, and thus increase in weed soil gene bank. The advise and training message is for the farmers is to do early weed management in the cropping seasons, as well as to ensure clean field and not to allow weed seeding to help reduce the soil gene

bank. Below is sample of common weeds identified in irrigated pasture farms.

Xanthium stramenium

Crotolaria lebrunii

Sesbania pea weed

Parthenium hysterophorus

Plate 102: Selected common invasive weeds in Rangeland pastures in the IGAD region

2.3.3 Post establishment pasture management practices in the IGAD region

Past pasture establishment management is critical for the IGAD region. This stems from the community or producers' management of utilization and protection from over utilization or underutilization through proper governance. The other management that is critical is soil fertility management, especially on cut and carry systems, which demands a strategy to ensure healthy and productive soils. The other care needed is strategies to reduce losses from quality deterioration from untimely use, overgrown utilization or also from wastage threats of pests like locusts. Locust has become one of the regions threats to pasture production and thus timely utilization or harvest and conservation is critical to avoid these losses. The use of community traditional

and customary grazing lands management practices and use of institutional and rules will also be useful in ensuring sustainable pasture system. Disease and pest management in fodder farms, mostly within dual purpose crop lands is also critical, with need for post-harvest losses reduction from factors like pests, molding, rotting, and aflatoxin risks.

Plate 103: Photo of a farm planted late with Dual purpose Sorghum infested by Fall army worm pest

2.4 Pasture seed production and Multiplication in the IGAD Region

Training discussion under the moderation of Master Trainer

(Plenary discussion on what are the pasture seed production and processing strategies as applied by the communities.

(All the pasture seed production and management/ practices/ methods used by the communities be listed for a discussion)

20-30 Minutes

(Master trainer to enhance free discussion on all the traditional/ modern pasture management after and post establishment)

(N/B -The discuss should highlight on what pasture seed production methods and strategies are employed by communities, both from traditional practices, modern practices and which species are common for seed production)

Delivery Approach

(Depending on number of participants, should be done in groups or as a plenary discussion)

	(Field photos printed on A3 photos of the different methods of seed harvesting, or photos and video presentation for visual learning) Practical Exercise Where possible, the practical aspect of the sessions be done in mature pasture fields with demonstration of seed harvest, processing and storage, or visit to existing pasture seed unit/ stores and or stockiest shops)
(Below notes to support the master trainer and TOTs on pasture seed production, processing and storage management in the region)	

2.4.1 Pasture seed production process and strategies

The IGAD region pasture production has been greatly affected by availability of quality and locally adapted pasture seeds, at an affordable cost to the already poor farmers. The region despite having wide array of local and indigenous pasture germplasm, very few are protected and propagated or improved for the future genetic conservation. The saddest lesson from all the IGAD countries is that there has been no formal range grass that is advanced with improvement on large scale. Kenya has been trying through Kenya Agricultural and Livestock Research Organization (KALRO), but only with a focus on few species like *Cenchrus ciliaris, Eragrostis superba* and *Enteropogon macrostachyus*. Ethiopia has no body that is mandated and solely focusing on range pasture seed production and marketing on range land grasses. Worse is Somalia has been relying on other nations for supply of reseeding or establishment pasture seeds like from Kenya. This has seen the regional pasture seed cost being too high, with about 10 dollars a kilogram of native seeds species. Other regional players who have been supporting pasture seed production, but only at research level like the International Livestock Research Institute (ILRI). Thus, for any success on pasture production in the region, communities should be in the forefront in directly getting engaged in sustainable pasture seed systems. The biggest challenges at community level are the lack of capacity and resources, with the needed technologies to support their activities. However, opportunities exist for structure regional pasture seed systems, if responsible governments come together and support the players and persons along the value chain. The need for seed production to conserve our regional biodiversity is also critical. Most of the agricultural production support in the region has ignored rangeland pasture improvement in terms of breeding and hence underdeveloped compared to food crops. The informal pasture production has faced many challenges where seed harvesting manually manual and tedious process at community levels.

The other challenges that we also face in quest to improve our local range grass seed production is the variability of species seed setting, with different maturation and ripening, where one plant can have both young, mature and ripened seeds,

hence collective harvesting become a challenge. This could be probably addressed through breeding. However, proper timing to have over 80% mature and ripened now can be done to supply the ever-increasing pasture demand. Many farmers rely on the physical appearance of pastures for harvesting seeds, despite the existence of other methods that test for moisture content, endosperm hardiness among others that may need skills from training and availability of necessary equipment. Below are the steps followed bin pasture harvesting;

Pasture seed farm plot management: Needs to well managed and proper agronomic practices like watering, weed control, pest control protected. Irrigation increases seed yields and also reduces water stress hence production of fully matured seeds that are more viable.

Harvest consideration: Ensure the pasture is well matured, well ripened before seed harvesting. Plating pasture or selecting areas for seed harvest in the farm need to be done well during growing, and well managed to reduce water stress as well as weeds, this increasing the quality and amounts of seed to be harvested.

Harvesting process: Pasture can be harvested keenly manually to ensure purity and picking of only mature heads/inflorescence, for quality seeds

Pasture seed cleaning: After harvesting, cleaning is needed to remove any impurities from the seeds and thus assured quality. After pasture harvest, cleaning and drying should be done under a shade in a dry environment, while continuous turning needs be done to avoid molding, which can be done 3-4 times in a day. This is necessary since heaping leads to heating and weathering, hence reducing viability. Stock harvesting tents to keep seed quality intact after harvest and also ease of handling. While stripping is faster and easy, one may lose many seeds in the field.

Drying process: After thorough cleaning, there is need to store pasture only after drying to moisture level below 12%. This will reduce spoilage and losses. Sun drying or dry shade drying is recommended.

Factors that determine yields: During pasture seed production, the total seed yields will depend on; husbandry practices, type of pasture species, climatic condition during growing period, harvest timing period before losses through shading, harvesting method that increase recovery and post gravest processing method that reduce losses.

Pasture seed harvesting methods: The harvesting methods depend on the pasture species, variety and available technology and resources. There are both manual harvesting methods done by communities, usually time consuming and slow. There are also mechanical harvesting methods using seed harvesters for high recovery and quick and useful for large scale seed harvesting.

Manual harvest methods are; whole plant harvest, flower stock harvest, inflorescence harvest or seed stripping methods. The methods used for seeds such as stripping are show in photos below;

a) Stripping of *Eragrostis superba*

Plate 104: Stripping pasture harvest methods. Photos source (KALRO-Kiboko- Mnene, W. N, E. C. Kirwa, B. K. Kidake, B. P. Ogillo, D. Kubasu and R. Kimitei)

b) Harvesting grass seed stokes for processing

Plate 105: Photos source (KALRO-Kiboko- Mnene, W. N, E. C. Kirwa, B. K. Kidake, B. P. Ogillo, D. Kubasu and R. Kimitei)

Plate 106: Drying of harvested grass seeds with cleaning process for purity in Marsabit Kenya, Photo sources: Oscar Koech

2.4.2 Seed Quality testing

The need for quality seeds in the region is the goal for pasture sustainability. To access better markets and get producers' trust, selling quality seeds should be the goal of producers. Quality matters start all the way from the discussed process of production and husbandry. Thus, after production and processing, it is also good to check on quality factors. The region has been trading and even using most seeds without quality assurance, with many cases of failures of major projects. Notably also, range grasses also provide us with other ecological adaptation issues that affect quality parameters, like germination rates is also affected by level of dormancy, things that can be address with proper harvest management and documentation to benefit the users.

There are international seed testing standards that are supposed to be adhered to for international trade and marketing. This includes checks for purity, germination, contamination etc. When seeds are stored, it is important to have regular checks for any damage or deterioration. One can plan to do seed viability tests from time to time and relate to the required standards.

Factors that influence seeds viability: Production process for quality seeds, seed storage temperature, level of moisture at harvest and storage, pest infestation (insects and rodents may injure caryopses).

Seed Quality assessment parameters: The physical cleanness and purity of seeds, the germination rate or index for (% of pure seed), Seed moisture content (% by weight), Seed physical appearance from (injuries, molds, colour), Seed infection

– fungal, mold, laboratory genetic purity tests and lastly the vigor (Sum total of those properties of the seed which determine the potential level of activity and performance of the seed).

Management of quality for producers: The easiest measures taken are mostly; purity, germination percentage or index, and moisture content. Random sampling of seeds before packaging and storage or sale or use in planting should be done from a stock to be used.

2.4.3 Grass seed packaging and branding

Proper grass seed packaging is important to facilitate proper storage and also support marketing and trade if it is the goals is commercial. Proper packaging should ensure easy storage, seed protection from pests and also transportation in safe ways. Factors like quality and seed value may determine the type of storage as well as availability and affordability by farmers. It is very important to ensure that all seed storage packages have labels with species names, date of harvest, location of harvest and maybe treatment after harvest.

Ideal Storage packaging materials: Many packaging storage materials are available ranging from; Aluminum tins that may be expensive but long lasting, Woven cloth material bags, brown paper bags- bought as branded or recycled, Nylon high density gunny bags, Nylon sacks that can be hermetic, and sisal gunny bags.

Many types of packages are available raging from tradition packages to modern commercial packages as can be seen below;

Plate 107: Grass seed packaging in plastic bag for small quantities

Plate 108: Grass seed packaged in tins for long storage and safety

Plate 109: Grass seed packaged in nylon gunny bags

Plate 110: Grass seed packaged in sisal jute gunny woven bags

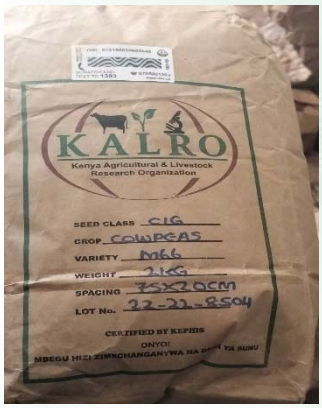

Plate 111: Grass seeds packaged in brown paper bags

Plate 112: Seeds packaged for sale display at farmers agricultural show in Kenya

2.4.4 Pasture seed storage

The need to have pasture seeds for strategic establishment and reseeding in the IGAD region requires standardized harvesting and quality processing with proper storage. This will not only allow for planting materials protection but also support the pasture value chain as a business, with ease of access and marketing by the producers. Pasture seed storage process is very critical especially in the quest to maintain its quality. Many range grasses have seed dormancy, and some periods of storage increase quality. For example, many species triple germination ability after storage of 3-6 months.

Reasons for proper storage: The pasture seeds are living, and they do require dry air for respiration. Hence storage in a cool and dry place is desired, with moisture of the seeds at 8-12%. Moisture exposure may trigger germination or result in rotting/ molding.

Requirements for Storage space: Pasture storage areas should be free of high humidity, tight from rodents and well-ventilated to avoid spoilage and also losses

from pests. Depending on farmer's capacity, storage facilities can be traditional well-designed structures or modern structures. Any good storage should be able to support control of environmental condition such as humidity, temperature, wind etc. Commercial seed require high capital investment since they may need to have refrigeration facility to keep seeds at lower temperature and seed moisture is controlled using dehumidifiers. Below are examples of seed stores in the region;

Plate 113 Conditioned seed storage facilities/stores/structures. Source: https://www.usga.org

Plate:114: Open and naturally ventilated Traditional seed storage by communities in IGAD region/Karamoja Uganda

Plate: 115: Local seed store by communities in Kenya, Turkana County

Plate 116: Seed store with packaged commercial seeds in shops/KALRO Kenya

Plate 117: Pasture Seed store with packaged commercial seeds in community groups/ Turkana County, Kenya

3.0 Pasture Preservation and conservation methods in IGAD Region

Training discussion under the moderation of Master Trainer ***(Plenary discussion on what pasture preservation and conservation methods are applied by the communities.*** ***(All the pasture preservation and conservation methods and management/ practices/ by the communities be listed for a discussion)*** ***20-40 Minutes***	
	(Master trainer to enhance free discussion on all the traditional/ modern pasture preservation and conservation methods by the communities) *(N/B -The discuss should highlight on the most common and most used preservation or conservation methods at community level, large scale commercial levels, with reasons for the choice of methods by practitioners)* Delivery Approach (Depending on number of participants, should be done in groups or as a plenary discussion)

	(Field photos printed on A3 of the different methods of seed harvesting, or photos and video presentation for visual learning on preservation/conservation methods can be used later for visual learning) Practical Exercise Where possible, the practical aspect of the sessions be done in a prior arranged areas for demonstration of presentation/conservation methods at community or research center where materials and equipment's can be found)
(Below notes to support the master trainer and TOTs on pasture seed production, processing and storage management in the region)	

3.1 Pasture preservation, conservation, value addition and storage

The main challenges facing IGAD region Pastoral livestock production systems is availability of quality and good quantities of feed throughout the seasons. The region continues to have increasing seasonality that has greatly affected feed availability over the years. The increasing climatic uncertainties that include frequent droughts with increasing variability and seasonal floods have made livestock producers destitute from livestock losses. The IGAD region continues to see increasing trends of humanitarian need support and this trend needs to be reversed and addressed urgently. The only hope to achieve sustainable livelihoods and build resilient livelihoods, is through the long-lived livestock keeping as a livelihood option for the region. There is increasing need to bridge the gap between fodder seasonality in IGAD dry rangelands, more so, with the current trends of climate variability and change. Pasture productivity both at natural fields as well as cultivated, are best during the wet seasons, and decline both in quality and quantity during the dry periods. This calls for the need to preserve pasture for use during these periods. However, the challenge is ensuring quality is maintained by the choice of preservation and conservation methods.

Factors to consider in preservation/conservation methods choice: The type of forage materials, the period of conservation, availability of the technology and required inputs, cost involved and the purpose of the conservation/preservation.

Factors that may affect the quality preserved materials: The type of pasture species, type of preservation method, period of harvest, post-harvest handling, processing and storage conditions and the prevailing weather conditions during harvest and storage.

Below is selected pasture preservation and conservation methods and strategies within the IGAD region;

a) Grass Hay making

This is the predominant practice within the IGAD region rangeland ecosystems. Hay making has been the oldest method of dry fodder/pasture preservation method for conservation to use during dry periods. Hay making is also a strategy to reduce losses, quality deterioration within the fields and as well as to support commercialization and trade on fodder grass.

Hay making technologies/practices: Hay can be made manually using hay bale boxes, mechanized using innovative manual compressor boxes locally fabricated. For mechanized systems, a bailer is used.

When do we make hay: Hay is made from mature grasses, well cared for, and during the dry periods to avoid losses and risks of contamination.

Hay making Process: The grass is cut, weathered if wet to about 20% moisture, then baled. Cutting for manual small-scale farmers is done using hand tools like sickle, machete. We also have motorized mowers for small scale farmers like the brush cutters commonly used in the IGAD region. The mechanized systems use tractor mower, raker and then bailed after curing.

Advantage of hay preservation: Hay bales are easiest and quick, especially when mechanization can be used. Storage of hay is easy, and the product will be determined by stage of maturity at harvest, pasture species used and a blend with leguminous for pasture can increase quality tremendously. Hay bales are easy to transport and easy to store for future use. Large hay bales can also be made using machinery when in large scale fodder banks.

Storage of grass hay bales: The storage condition is important. Dry, well-ventilated and clean environment preserves hay better. Hay can be easy to manage and use, especially when standard seizes are used,

Risks in hay making: When hay is not well cured and baled, stored, it may undergo heating and temperature increase resulting to decline in DM and CP. If stored when moisture is high >12%, it favours bacteria, yeast, and fungi respiration which further degrades the soluble sugars and increase in heat and hence quality decline.

Below is manual hay making process

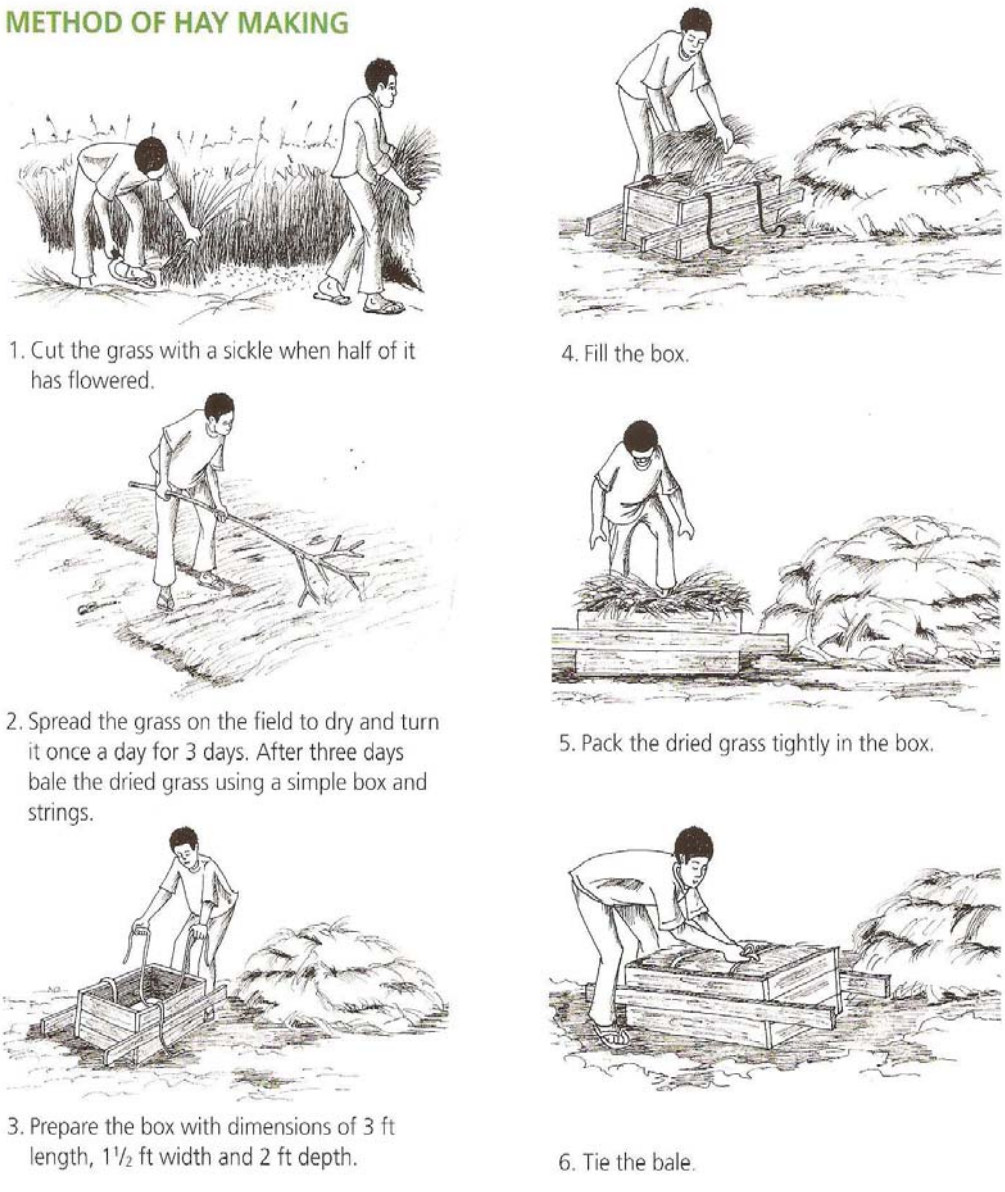

Plate 118: Manual hay making using hay box process for conservation.

Example of easy made foldable hay making box below;

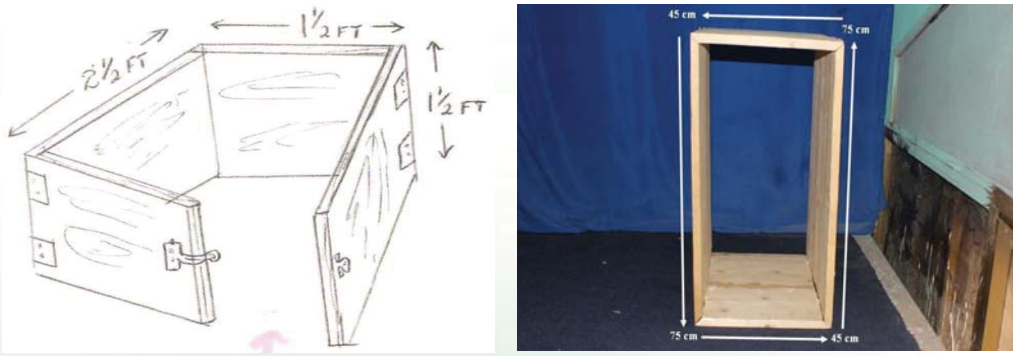

Plate 119: Hay boxes design and specification for standard hay making of about 17kgs

Mechanized hay making using tractor is presented below

Plate 120: Tractor mechanized Hay making process for commercial farms and large-scale farms (Mowing, Curing, raking and bailing process).

Below is hay storage for use during needs

Plate 121: Transportation of Hay for storage by tractor

Plate 122: Stored hay for preservation and conservation

Plate 123: Traditional hay store made using locally available materials

Plate 124: Community stores full of hay as strategic conserved feed

Standing hay

Standing hay is one of the oldest practices, which is very much like the dry season preserved grazing varies under the traditional pastoral communities grazing plan management. The practice basically keeps grass in the fields for use during critical periods. Traditionally, pastoralists of the IGAD region have been leaving dry season grazing areas as standing hays, and using traditional grazing resource governing systems and institutions, the practice has been working well in areas where this still works.

Benefits of standing hay: For animals' maintenance during the dry seasons or droughts, this is still an important source of forage for sustenance. The methods are cheap and cost less, as well as supporting inherent soil genetic seed bank within the landscape. It also provides forage for other wildlife species and habitat to wild biodiversity.

This method has a lot of continuous quality deterioration, however, is the cheapest and does not incur any expenses other than protecting the fields from grazing until the right season comes.

Disadvantages of standing hay: The challenge however is the loss through avenues like termites, rotting, rodents etc. as well as continuous growth and the related decline on CP and increased structural carbohydrates. The other challenge is losses due to illegal grazing as observed in many pastoral regions, especially where traditional resource governance structures have failed.

Below is a photo of standing hay in a farm.

Plate: 125 Standing hay for seed bulking and strategic feed resources in Turkana County, Kenya.

b) Silage making from green forage

Making silage has become one of the strategic fed conservation strategies in the IGAD region, with many pastoralists adapting, with increasingly becoming useful in the peri-urban systems, with some level of intensifications. The practice has been seen to benefit more the agro-pastoral areas, with pasture /fodder production under irrigation systems benefiting due to green matter availability. Silage is one of the superior methods that can conserve pasture for many years if well done. It also increases feed value from enhanced degradability and thus feed quality and feed value.

Silage is a type of fodder made from green foliage crops which have been preserved by fermentation to the point of acidification.

Benefits of Silage making: Silage allows storage of pastures for long and maintains quality better than hay as long as the right treatment is done. If the forage is low in fermentable sugars, there may be need to add sugar/energy source in the form of molasses, sugar beet etc., especially when dealing with low energy feeds. Most rangeland grasses can make silage.

Silage is easy to store, saves space since there can be on farm bales using high density papers, and feeding is easy using silage. The quality of silage can also be maintained, and animals benefit from lactic acid used in preservation.

Silage making technologies: There are also various forms and shapes of silage, container, round bales, squire bales etc.

Challenges to silage making: Silage storage may be affected by heating or molding if poorly stored. The key precondition is ensuring anaerobic condition, tight of air entry for long preservation.

Process of silage making: Silage can be made manually at smalls scale level using farm hand tools and silage making bags, pits or containers. The mechanized systems are suitable for large scale intensive systems using tractor choppers and bigger storage silos.

Preconditions for silage making: Immediately after reducing the particle size, and should be quickly stacked together, compressed well to remove all the air and create anaerobic conditions, sealed and stored for fermentation. Low sugar feed materials may need additives like molasses to increase sugar content for effective fermentation.

Process of Manual Process of silage making

Plate 126: Harvesting of feed materials for silage making in Somaliland: Photo Source FAO Manual

Plate 127: Chopping of the feed before ensiling: Photo Source FAO Manual

Plate 128: Making silage in bags with additives-Molasses or silage fermenters

Plate 129: Making silage in bags with additives-Molasses or silage fermenters

Mechanized silage making process: Small Scale System

Plate 130: Gasoline Brush cutter

Plate 131: Training on use of brush cutter

Plate 132: Manual Chaff cutter for silage making

Plate 133: Tractor PTO silage chopper for silage making

Plate: 134: Silage bags stuffing for airtight anaerobic conditions

Plate 135: Stored silage for proper fermentation and strategic use after maturing

Plate 136: Packaging of silage in small bags for sale or ease of use and storage: Photo Source FAO Manual

Mechanized silage making process: Large Scale System

This involves tractors and machinery for making the silage. The tractor uses the mower to cut the grass, curing is done, then raked for bailing after appropriate moisture (less than 20%) is attained, then bailed and transported for storage.

Plate 137: Tractor chopping silage with PTO driven chopper

Plate 138: Silage being stuck and compressed for airtight coverage

Plate 139: Tractor being driven on silage for proper compaction before airtight coverage

Plate 140: Use of drum with water to provide compression as a strategy

Plate 141: Silage covered with polythene sheet for airtight conditions

Plate 142: Alternative silage method in plastic containers, compaction before airtight storage

143: Covering of sunken pit silage storage with assured airtight conditions

144: Stored plastic containers silage after proper preparation with assured tight lid for anaerobic conditions

Hay grass silage

Plate: 145: Portable hay grass silage making equipment through airtight wrapping

Plate 146: Hay grass prepared to round bales for airtight wrapping for haylage

Plate 147: Round bales well wrapped in field

Plate 148: Stored haylage for proper fermentation

c) Feed Briquette making

This is one of the modern ways to make feed for preservation and conservation over a long period of time. Briquetting making has been made easy from the availability of both small-scale machines (gasoline or electric) as well large-scale machines using tractor PTO or electric. The process is mechanical after the material has been prepared.

Benefits of briquetting: To maximize nutrient content per unit weight of roughages (grasses), briquetting would be the ideal processing method. This would allow a large amount of grass/fodder to be stored within a limited space. Transportation would be eased as it will be possible to transport large amounts of process feed with high dry matter content at once. This would encourage the use of processed grass products for commercialization and use by traders in the export business.

Added value/opportunities in briquetting for IGAD region: Briquetting can also be done with ration formulation from grass being produced with fodder tree leaves and pods for better quality feed. The region has great potential to incorporate silvo-pastoralism in the efforts of pasture reseeding and establishment, with *Moringa oleifera* offering good opportunity for fodder trees, together with the indigenous

acacia trees. This will further support value addition as briquettes. Encourage private sector involvement in distribution and installation of briquette making equipment's of various capacities depending on users through incentives and concessions.

Support needed in briquette as an opportunity: The regional development partners should support and promote fodder production with species that can increase value processing, like the suggested fodder trees e.g. Moringa, acacia trees as envisaged within pasture production support sites. There is also great potential to consider multipurpose food-fodder crops within the potential pasture production and pasture irrigation farms within the agro-pastoral areas in the region.

Potential of the technology for the region: The technology can be used to promote integrated crop-livestock production system in the regions. The potential of dryland crops includes multipurpose sorghum type, finger millet, pearl millet, together with legume crops like soya bean, Sim-sim, chickpea, and common beans offering the opportunity. The crop residues from such crops will be of great use in briquetting processes.

Advantages of briquette when used for rations: The feed is of importance to the users, are; Easy transportation and carrying convenience, long preservation time, High nutritional value, good palsy reducing the incidence of illness in livestock and easily digestible to animals. Self-processing and production of feed pellets can improve work efficiency, and reduce feed costs, to increase profits. It can not only process cattle and sheep feed, but also can process pig, chicken, duck and other feed pellets. When making your own feed particles, **different materials can be added according** to the different needs of animals to ensure the safety of feed and the comprehensive nutrition of animals. Feeding granulated feed can increase animal intake and **avoid animal selectivity,** which is conducive to digestion and absorption. It can shorten the growth period of animals, **easy to transport**, and can be **kept for years.** For small-scale farmers, compared with the market to buy feed pellets, the purchase **of simple feed pellet plant** is a good choice, the cost is not high, and can be based on the specific conditions of animals to produce feed pellets.

Animal Feed Pellets Making Process: The processing process of animal feed particles is mainly physical. The process mixes the material and additives without changing the nutrients contained in the material.

Material selection: Choose materials and suitable additives that can provide the different nutrients that animals need. In addition, the content of each material should be strictly controlled, as it directly affects the durability of the particles.

Crushing: Crush the materials into powdery materials by feed hammer mill.

Mixing: Mix the crushed ingredients evenly by feed mixing machine.

Pelletizing: In this step, material modulation and physical condition control are critical to particle quality. Heat, water time and quantity, steam are important factors

in granulation. The diameter and die thickness of the feed pellet machine also affects the quality of the pellets, the relative pellet hardness and the yield of the pellet machine.

Cooling: In fact, it is not necessary to make feed pellets at home, as small capacity production allows feed pellets to cool naturally. But for relatively high productivity, pellet coolers can be very helpful and save farmers a lot of time. The quality of feed particles directly affects the animal's feeding status and the interests of farmers, so the production of high-quality animal feed pellets is very important to farmers

Small scale pelletizing technology

Plate 149: Pelletizer machine for small scale farmers

Plate 150: Pellets made from feed materials using the above pelletizer

Plate 151: Potential ways top package pellets for market and ease of transportation

Large scale pelletizing process and technology

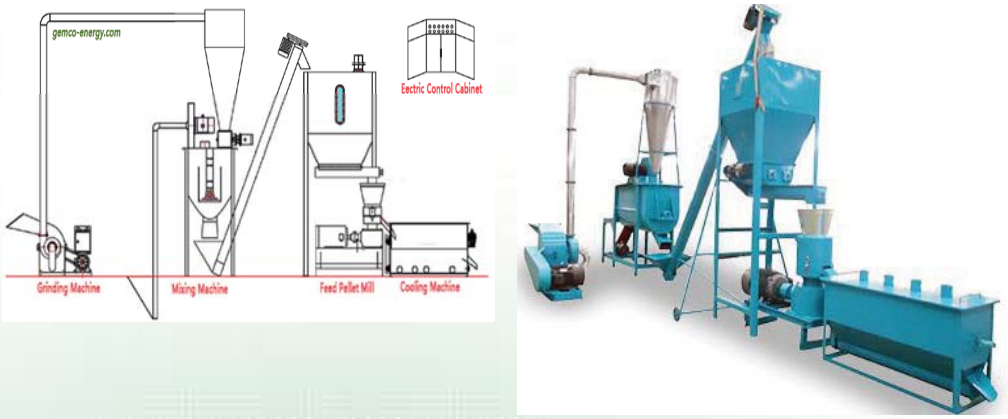

Plate 152: Large scale Feed Pellet making line technology illustration: Photo source: lhttps://www.gemco-energy.com/Small-Feed-Pellet-Line.html

d) Feed block

The need for long term storage and a strategy for strategic feed resources has also provided feed block making as an alliterative feed preservation value addition process in the IGAD region. Feed block making is something that can be easily done at community groups and offer an opportunity for private investment or through public private partnership arrangements. There are locally fabricated briquette making machines, motorized or manual block making types. Feed block making will allow for value addition through ration formulation and offer the opportunities of easy to transport and store, as well as commercialization by branding and marketing as concentrates of feed block meal. The same ingredient and strategies for making the briquettes apply to feed block making.

Advantages of making feed blocks: Feed blocks are very useful during drought periods characterized by scarcity of forage. They are useful supplements to daily ruminant fodder. FB is enriched with vitamins and molasses making it ideal as a source of energy. Feed blocks are a feed supplement which **can enhance efficient utilization of native and improved pastures.** Their main effect on animals is to **increase appetite and intake** of **poor-quality forages** and pastures which boosts animal performance and consequently improves **productivity.**

Benefits of feed blocks: Strategic feed availability for maintaining ideal body condition for ease of calving. Cost effective maintenance of weight **during the dry season.** Boosts **palatability and digestibility**, leading to rapid weight gain.

Process of feed block making: Generic feed ingredients include-urea, the **"strategic"** ingredient, fibrous feed ingredient, mineral premix, molasses (Optional) bonding agents (White feed cement).

Table 3: Generic standard formula for making feed block ration

Ingredient	*Formula 1 (kg per 100)*	*Formula 2 (kg per 100)*
Copra meal (fibrous feed ingredient)	**45**	**60**
Molasses	**20**	**0**
Cement	**15**	**20**
Urea	**10**	**10**
Salt	**10**	**10**
TOTAL	**100**	**100**
Water	**25**	**40**

Process of making feed blocks: The manufacture technique is simple, and easily accessible to small farmers. The equipment required is very simple and relatively cheap. *Mixing may be done by hand*, in a concrete mixer or in a horizontal barrel mixer. Whatever the applied formula, the steps for making the blocks remain the same. These steps consist of weighing, mixing, Molding and drying. Small (10 to 20 kg) or large (50 to 100 kg) quantities can be prepared in each batch

The procedure using Formula above.
Steps for making up the mixture (100 kg)

Mixing: Urea (10 kg) is mixed with salt (10 kg) in a large container. A solution is made up using 25 litres of water. Avoid urea lumps as this could lead to animals being poisoned due to an overdose. Then add molasses (20 kg) and stir the mixture well with a wooden stick for five to ten minutes. The specified amount of copra meal (45 kg) is placed on the ground in a round heap on a hard and even concrete drying floor. Then add to it the amount of cement (15 kg). The mix of copra meal-cement is thoroughly mixed using shovels and/or forks. For preparation of small amounts (10 kg) the mixture can be **prepared** by **hand in a** large plastic bowl. When the mix of copra meal-cement is carefully mixed, form a hole in the middle of the heap and gradually sprinkle by hand or using water sprinkler the mixed solution of "molasses-salt-urea" and carefully knead until a uniform paste of good consistency has been prepared (balls should not disintegrate when moulded in the hands). If these balls tend to crumble, then one should add a little more water (3 or 5 litres) and continue mixing

Moulding: Once the mixture has been properly kneaded, small amounts are progressively stacked into separate moulds. The cubic mould type (20 x 20 x 20 cm) consists of four flat pieces of wood in which slots have been made so that they can be easily assembled to form the mould and then later dismantled when the brick is removed. The mixture is then strongly compacted in the mould using a heavy

wooden or metal pounding rod. Simpler motilds can also be used, such as half buckets, cans cut to size or any other receptacle which is locally available. Taking the bricks out the motilds may be eased if they are lined to start with, using plastic sheet

Drying: Once the mixture has been well compacted, the blocks are carefully taken out of the moulds and arranged on a drying floor. Preferably in the shade as the strong sun can cause cracks in the blocks. Blocks weighing 8.5 to 10 kg when dried can be made with this type of mould. The blocks should be sufficiently resistant for transport and hard enough to withstand licking without crumbling. Once dried the blocks can be stored in a dry place for several months up to 2 years.

Case example of feed block: Feed Block Making from Prosopis Pods

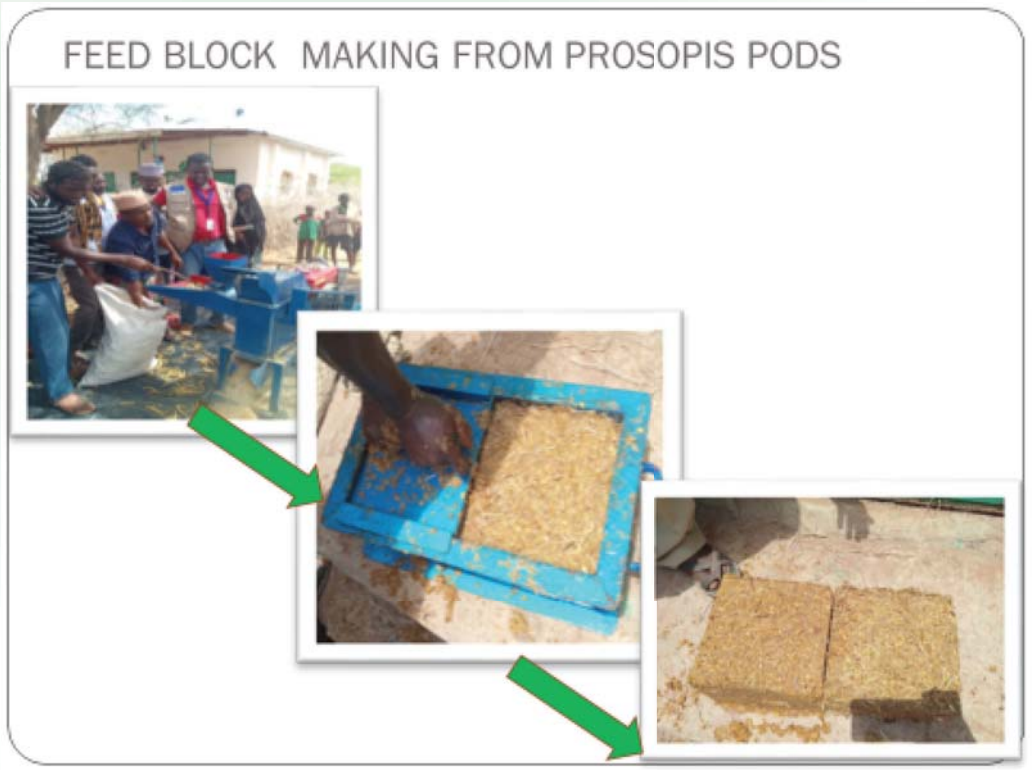

Figure 4 Prosopis juliflora feed block manual molding process

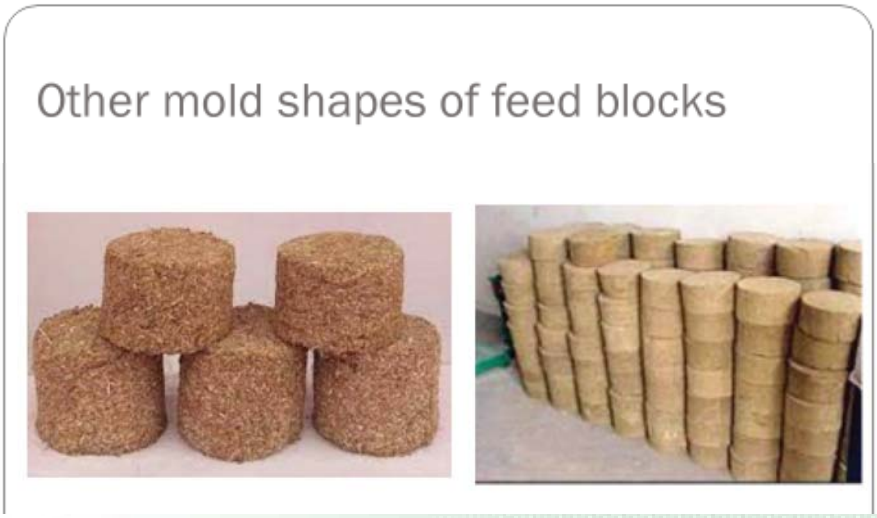

Figure 5 Different sample of feed block shapes molded

Plate 153: Hydraulic feed pelletizing machine for large scale commercial process. Photo source: https://china-hydraulicpress.en.made-in-china.com/product/KsinuclvLWhB/China-500t-800t-Animal-Feed-Block-Making-Hydraulic-Press-Machine.html

Utilization of feed blocks: Blocks constitute a feed supplement that improves utilization of poor quality-forage and unbalanced grasses. How to use these blocks depends upon the feeding system. If the animals graze pasture, the farmer can leave the blocks available to them in a sheltered trough. When animals remain in confinement (animals being milked or fattened) and are fed with silage and cut grasses, the farmer can leave the blocks available at all times in a feed box. Blocks containing urea can be toxic if consumed more than the normal dose; it is therefore recommended to respect the following precautions. Only give the blocks to ruminants because only ruminants are able to take advantage of the urea in the blocks. The blocks should not be given to pigs, equines, chicken.

Calves can have access to blocks after the age of 2-3 months. Wet blocks (due to rainfall) become very soft and can easily cause intoxication due to urea high intake. Consequently, blocks should be always kept under shelter and far from water trough

e) Pasture and Crop residue stacking

This is one of the most common pasture and forage conservation methods observed in the IGAD member states, especially among the pastoral, and agro-pastoral communities. The practice is low cost, and because of low capital for proper storage of the feed resources. The common practice is feed materials put on the ground stacking or house roof top of trees within the household areas by communities.

Benefits of stacking: Allows for low-cost conservation of high volumes of feed for strategic uses.

Disadvantages: The materials stored lose quality due to lack of protection and environmental impacts. Termites also cause a threat to the stored materials. Rainfall may lead to risk of rotting, molding and aflatoxin threats.

Materials used in the method: Many roughage sources come from crop residues (wheat, rice straws, millet, sorghum, maize straws). Most are of poor animal feed because. The level of lignin is about 6% and silica 14% which makes it indigestible. The protein levels are too low **(2–6% CP)** to sustain animals without addition of protein supplements or urea.

Plate 154: Open field fodder conservation: Poor method leading to losses in quality and quantity, with deterioration from weather effects

Plate 155: Crop residue stacking in bags for storage as strategic feed resource in drylands.

Plate 156: Maize crop residue stack in compound as storage or awaiting processing through milling for conservation

Plate 157: Animal utilizing grass stored as open stack in homestead as strategic feed

4.0 Pasture biodiversity conservation and Research for Sustainability in the IGAD region

The observed challenges of loss of pasture biodiversity over time in the IGAD region as reported by many country teams requires urgent measures for protection and reversal of the threat. Research will play a key role in ensuring improved productivity of pastures in the IGAD region drylands. This will contribute to biodiversity protection and support efforts to the availability of adapted pasture species and varieties in the dry environmental conditions. Breeding of the critical native regional biodiversity of pasture and forage resources is an opportunity that research support can contribute to. The need to find or improve on the well adapted germplasm to microclimates and environments such as saline irrigation water and soils that are problematic is a need. The access to research information and knowledge is important for the farming extension staff and communities for quick adoption of appropriate technologies and production systems. Thus, the regional governments and supporting organizations should strive to enhance the needed collaborations and partnerships to this need.

4.1 Research on pasture production and utilization

Regional pasture research is an important activity if productivity is to be increased in the rangelands of IGAD region. The search for better production technologies and agronomic practices that increases productivity at specific localities/range sites/ecological units requires research at onsite for adaptability. This creates the need for citizen science with adaptive

research approach for the IGAD countries support. For improved varieties, breeding research becomes critical for selection and adapting species to local conditions. The important areas that should be researched for improved pasture productivity includes; pasture and forage planting technologies, reseeding technologies, seed harvest and storage technologies, water use efficiency and pest and diseases management. Quality and utilization of the pasture by livestock should be included during improvement. Below is recommendation from this training manual to trainees as key players in support to the pasture and livestock sector within the IGAD region, for consideration after training for implementation and support;

Box 8: Strategies for consideration by IGAD member states and partners in support to pasture and fodder production in the region

To ensure increased production of pasture/livestock through generation of new technologies that benefits communities in the region, the member states and partners should;

i. Support the established pasture research centers to be well equipped and facilitate working with communities to address the local pasture production and utilization challenges in the IGAD countries.

ii. IGAD member states should also support local capacity development of the national extension staff and the lead farmers or ToTs staff working in pasture research and extension for effective delivery of information and technologies to local producers.

iii. IGAD and the member states should enhance partnerships and linkages with research organizations in the respective like Kenya Agricultural Research organization (KALRO), National Agricultural Research organization (NARO), Ethiopian Institute of Agricultural Research (EIAR), International Livestock Research Institute in all countries (ILRI) and Universities among others working in pasture research and development in the region.

iv. The IGAD member states should strive to enhance public-private partnership in research activities that contribute to increased pasture production and management in the region

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4.2 Knowledge sharing in pasture production in the IGAD region

The country status from the engagement on pasture extension support services reveal that many new technologies are developed but remain in shelves, they do not serve any purpose at helping communities in the region, both from local and even regional institutions. As such, knowledge sharing is very important if pasture/ livestock production is to be increased in IGAD states. The need to have effective learning between researchers, producers, consumers and the community in the region is important. Therefore;

i. The IGAD Countries and partners should strengthen extension services and allow for platforms that enhance knowledge sharing like farmer field days.

ii. The countries should also encourage participatory research activities, citizen science approaches that allows step by step learning between researchers and producers/farmers for effective learning and domestication of beneficial technologies developed.

iii. The countries and partners should establish a community technology hub for demonstration where the pastoralists and farmers can learn farming technologies, including pasture and livestock production, with the potential of setting up within the livestock finishing hubs within the member states research centers and, if possible, at communities' project areas.

iv. The IGAD countries and partners should strengthen pastoral field schools to enhance training on rangeland management including grazing systems, pasture and browse management, as well as support the traditional range resource governance systems that was reported as disappearing and this is a threat to sustainability.

5.0 Pasture Production as a business opportunity in IGAD Region

5.1 Pasture business opportunity in the IGAD Region

Most of the IGAD region is reported to have pasture value chain that is narrow, less vibrant, partly due to cultural practices of natural pasture utilization with free access to pasture as well as to the low productivity as affected by impacts of climate change discussed earlier. This has narrowed down marketed pasture, which is understandable from the high number of animals in the vast rangelands. However, the production of pasture and conservation for use during dry seasons has been identified as great potential for supporting communities' resilience to climate change impacts. The region's pasture production and its value chain start from pasture establishment with most support from the local governments or development partners, or projects by national governments. The communities' contribution is land and labour for land clearing and planting, at times with cash for work arrangement. The supporting organizations of partners provide the seeds and technical support. The communities' nature the grass and do the harvesting using manual tools and manual bailers, with few supported areas in the members' states providing mechanization. The seeds are also harvested manually by stripping method. Within the value chain, some pasture hays are sold directly to local community members during dry periods, with most kept in their supported fodder stores in search of market. Other region in the members' states, like Ethiopia, there are projects supporting national fodder banks, like the Afar and Oromia projects. The value chain support services to most regions

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to the communities is free seed supply, extension service by NGOs, governments and other partners and market linkages after production.

To make the regional pasture value chains more sustainable, there is need to create market linkages, privatize the process and support reliable market outlets for producers. This could be achieved by supporting public private partnership for production, and marketing, including investment into livestock finishing for assured markets to pasture producers, within the communities for support to community offtake as a strategy. Also, notably, most support has been for community groups, and thus, there is need to consider also opportunities for private farmers/individual farmer's support to the pasture value chain for sustainability. To this end, this manual analysis finding recommended that for regional pasture value chain to be sustainable, the countries and development partners should;

i. Encourage public, private partnership in pasture/fodder value chain, with the need to create terminal markets that consider value addition like fattening/finishing units (feedlot) stations within the countries to support local production and not pasture/fodder exports or important despite our region's potential.

ii. The IGAD states to support value addition and linkages to consumers, traders to sustain the demand and make it lucrative to producers, e.g. processing of feed to pellets or blocks as for business, or as strategic feed reserves to cushion our vulnerable communities from climate shock in the region.

Below is a Hay and pasture seed business case example from 1 ha pasture establishment suing range grasses (*Eragrostic superba or Cencrus ciliaris*) enterprise. The business case assumption is conservative figures for two seasons production period (3-4 months for short and long rains seasons), with returns after establishment under rain fed system.

Table 4 . Business case example of a one hectare pasture hay and pasture seed from range grass establishment in Regional Rangeland

		Expected returns				
Investment activity	**Est establishment cost**	**Revenue Year 1** *(Note one season harvest to increase establishment of sward)*	**Year 2** *(Note: Two season harvest after establishment of sward)*	**Year 3** *(Note: Two season harvest after establishment of sward)*	**Year 4** *(Note: Two season harvest after establishment of sward)*	**Year 5** *(Note: Two season harvest after establishment of sward)*
Land of 1ha	Land preparation/ ploughing/ripping USD 50/ha (1acre) Total USD 50 Seed costs for Re-seeding 1 Ha 5Kgs /ha USD 10/Kg Total USD 50 Protection of reseeded areas Labour for fencing using local materials USD 50 Labour for reseeding USD 30 Pasture agronomy/ weeding and maintenance USD 150 per growing season	Grass Hay bale 1/ha=600 Cost per bale USD 2.5 Revenue sale =USD 1500 Pasture Grass seed revenue sale =USD 10 kg for 125Kg per 1ha =1250 **Total Year 1** One **USD 2750**	**Hay Revenue** Grass bales from 1 ha =650 bales/ha per season Two seasons=2*650bales =1300 bales Sale at USD 2.5/- per bale Total Hay revenue= **USD 3250** **Pasture seed Income 150KGS at 10 USD per Kg** Total Seed revenue= **USD 1500** **TOTAL Revenue Y2 =USD 4750**	**Hay Revenue** Grass bales from 1 ha =650 bales/ha per season Two seasons=2*650bales =1300 bales Sale at USD 2.5/- per bale Total Hay revenue= **USD 3250** **Pasture seed Income 150KGS at 10 USD per Kg** Total Seed revenue= **USD 1500** **TOTAL Revenue Y3 =USD 4750**	**Hay Revenue** Grass bales from 1 ha =650 bales/ha per season Two seasons=2*650bales =1300 bales Sale at USD 2.5/- per bale Total Hay revenue= **USD 3250** **Pasture seed Income 150KGS at 10 USD per Kg** Total Seed revenue= **USD 1500** **TOTAL Revenue Y4 =USD 4750**	**Hay Revenue** Grass bales from 1 ha =650 bales/ha per season Two seasons=2*650bales =1300 bales Sale at USD 2.5/- per bale Total Hay revenue= **USD 3250** **Pasture seed Income 150KGS at 10 USD per Kg** Total Seed revenue= **USD 1500** **TOTAL Revenue Y5 =USD 4750**

	Pasture seed harvest cost 2 Dollar per kg for 125 Kgs from 1 ha Total USD 250 Labour for bales harvest, =600 bales per 1ha at 0.6 Dollar per bale machine baled Total USD 360 Hay burn for up to 5,000 bales Made of local materials (Timber and iron sheets) USD 1000		**Operation Costs** ***Hay harvest*** (harvesting 1300bales *0.6 per bale) =USD780 ***Transport*** Hay transport USD 0.4Per bale) =USD 520 ***Seed Harvest costs*** 150Kgs*2Dollars =USD300 **Pasture agronomy/ weeding and maintenance** Per season USD 150*2 Seasons =USD 300 **Total Production costs** =1900	**Operation Costs** ***Hay harvest*** (harvesting 1300bales *0.6 per bale) =USD780 ***Transport*** Hay transport USD 0.4Per bale) =USD 520 ***Seed Harvest costs*** 150Kgs*2Dollars =USD300 **Pasture agronomy/ weeding and maintenance** Per season USD 150*2 Seasons =USD 300 **Total Production costs** =1900	**Operation Costs** ***Hay harvest*** (harvesting 1300bales *0.6 per bale) =USD780 ***Transport*** Hay transport USD 0.4Per bale) =USD 520 ***Seed Harvest costs*** 150Kgs*2Dollars =USD300 **Pasture agronomy/ weeding and maintenance** Per season USD 150*2 Seasons =USD 300 **Total Production costs** =1900	**Operation Costs** ***Hay harvest*** (harvesting 1300bales *0.6 per bale) =USD780 ***Transport*** Hay transport USD 0.4Per bale) =USD 520 ***Seed Harvest costs*** 150Kgs*2Dollars =USD300 **Pasture agronomy/ weeding and maintenance** Per season USD 150*2 Seasons =USD 300 **Total Production costs** =1900
Total Revenue	0	Year One Revenue **USD 2750**	Year Two Revenue **=USD 4750**	Year Three Revenue **=USD 4750**	Year Four Revenue **=USD 4750**	Year Five Revenue **=USD 4750**
Total Costs	**Total Establishment Cost Year 1** **USD 1940**	**USD 1940**	**USD 1900**	**USD 1900**	**USD 1900**	**USD 1900**

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Profit Margin (Total years Revenue-Production costs)	**(-1940)**	**(USD 810)**	**(USD 2850)**	**(USD 2850)**	**(USD 2850)**	**(USD 2850)**
		Five Years Benefit from pasture business investment (Hay and seeds) **Total Revenue USD 12,210**				

5.2 SWOT Analysis of pasture/fodder value chain in IGAD region

Below is a synthesized IGAD region SWOT analytical framework that provides an overview of areas of strengths within the larger pasture production and rangeland management and pastoralism. The analysis provides areas in which the actors can take best advantage of and focus to consolidate gains and address the observed weaknesses, as well as capitalize on the potential opportunities and mitigate the threats that exist within the region's livestock production environment.

Table 5. Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis of Pasture Value Chain in IGAD Region

Strength	Issue To Address	What to do With Strengths	Threats
Existence of knowledge on pasture production and management within line ministries and research organization in IGAD countries	• Inadequate extension and adoption of trainings knowledge • Limited dissemination of information	• Support coordinated extension service to the vast potential; pasture and fodder growing areas • Promote sustainable pasture/rangeland management interventions/ technologies	• Lack of proper documentation of extension support and dissemination • Low adaptation of the new knowledge by community situations/low adaptation • Climate factors reducing performance after adoption
Existence of pasture species and fodder trees adapted to the IGAD rangelands for establishing pastures/fodder farms	• Low Conservation and protection of the existing pasture and fodder biodiversity in the IGAD Region	• Promote conservation measures on existing biodiversity • Support research on existing pasture/ fodder for screening and out scaling promising germplasm in different agro-ecological zones and range sites	• Climate change impacts on biodiversity of pasture /fodder plants • Existing unsustainable land use leading to degradation of grazing lands
Availability of vast rangeland in the IGAD region to be reseeded/ pasture farms establishment	• Rangeland degradation in many parts of the IGAD member states	• Sustainable support to the utilization of the rangeland; support land rehabilitation and reseeding of degraded lands in the region	• Due to the vastness, management is a challenge • Loss of traditional rangeland resource governance structures at communities in the region

			• Decline in soil health and water quality due to climate change and extreme weather events
Existence of adaptable pasture production and conservation technologies for rangelands in the IGAD region	• Low adoption of the available suitable technologies in rangeland management	• Promote the adoption of the existing pasture establishment and conservation by communities	• Low adoptability of technologies/initial high costs • Socio-cultural systems/ pastures are gift from God • Heterogeneous rangeland types limiting adoptions/ limited applicability
Availability of diverse rangeland natural resources for multiple uses in livestock systems support	• Underutilization of the diverse rangelands natural resources to support livestock sector	• Support sustainable exploitation of the diverse natural resources with support to livestock sector development	• Diminishing access to the resources • Over exploitation by immigrants/ refugees • Increasing demand of some non-renewable resources
Weaknesses	**Issue to Address**	**What to do with Weakness**	**Threats**
The IGAD region rangelands are fragile ecosystems	• Sensitivity of the rangeland ecosystems to disturbance/ land preparation for pastures/fodder may affect natural balance of plants	• Develop and support sustainable land preparation for pasture and fodder establishment like no cutting trees, minimum tillage • Promote measures that support sustainable land resource utilization	• High variability of ecosystem drivers in rangelands of the region • Uncontrolled development/ land use changes/ increasing development/ settlements within the region's rangelands

Low and highly variable precipitation/ rainfall received in the IGAD rangeland areas with frequent droughts	• Inadequate and unreliable water for reseeding/ pasture establishment • Lack of wide applicable technologies for water harvesting and utilization in the cast IGAD rangelands.	• Promote and support soil and water conservation technologies for reseeding and pasture establishment like onsite rainwater harvesting structures (Zai pits, semi-circular bands, spate irrigation pans etc.)	• Dynamic climate change and variability impacts which is beyond our IGAD nations control
Low adoption/ uptake of rangeland management and pasture production and conservation technologies	• Low productivity due to low adoption of appropriate technologies, partly due to lack of initial capital/support	• Increase access and uptake of appropriate rangeland management, pasture production and conservation technologies for sustainable land management in the IGAD region	• Low literacy levels of community members • Cultural mindset that limits adoption, animal keeping as culture not commercial activity for most pastoral communities in the region
Increasing land degradation in the IGAD region	• Loss of pasture/forage productivity from natural and established pastures	• Put in place measures to reduce land degradation like rehabilitation measures/reseeding activities, soil conservation structures in the region's rangelands • Rehabilitate degraded landscapes in pragmatic manner and community capacity development to take up the activities in the region with partner's support	• Limited financial resources for states in the region • Changing climatic conditions that keep challenging the efforts

Reduced mobility and increased sedentarization of livestock keepers from the observed land use changes and investments in the regions members' states to rangeland environments	• Land degradation from over exploitation/ over grazing leading to loss of productivity and diversity of critical rangeland grazing resources and space	• Support rangeland management planned grazing, support technologies on water harvesting and feed production, conservation and management	• Political interference • Land tenure policies • Increase in human and livestock population • Lack of spatial plans that support animal mobility in the region
Conflict over rangeland resource use in the IGAD member states rangelands: Mostly grazing resources/feeds access/water resources	• Reduced access to pasture areas in most regions • Affected resource management by community with breakdown of traditional structures • Loss of livestock/ resources and human life due to conflicts • Loss of rangeland productivity and products support services in the region	• Support interventions that reduce pasture/ feed resource related conflicts e.g. community governance, resource use negotiations among communities including cross border resource areas in the IGAD states • Enhanced conflict resolution initiatives supported by all stakeholders in the Region • Put in place appropriate water harvesting and feed conservation/ management initiative and use of appropriate technologies to support resource use and reduce pressure on natural resources in the region during stressful periods	• Political interference • Ethnicity and cultural challenges • Low uptake of technologies on water harvesting and feed development

Increasing Invasive species challenges reducing pastures and forage resources like *Prosopis juliflora in the IGAD REGIONS*	• Loss of pasture and forage productivity • Loss of pasture/ browse biodiversity	• Promote interventions and adoption of technologies to control invasion and support management by utilization • Undertake research on invasive species management and control	• Inadequate research • Inadequate funds to control the species and lack of community involvement
Lack of strategic livestock feed reserves for communities in most IGAD region areas leaving communities vulnerable to climate change impacts	• Lack of adequate strategic livestock feed reserves for communities for critical deficit periods in the IGAD regions	• Put in place livestock feed reserves through pasture establishments, production and conservation strategies for different regions in the IGAD states • Promote livestock feed conservation and value addition in the region states	• Frequent droughts and Climate variability • Inadequate certified quality pasture seeds for pasture production
Breakdown of traditional pasture/forage resource management institutions within the pastoral communities in the IGAD region	• Unsustainable utilization of resources • Los of resource governance structures	• Promote and support traditional practices consistent with sustainable utilization of pasture/forage resources • Relook into traditional governance structures among communities in the region and strengthen for sustainable land management, including inclusion into region and counties policies and institutions for support.	• Resource based conflicts • Political interference
Opportunities	**Issue to Address**	**What to do with the Opportunity**	**Threats**

High rangeland pasture/fodder and browse biodiversity in the IGAD region states	• Unsustainable utilization of pasture and forage/fodder biodiversity in the region • Loss of critical pasture/fodder diversity in the region	• Sustainably manage the existing pasture and forage biodiversity in the IGAD region • Research on other indigenous pasture/forage/ fodder biodiversity with potential for production and out scale in the IGAD region	• Cultural mindset by communities to grow pastures/ fodder • Land use changes and degradation
Increasing demand for pastures/ fodder/browse in the IGAD region due to development/ urbanization and Globalization/ international markets	• Low and unsustainable pasture/ fodder/browse resource exploitation to meet the incre4assing demands • Low marketing of pasture/ fodder products with developed sustainable value chains.	• Support efficiency of pasture resource production, conservation and exploitation in the region states • Promote marketing and develop marketing structures for the pasture/ fodder resources in the region	• Unsustainable exploitation of pasture resource • Land Degradations • Climate change and variability impacts
Growing livestock and livestock products markets in the region	• Low supply of reliable quality animals in the region despite the high demand locally and internationally • Low development of marketing channels for animals and products in the region	• Support sustainable livestock production systems to meet the increasing demand of quality animals and products in the IGAD region • Support animal finishing within the value chain, with need for quality feeds and sustainable feeding strategies in the region	• Unsustainable exploitation of pasture resource • Land Degradations • Climate change and variability impacts

Public and private interests in pasture and livestock value chains in the region	• Lack of well-planned and sustainable plans to support the upcoming opportunities in the livestock value chain, e.g. feed availability will still be main challenge in the region	• Support the upcoming opportunity for animal feeds and pasture for finishing animals • Promote the upcoming Business opportunities for pasture/fodder and animal for communities in the region with assured sustainable practices adoption only.	• Lack of adequate quality feed resources • Unsustainable exploitation of pasture resource • Land Degradations • Climate change and variability impacts
IGAD region has availability of the vast land for sustainable pasture/forage and livestock resource production and utilization	• Unsustainable utilization of vast rangeland resources	• Support sustainable utilization of the land for pasture/forage resources production in the rangelands of the region • Promote Public – private partnerships to create business opportunities sin feed/pasture/forage and livestock in the region	• Land use changes • Cultural mindset • Financial support
Existence of diverse eco-friendly technologies for exploitation of pasture/fodder resources in the region	• Low adoption of eco-friendly technologies for pasture and livestock production and pasture conservation technologies	• Promote access and adoption of eco-friendly pasture/ forage resource production, conservation and exploitation technologies in the region • Promote technologies for pasture value addition for commercialization in the region	• Cultural mindset • Capacity to adopt technologies • Limited resources

Regional good will for pastoralism, pasture /forage production e.g. IGAD efforts to sustainable rangeland management	• Insufficient support for the good will • Inadequate institutional support, localized regional and national policies/ strategies at county levels	• Strengthen regional agenda that support pastoralism/pasture production and conservation at local scales within the countries • Recognize and embrace pastoralism as a way resource exploitation and support land rehabilitation in the region • Support cascading down national and regional strategies that support sustainable rangeland management an pasture production and management	• Politics • Weak legislative framework at local levels
Availability of experts in rangeland management, pasture production in the IGAD region	• Low engagement of the local experts	• Capacity development for pasture development, pastoral production, rangeland management system to increase knowledge sharing and adoption	• Financial resources • Dynamic system • Inadequate synergy among the experts
Availability of livestock breeds adapted to the rangeland conditions (Both cattle, camel and Shoats) in the Region	• Underutilization of the existing breeds for commercial gains in the IGAD region	• Improve, protect and conserve the existing breeds • Support breed improvement through breeding for increase pasture/fodder utilization efficiency • Support livestock breeds value chain development though animal finishing and marketing	• Financial constraints • Climate change • Risk of extinction of the indigenous breeds

		• Support partnerships with private sector for value chain development and business opportunities development	
Availability of Traditional Pastoral Institutions and Indigenous knowledge	• Insufficient involvement of traditional institutions in pasture /fodder production and conservation in the region IGAD states • Loss of and underutilization of indigenous knowledge inn pasture production and conservation like grazing plans	• Formal recognition of traditional pastoral institutions and utilization of their indigenous knowledge in sustainable pasture/ feed/fodder management and utilization in the region	• Pastoral institutions not registered • Indigenous knowledge not documented • Modernization threatening traditional values

6.0 Pasture production manual Summary

This training manual has provided highlights of the IGAD region's pasture production status, challenges and opportunities to support the governments, partners and agencies in addressing the constraints identifies. The manual has used a participatory development approach in its development with region status evaluation and situation analysis in its synthesis and presentation. The manual use should be customized to address location and localities independent issues in its use. Below is a synthesized summary of production, management, marketing and utilization issues that should be considered in practice and policy support for players in the IGAD region.

Pasture and Livestock Sector identified Issues by the manual	Challenges to be addressed	Proposed Policy Interventions in the region	Proposed Timeline
1. Low pasture productivity and production in the IGAD Region	1. Loss of land productivity/ degradation and biodiversity loss and climate change impacts	Map the potential pasture production areas within the IGAD countries and identify Niche production areas where the moisture and soils are suitable for higher yields and of better quality. Protection of local pasture biodiversity in practice and policy by IGAD states and improvement strategies developed.	Immediate
	2. Lack of land use plans in rangeland settlement and for pasture production in the region	i. IGAD Region states to have land use plans with right ownership for pastoral communities by delineation in consultation with the communities for pasture niche areas and agree on modalities of setting them as pasture production units that should be protected under the guiding principles and laws of the country agreed upon between the parties. ii. Develop land use plans in consultation with the community owners with clear planning for pasture production in regions rangelands	Continuous
	3. Lack of appropriate pasture production inputs (seeds and fertiliser) in the IGAD region specifically for rangeland production systems.	i. Ensure pasture producers have access to quality seeds that are adapted to the environment within the region through adaptive research and seed bulking at community level	Continuous

		ii. Ensure enforcement of pasture inputs quality control measures to meet the required standards in the region with community seeds systems support iii. Promote Public private partnership within pasture input supply in the region	
	4. Low access to adapted pasture production technologies in the IGAD rangelands	i. Governments and partners to promote access and adoption of adapted technologies for pasture production from planting, management, harvest and utilization within the IGAD states	continuous
2 Low pasture/ fodder Preservation, conservation, storage and processing in the region	Minimal/lack of preservation and Conservation for storage harvested pasture and fodder in the region leading to feed seasonality.	i. Provide incentives aimed at lowering the cost of pasture harvesting, preservation and conservation for ease of storage in the region, this could include technologies and equipment's/inputs support services in policy ii. Create an environment that promotes Public-private partnerships in developing industries for pasture processing, preservation and storage in IGAD region iii. Invest in technologies and equipment that will help the Region preserve and conserve produced fodder for safe storage and utilization when needed, as strategic feed reserves to adapt to climate change impact for our pastoral communities.	Continuous

		iv. Train the extension staff in the region by states on appropriate pasture preservation and conservation technologies for transfer and adoption by pasture producers within community support varies in the IGAD region v. Support national strategic feed storage facilities for pastures to provide relief and emergency support to communities ta times of need. vi. IGAD nations to provide environment at encourage private sector involvement in pasture value addition in the member states with technologies support.	
3 Low business opportunities/ Marketing of pasture and fodder in the IGAD region	Low business support/ commercialization/ Marketing for pasture/ fodder	i. Support initiatives that create local markets like establishment of fattening (feedlot) stations within the regions production areas through public private participation ii. Encourage peri-urban livestock keeping supporting livestock feed value addition and create markets for produce pasture and fodder.	Continuous
4 Research and knowledge management in pasture production in the region	Weak research extension linkage pasture and fodder production, poor funding of research in the IGAD region	i. Support strengthening and establish where none research centre that are well equipped to address local pasture production and utilization challenges in the member states ii. Member states invest in the capacity development of staff working in pasture research and extension for effective delivery of information to producers like with the present manual for active use in the region.	Continuous

		iii. Strengthen or establish partnerships and linkages with research organizations and universities among others working in pasture research and development in the region iv. Strengthen extension services and allow for platforms that enhance knowledge sharing like farmer field days, pastoral field schools in the region for increased technologies adoption.	

7.0 Trainees self-test assessment on pasture training

1. What are the major pasture prodution practices in your region/country?
2. What are the challenges in pastur and pasture seed production in your region?
3. What are the factors to consider when planning for pasture and pasture seed production project?
4. Why is land preparation important before pasture establishment?
5. What technologies are available and applicable in pasture land preparationnand establsihementbin your region/country?
6. Explain the various pasture reseeding technologies applicable in your region/country?
7. What are the adapted pasture preservation and conservation technologies in your region/country?
8. What are the benefits of pasture conservation and utilization in pastoral production systems?
9. What technologis are available in pasture production and processing in your region/country?

	10. What are the considerations for pasture seed storage for quality management in your region/country? 11. What are some of the policy support interventions needed to support sustainable pasture and pasture seed productuion in your region/country? 12. Explain how pasture and pasture seed systems are critical in supporting communities adaption to climate change impacts in your region/country

8.0 Practical assignment: Group/Individual work on pasture production and management Project development

Assuming you have been appointed as the country director of pasture and pasture seed production. There is a need to develop a pasture improvement strategy for the country/region. Develop a program design for pasture/fodder production and conservation for a region of your choice, in support sustainable pasture system. Provide a step-by-step plan with activities to be followed and the needed support for a successful project.

9.0 Recommendation for Sustainable development of IGAD

Regional Pasture production and pasture lands/rangelands management

1. The development partners and government support systems should first work to understand the community adaptation and mitigation practices on climate change impacts and build on them, and benefit from the long-lived community climate resilience strategies that have been tested over time.
2. There is need for support interventions on pastures and rangeland management to consider indigenous strategies and identify the working ones to be strengthened instead of new /modern strategies that have often failed to address community needs.
3. The regional communities have vast knowledge and practices that are traditional in sustainable rangeland management and should be considered in modern development processes. We note that these are weakening very fast with land demarcation, alternative rangeland uses like mineral exploration among others. The states should engage communities in development planning in participatory ways for sustainable planning.
4. The region seems to be undergoing rapid development with population increase, putting pressure on grazing ecosystems, and the lack of proper land use planning aggravating pastoral loss of their grazing assets. As such, there is need for nations/states in the IGAD region to consider pastoralism and livestock systems as critical land use options owing to their contribution to national and regional economies, thus need to map and protect grazing lands/rangelands from encroachment and promote unsustainable land uses as a priority at the present.
5. With the increasing urbanization, and the corresponding increased demand of animal products (Meat and Milk), there is need to develop pastoral systems with linkages to markets, with corresponding investments like animal finishing for quality and quick products. There is a great opportunity for the peri-urban dairy systems that can be linked to feed resources from the rangelands and create markets for pastures and fodder produced. Thus, the need for investment in technologies and infrastructure to support feed value addition for peri urban systems. This may include the need for targeted livestock breed's improvement to support animal finishing and dual-purpose breeds for the benefit of producers. To achieve this, quality feeds will also be needed and thus, adaptive research on feeds and feed value addition will be critical.

6. The regional governments and local governments within the countries in the region should take investments and support to sustainable rangeland management as a serious consideration for support. The present dependence on NGOs and development partners may not be sustainable, and thus, governments must take a lead to support sustainable pastures and livestock production systems with the seriousness it deserves, especially in support to large scale pasture production and rangeland management projects, benefiting from the proven present donor/partners support successful interventions that have failed to be upscale by governments.

7. The IGAD region governments should consider joint investments in support to pastoralism, especially within transboundary shared resources, which have many gaps to infrastructure support, like water development, animal health and rangeland management costs and investments to the system. This is a realization of the fact that the benefits accrued from the pastoral livestock production system go beyond the sovereignty in terms of country boundaries, and as such, joint investment within the spirit of East African/ IGAD community should be strengthened in support to pastoral livelihoods.

8. There is need to support both qualitative and quantitative risk analysis to pastoral livelihoods with measures to address them. The consideration of approaches that benefit from the understanding of pastoral social systems and local institutions is recommended, rather than from external perspective of risk management and assessments not related to the uniqueness of pastoral production system context among the experts. Thus, the need to have risk assessments with local context approaches is critical in support to sustainable rangeland management and pasture production in the region.

9. The region has a wide diversity of feed resources that has not been exploited with support to their management, improvement and expansion on their availability and uses. The diverse forage trees and grasses offers an opportunity for adaptive research, with local adaptation support to their management and protection, as well as improvement for the benefit of the communities. Thus, the regional governments should support efforts to citizen science for development to increase forage resource and land protection for sustainable livelihoods.

10. There is need to have regional governments control on investment opportunities in the spirit of Public Private Partnerships, with the urgent need for sustainability consideration of any investment opportunities, considering the agro-ecological regions potential and the priority of the local communities and the countries at large. The region notes many international and externally led development initiatives with questionable sustainability status, which have brought in a layer of community displacement as well as environmental degradation through loss of biodiversity with their implementation. For example, large-scale mono cropping of foreign pasture species after removal

of native pasture/forage and other diversity, with indications of short-term gains and long-term losses to communities and the ecosystem. Also, mining and increasing crop land as a land use within pastoral grazing land, has also seen loss of grazing lands into marginal landscapes, with low sustainability outcomes noted.

11. The region has seen efforts for livestock breed improvement, but with concerns of support structures to also conserve the indigenous local breeds that have supported livelihoods and well adapted to the environments, with known disease tolerance, low feed demands, drought tolerance as well as resilience to adverse climatic conditions. The replacement with the desired breeds of high gains and better quality, but high feeders and high-water demand and husbandry management need, makes the future unpredictable, since we are not increasing rangeland productivity, but add to it grazing resource use demand pressure. Some regions have provided this as the reason for increased land degradation as well as reduced communities' resilience. Thus, the region states should also consider local breeds as useful and important gene resource to be conserved, protected and promoted for their uniqueness and roles to community resilience, example being the east African Zebu cattle, black headed Somali sheep, Red Maasai sheep and the other indigenous cattle and camel, goats and sheep breeds in the IGAD region. Noting the need to increase livestock productivity, the states should have both strategic introduction of high performance breeds, local breeds improvement for high performing animals as well as indigenous breed's conservation and their improvement through strategies like cross breeding.

12. The region rangelands have received significant stakeholder/partners support in rangeland improvement and pasture production and management support. However, there is lack of coordinated efforts to create synergy and increase sustainability of the interventions, and thus, some past good project outcomes have been reduced, while still there exists a lot of efforts duplication reducing the value for money. Thus, the region states should work closely with partners to synergize efforts and promote the scaling of best practices and positive output and outcome from project activities to cover the vast rangeland areas within the IGAD states.

13. Water has been reported to be the major limiting factor to pasture production in the region. The need for strategic use of limited water for pasture production, with opportunities for rainwater harvesting that need to be enhanced by the governments and partners.

14. Natural pasture seems to be the main source of feed and major support to livestock production in the region, even though highly threatened by land degradation because of climate change with declining biodiversity. Thus, strategies to increase natural pastures conservation and management are critical, including strengthening community rangeland management capacity

and institutions, e.g. grazing management committees and rangeland management committees. The need to regularize their mandates within the different regulatory frameworks is a big gap for official operations.

15. The region seems to face challenges with access to quality and adapted pasture species seeds, and thus need for strategies to multiply and develop region specific seed systems in a participatory manner of identified pasture/ fodder species for community support.

16. Pasture produced from pastoral areas has been reported to be lacking good markets to support producers, however, this may be a gap of just lack of market linkages and marketing support from the pasture groups and community producers. There is a need to relook at the value chain, in terms of production volumes, quality and pricing by our producers. Notably, pasture/fodder and feed from outside are getting good market share in the rangelands and thus we can't say we lack markets.

17. There is need to work so hard to reduce post-harvest pasture/fodder losses in the region, with need for capacity development to communities for increased utilization efficiency and preservation/conservation support.

18. The regional governments need to support land use policies in pastoral production areas to manage land use changes and support sustainable production systems. The policies should also address the emerging challenges like investors contracts, other land use options licensing like mining.

19. Invasive species seem to have become an important emerging threat to our rangeland ecosystems affecting pasture and livestock systems. There is need for governments and partners to work hard to support efforts to control, manage and eradicate the serious invasive species.

20. Trees have been identified as a critical feed resource in the region and in support of pasture productivity and livestock systems. Efforts for improved rangelands should include fodder trees, with technologies and practices like Farmer Managed Natural Regeneration (FMNR) proving to be sustainable and increase productivity.

10.0 Recommended Further reading materials

Abebe, W. (2021). Food insecurity in the horn of Africa and its impact on peace in the region. IPSS Policy Brief, 15(2), 1-8.

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11.0. Appendix

Appendix 1. Contributors to the Manual development

The manual has been developed with inputs from dedicated teams from the IGAD member states, with their experiences and lessons being part of the manual presentation. Special thanks to the following team;

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