PASTURE PRODUCTION AND CONSERVATION TRAINING MANUAL

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IDRC Grant/ Subvention du CRDI: 109213-001-Socially inclusive adaptation knowledge for resilient livelihoods in northern Kenya

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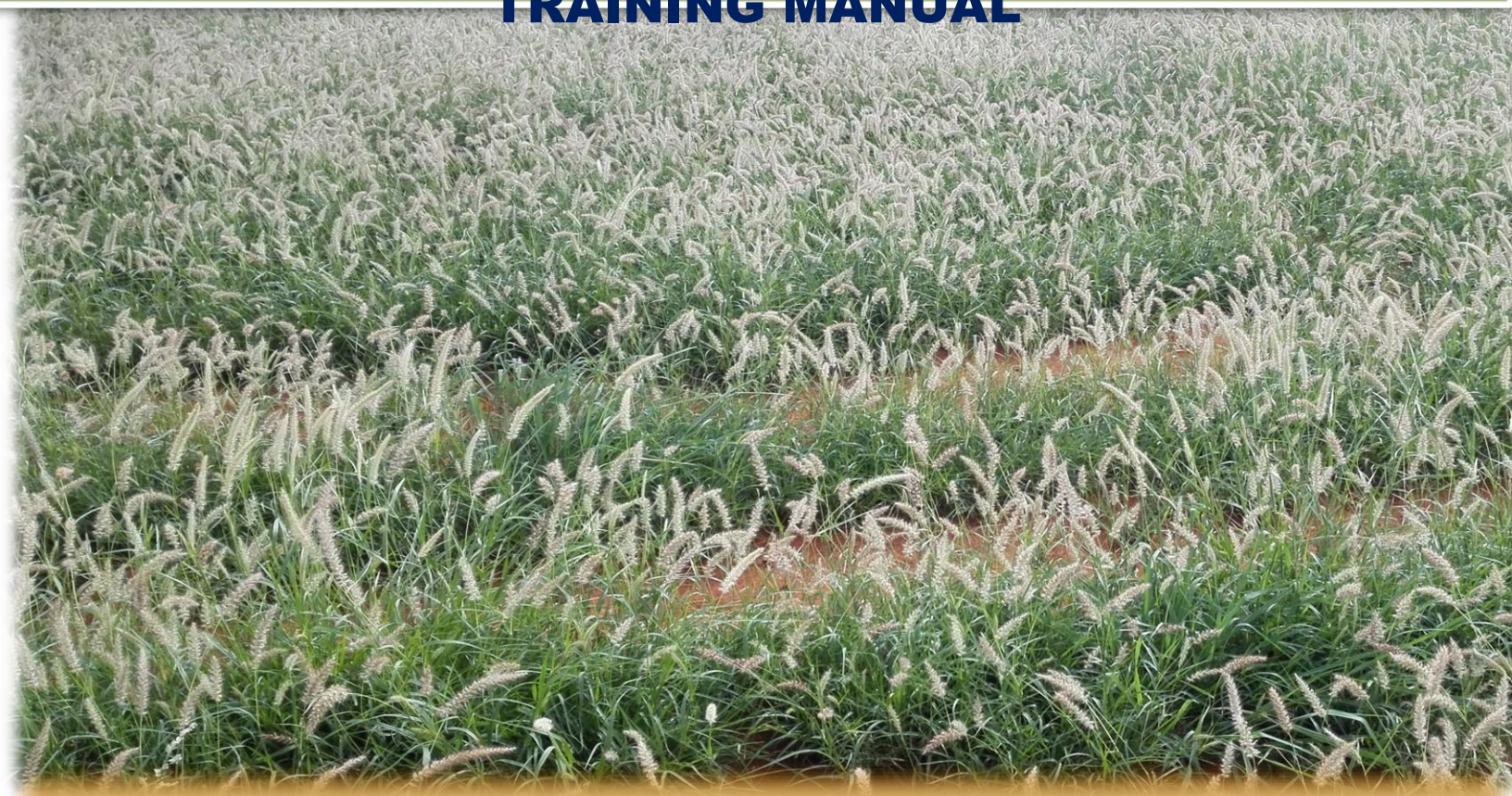

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PASTURE PRODUCTION AND CONSERVATION TRAINING MANUAL

This manual has been prepared to support Field Extension Workers and the communities in pasture production technologies in ASAL Counties, Kenya

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The training manual has been supported by 'Socially inclusive adaptation knowledge for resilient livelihoods in northern Kenya (SOAK)' Project

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TRAINING PRELIMINARIES AND PROCESS

This manual is designed to cover pasture production and conservation in the arid and semi-arid areas. The manual has topics that provide guideline and technical knowledge to community pasture producers.

Below are the training Norms, expectations and guiding training schedule for the communities.

TRANING NORMS TO BE FOLLOWED

- *The participants should commit to take the whole course*
- *Active engagement in a participatory manner at all levels is mandatory by trainees*
- *Cooperation between trainees and trainers is important*
- *Trainees should focus on knowledge acquisition during lessons*
- *Trainees and trainers should strictly keep to the agreed training times and periods*
- *Respect for other people's opinions or views will be critical*
- *We expect coordinated discussion- One speaker at a time facilitated by the trainer*
- *Avoid unnecessary movements during training*
- *All mobile phones to remain on silent mode/vibration during training sessions*

EXPECTATIONS FROM PARTICIPANTS

(Trainees to be asked to state their expectations. Below is some of the expected/ what the training manual seek to achieve)

- *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 resources so that more and more pastures for our animals can be produced*
- *To know learn on pasture seed harvesting, storage, utilization*

- *To learn on land management for pasture production/Reseeding*
- *To learn on commercial fodder production*

PROPOSED TRAINING SCHEDULE

This training is planned to be a five day interactions and learning process between trainees and trainers. Below is a schedule to the topics proposed?

Day	Time	Sections	Content
Day 1	8.00am - 11.00am	Module 1:	1. 1. Introduction 2. 2. Training objectives 3. 3. Land degradation and loss of natural pastures
Day 2	8.00am - 11.00am	Module 2:	4. Pasture Production and Reseeding 5. Selection of reseeding areas 6. Types of important pasture types in rangelands
Day 3	88.00am - 11.00am	Module 3:	7. Common rangelands grass species used in reseeding and pasture establishment in ASALS of Kenya 8. Land Preparation for pasture establishment
Day 4	8.00am - 11.00am	Module 4:	9. Pasture Establishment 10. Pasture Management Practices
Day 5	8.00am - 11.00am	Module 5:	11. Rangeland Forage Seed Multiplication 12. Fodder Storage and Conservation 13. Management of natural pastures

1.0 Introduction

Class discussion- 20 Minutes

	**Why do we need to produce pastures?**

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 ASAL areas of Kenya. This has immensely affected forage supply for livestock which is the main livelihood option. The community's actions have also contributed much to the increasing frequencies of droughts which threatens 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 manmade disasters and continue to live below the poverty line. This however, put pressure on the current resource governance system to come up with suitable plans to alleviate poverty and build the resilience of these 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 and rangeland management practices. This manual will provide insights on pasture agronomy, management and utilization in the context of pastoral production system.

This is important since we need to meet the nutritional demands of cattle and small stock (shoats) and camel in extreme drought situation. While, we also still need to protect our grazing lands from degradation.

1.1 Expected Learning Outcome

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

By the end of the training, the learners should be able to:

1. Explain the pasture production practices in the rangelands
2. Demonstrate pasture reseeding technologies
3. Describe pasture conservation technologies in the rangelands
4. Explain the challenges to pasture production and conservation in ASALS of Kenya and their solutions

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 also highlight of the community/societal challenges they would want to address after the training.

1.2 Land degradation and loss of natural pastures

Class discussion on what the trainees understand by Land Degradation - 30 Minutes

What is land degradations?
How does land degradation occur?
What are the impacts of land degradation?
How does it affect livelihoods of the communities
How can land degradation be addressed?

What is land degradation?

This refers to the reduction or loss of biological or economic productivity of cropland, pastures, forests and woodlands.

What are the causes of land degradation?

The main causes include;

- are poor land uses and agricultural practices,
- overgrazing or
- deforestation and
- the frequent droughts

All these results in deterioration and erosion of soil properties resulting to loss of ground cover. Droughts occur naturally every one out of five years in Eastern African rangelands, but in the recent past, the frequencies of drought events spells have become almost yearly with rainfall becoming more and more scarce.

Impacts of land degradation?

Degradation of grazing lands is associated with loss of primary productivity, mostly as a result of overgrazing coupled with frequent droughts.

- Degradation of rangelands reduces the availability of forages for livestock this decreasing their productivity (less milk, meat)
- Land degradation leads to decline in palatable species such as *Cenchrus ciliaris, Chloris roxibhurghiana, Digitaria macroblephara, Enteropogon macrostachyus, Eragrostis Superba, sporobolus pellucidus* among others
- Degraded land results in increase in unpalatable species in some areas where continuous grazing is practiced.,
- In some instances, degradation results in areas dominated by annual plant species like *Aristida himensis.*
- Bush and weeds encroachment also becomes a potential threat due to degradation, where species native (Acacia reficiens, Ipomoea kituensis and *Astripomoea hyocyamoides*) and nonnatives (e.g. *Prosopis juliflora*) species spread unprecedentedly thus worsening availability of forages for livestock.

How does it affect livelihood?

- Decline in livestock carrying capacity hence decline in income
- Increase cost of production and management
- Decline in or complete loss of ecosystem services (poor water quality, decline in water table, climate regulation

How can land degradation be addressed?

- Through good agricultural practices (e.g. sustainable stocking rate of livestock)
- Avoid deforestation
- Avoid introduction of alien invasive species
- Restoration of degraded sites through removal of unwanted weeds and reseeding with native species

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

Degraded bare land

Reseeded areas in Marsabit county

1.3 Pasture Production and Reseeding

Class discussion on trainees understanding on pasture production and reseeding? – 30 Minutes

	**Have the trainees ever participated in pasture production/reseeding before?** **What has been their experiences with pasture production activities?** • **Challenges,** • **Opportunities** **What are knowledge gaps in engaging in pasture production/re-seeding** **What inform the selection of pasture establishment/reseeding sites?** **What inform the choice of pasture species for establishment/reseeding?**

1.3.1 Selection of 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 soils.

Timing for pasture establishment/Reseeding

There is need for proper timing for reseeding. Proper timing allows for;

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

Some of the considerations for sites selections include the following:

- 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
- Deep soils to support soil water moisture
- Fairly flat areas to reduce possibility of seeds being washed away by runoff.

1.3.2 Selection of pasture/Fodder type

Reconnaissance visits play an important role before actual decisions on which pastures to produce. This allows one to select species that once existed or that exist but with threats of decline and therefore adapted to local conditions

The key consideration in pasture/fodder species for reseeding are;

- Adaptation to prevailing ecoclimatic zones (rainfall, temperature, radiation etc.)
- Adaptation to prevailing soils types
- Species attributes such as growth rate, productivity, and resistance to herbivory, palatability etc.
- 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 introduce species.
- Available knowledge (scientific or indigenous) about the species
- Multiple species/multiple functional traits preferred than monocultures. This increase diversity of diets to livestock, habitat for biodiversity, increase resilience to environmental shocks etc

1.4 Types of important Feed/Forage Resources in rangelands

Class discussion on trainees understanding on fodder types in their locality - 30 Minutes

	**Which feed resource types does the community know in their locality?** **What are the most important types, why and for which seasons?** **What challenges faces the different feed types?** **What opportunities exists with the available feed/forage types?** **What inform the selection of fodder types for establishment?**

The rangelands have wide array of feed resource species that are adapted to different rangeland sites. This is determined by climatic and soil types. The trees, shrubs, grasses and forbs are all adapted differently to these conditions. Therefore, during selection of fodder/pasture species for reseeding, knowledge of species adaptation is important. This determines the end productivity of biomass and seeds.

1.4.1 Grasses

These are largely herbaceous monocots and are found everywhere in the world. Bamboo is the only tree in the group. Grasses are either perennial (live more than two years) or annuals (lifespan less than one year). Most rangeland grasses are efficient in water use and fast growing.

Attributes of preferred rangeland grasses species for restoration

- Fast growth rate
- Strong rooting system
- Tolerant to grazing
- High palatability and digestibility
- Tolerant to erratic and unreliable rainfall
- Produces lots of biomass

The rangeland grasses can be produced in a wider geographical scale than many leguminous plant species. The key determinate factor is availability of moisture. It has been documented that depending on moisture availability, most of the rangeland grasses are perennial especially within the semi –arid areas. However, in the very arid zones, we have annual grasses that also form an important source of forage. A number of rangeland grass species have a confounding adaptation to water stress, salinity, sodicity, water logging, and grazing pressure as well as to pests and diseases.

1.4.2 Legumes

These are plants species that are able to fix nitrogen are therefore common in rangelands where soils are infertile.

Legumes are an important livestock feed resource in the drylands as source of proteins. Legumes occurred in form of either 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.

Legumes can be evergreen, semi-deciduous or deciduous. Shedding of leaves is an adaptation to region with erratic and unreliable rainfall. This means legumes are adapted to many climatic zones from humid to hyper arid respectively.

1.4.3 Fodder trees

There are three main reasons why we need to plant or protect fodder trees on our pastureland.

i. Fodder trees provide cheap protein source (from legumes mainly)
ii. Fodder trees provide dry season feed supplement
iii. Fodder trees provide other ecosystem services such as shade, control soil erosion, fix nitrogen and improve soil fertility, firewood, construction materials etc.

Qualities of good fodder trees

- ❖ Leaves and pods should have a high nutritive value, which means that they contain a lot of protein.
- ❖ Trees should produce many leaves and regrow easily after frequent pruning.

- Edible parts of the tree should not contain toxins.
- Tree leaves need to have a high palatability and digestibility.
- Preferably tolerant to drought, pests and diseases and should not compete too much with other crops when grown in agroforestry system. They should be deep rooted in order to avoid competition with shallow rooted crops for water.

Fodder trees can be fed to livestock in form of cut and carry or allow them to browse the trees directly. In rangeland pollarding (*Cutting of branches to feed animals*) of trees during dry season is done to supplement livestock is common.

Fodder trees have been the main source of forage in drylands for many decades. Many species can tolerate low amounts of rainfall owing to their deep rooting habit, but must have sufficient water during seedling stages.

Other benefits from leguminous fodder trees;

- Most seed production programme failures are caused by poor choice of site than any other factor
- There exists opportunities for income diversifications with legumes, e.g. seeds production and apiculture for honey.
- Legumes also provide high quality manure with high crude protein for soil fertility management in an agro pastoral system.
- Legume scan be incorporated within pasture fields for enhance feed quality and soil conservation

1.5 Common rangeland grass species used in reseeding and pasture establishment in ASALS of Kenya

The Kenyan rangelands are characterized with a wide array of grasses, tree, shrubs and grass like plants. Most rangelands have a combination of naturally growing grass species. The most dominant grass species that are always found growing in association are;

1) *Chloris roxburghiana*

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

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.

2) ***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 almost all the ASALs of Kenya, forming varied ecotypes. They are very prolific and high seeding capacity and very drought tolerant.

3) ***Enteropogon macrostachyus***

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

This is a Tufted annual or perennial found in many areas of Kenyan ASALs, 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 Kenyan Rangelands.

4) *Cenchrus ciliaris*

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

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

5) *Panicum maximum* (Common name:True guinea)
Local Names: Finichal (Borana);

Native of Africa and widely distributed in Kenyan rangelands. The grass has been introduced to almost 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 contains 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 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.

6) *Cynodon dactylon*
Common name: Star grass, Bermuda grass or couch grass; Local Names: *Emurua in maasai*

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

7) 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.

8) 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.

9) 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.

10) 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 griows 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 suppress 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.

1.6 Land Preparation for pasture establishment

1.6.1 Land Preparation

Class discussion - 20 Minutes

	**Is land preparation for pasture establishment necessary?** **If yes, why? If no why?** **Has any member ever done land preparation for pasture establishment?** **Explanation on how.** **Challenges to land preparation**

Land preparation for reseeding or pasture establishment is very critical for the success of sward establishment. 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 even more serious considerations in the arid environments where planting should be done early to capitalize on the first rains.

In Kenyan rangelands, the short rains of October 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 present challenge is the high variability of rainfall periods in ASALs, where variation between years and also within seasons makes predicting a big challenge. However, getting timely meteorological information that is reliable can help in making appropriate timings.

Land preparation confers many benefits to pasture establishment, this includes;

- Loosen the soil surface
- Reduces the rate of runoff hence controls soil erosion
- Enables better infiltration of rain water into the soil
- Eases the penetration of roots of the crop into the soil
- Prevents grass seed from being blown away by wind
- Removes all unwanted plants (weeds) so as to give the target crop a head
- start after planting

For land preparation to be done effectively, material, finances and labour are needed. The use of community labour can be cheaper if the benefits are to be realized by them, while, some interventions could need finances especially where equipment's and inputs are needed.

Land preparation methods

This could include both mechanical by use of a tractor or oxen drawn tools as well as human labour with hand held tools.
Land preparation often starts with bush clearing if selected sites are highly invaded. However, please note that this sometimes could be the opportunity to utilize natural vegetation as micro catchment. Bush clearing should be done carefully to avoid exposing the land to agents of erosion.

The purpose of land preparation by clearing can only be done mostly when seed production is the target and hence need to eliminate contamination/mixes. For faster land preparation use a tractor can be employed, but thereafter harrowing may be needed to get the fine tilt. Land preparation at small scale farms can be done by use of ox plough or hand tools like jembes, forks etc.
The most important part of land preparation is increasing water harvesting for maximum benefits to the grass crops. There are several technologies that could be used for water harvesting after land preparation. Depending on where the site is and the type of terrain and, soil types etc, the following

a) Fanya juu terracin

b) Contour bunds

c) Nega rims

d) Semi-circular and trapezoidal bunds

methods could be selected appropriately;

e) On-farm micro-catchments

f) *Zai* pits

g) Tumbukiza

h) Tied ridges

i) Jembe scratching and placing cut-thorn bushes on hard crusted soils.

j) Semi-circular and trapezoidal bunds

These are usually earthen bunds in the shape of semi-circle, a crescent, or a trapezoid facing directly upslope.

1.7 Pasture Establishment

Pasture seeds are too small for most rangeland species and their planting requires careful placement and cover of the seeds to enhance germination. There are several methods of seed placement to the prepared land, where the choice will depend on land size, preparation made and scale of production.

1.7.1 Broadcasting (by hand or machine) or seed drilling

This is done manually by hand under small scale production systems. However, we do have seed broadcasting machines where the land area is expansive and the production system in mechanized. This can be tractor pulled equipment (broadcasters) that are calibrated to broad cast seeds at a known rate. Other modifications are use of fertilizer spreaders or seeds. Immediately after seed broadcasting, it should be lightly covered with soil.

The easiest practice can be the use of tree branches pulled over the area broadcasted in small scale farms. While in the large mechanized farms where erosion can occur, rollers are used. Other ways are the use of tractor to pull arranged branches on a bar for the same. The use of homemade harrows can also be used in small farms.

Carry home messages

- Ensure uniform spreading of seeds on a prepared soil surface
- Avoid seed broadcasting on a windy day
- Avoid soils easily compacted by rain
- Avoid broadcasting during the hot and dry weather

- Due to the size of seeds, mix with an inert material e.g. sand or sawdust.
- Rake the area to ensure good seed to soil contact




1.7.2 Seeding using seed drill

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.

1.7. 3 Oversowing or sod seeding

This is a pasture establishment technique that involves improving an existing pasture sward by seeding over with an adapted, improved or better forage material. The process demand utilization of existing pastures to 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.

1.7.4 Undersowing

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.

1.7.5 Vegetative propagation

There are many grasses that are low seeders or produce unviable seeds such as Napier grass, kikuyu grass, Bracharia spp and star grass. These species are mostly established vegetatively by use of stem or root cuttings or splits. When using cutting, it is important to ensure at least 2-3 nodes are buried in soil.

1.7.6 Furrow line sowing

This can be done by hand tools with light seeding along the furrow lines covering with light soils.

It is however important to ensure that the furrows are along the contours to avoid erosion and loss of seeds

1.7.7 Enclosures for natural regenaration

This can easily be done using natural plant twigs/thorns and branches to prevent grazing, allow grasses to fruit and seed as well as protect the soils to allow natural regeneration to occur.

1.8 Pasture management practices

1.8.1 Weed control

A weed is a plant out of place not intentionally sown; whose undesirable qualities outweigh its good points. 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 outcompeting the planted pasture species 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.

Methods of weed control in pastures

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 available.

i) Mechanical control
ii) Chemical control
iii) Crop rotation
iv) Fire; prescribed burning
v) Biological control
vi) Crop competition

a) Mechanical Control

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.

b) Chemical Control

This can be done by use of systemic chemical, which at time can be selective depending on the weeds to be controlled. However, environmental concerns may not allow this method as a priority. Herbicides have been used mostly which can be applied at pre-plant, pre-emergence, and post-emergence

c) Crop Rotation

This is biological and environmental friendly way to control weeds. Rotating crop with different types that can't act as alternative hosts to pest and diseases, as well can help in soil fertility and structure improvement especially when legumes are part of the cycles.

d) Fire/prescribed fires

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.

e) Biological control

This involves use of natural enemies such as pest/insects etc to manage weeds. This is useful when dealing with alien weeds. Not commonly used in developing countries. Crop competition can also fall in this category where most dominant and best fit takes over, and if it's the desired species, then weeds are suppressed.

1.8.2 Post establishment pasture management practices

The need to increase pasture yields demands other management practices depending ongrowing conditions. For example, if in dry areas or during dry seasons, irrigation may need to be done to enable the plant to survive or maintain productivity.

Also, depending on soil conditions, fertilization may be necessary, which may need soil analysis to supply the limiting nutrient. Mostly, N is the limiting factor, and more so, when doing pasture seed production due to the cut and carry fodder – mining the nutrients. The timing of fertilization needs be done when wet season sets in to allow utilization, and also at the right stage of plant growth, mostly at vegetative stage.

The pasture harvesting should also be done at the right timing depending on management objectives, if for high yielding, then harvest should be done before seeding to have high CP, this is at the expense of DM yields, while maintenance requirements can allow prolonged growing periods to increase biomass, but CP will decline with time. The harvest of pasture also helps increase productivity in subsequent growing seasons by stimulation tillering, as well as compensatory growth allowing for increased productivity over time.

Pests like grasshoppers, termites, rats, mice among others may also be a challenge, which a rancher may have to deal with. Birds have also been a challenge when looking forward to produce seeds, and this may need bird scares during seed setting until harvest.
Grass/pasture diseases also do occur, even though no much has been done on the same, but treatment for fungus and bacterial diseases could be present. Legume pastures can be managed with care for diseases and agro-vets can provide solutions.

1.9 Rangeland Forage Seed Multiplication

1.9.1 Pasture seed production

The production of tropical pastures has always been met with greater challenges of seed availability. Most tropical rangeland grass pastures have not been put into the structured seed production and distribution systems. Most agricultural production support has ignored 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 is tedious. The species also have a high variability of seed setting, 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 at the moment can be done to supply the everincreasing pasture demand. Many farmers rely on physical appearance of pastures for harvesting seeds, despite existence of other methods that test for moisture content, endosperm hardiness among others that may need skills from training and availability of necessary equipment.

During pasture seed production, the total seed yields will depend on;

- Type of pasture species
- Prevailing weather condition
- Timing of harvest
- Method used for harvesting
- Method used for processing after harvest
- Production conditions whether underirrigation or rainfed

Timing of seed harvest and weather may determine storability of seeds. Low moisture avoids molding, which is the most critical in storage ability. Harvesting pasture at mature and ripened stage when moisture has been significant reduced in the endosperm is desirable. Mechanized harvest can recover most seeds with ease before shading, while manual harvest by hand/human labour may not achieve higher recovery of ripened seeds. Processing may also result to losses due to wind; birds' etc.
Irrigation increases seed yields and also reduces water stress hence production of fully matured seeds that are more viable. There are several approaches to seed harvesting manually in the local context. This includes;

- Whole above ground plant harvest
- Harvesting grass flower stokes
- Harvest of the seed head/panicle/inflorescence
- Harvest the seeds only by stripping method.

The methods used for seeds such as stripping are show in photos below;

a) Stripping e.g. *Eragrostis superba*

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

b) Harvesting grass flower stokes

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

After pasture harvest, cleaning, drying should be done under a shade in a dry environment, while continuous turning need 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.

Photo sources: Oscar Koech

1.9.2 Pasture seed storage

Pasture seed storage process is very critical especially in 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.

The factors that influence seeds viability include:

- storage temperature,
- moisture at harvest and storage,
- pest infestation (insects and rodents may injure caryopses)
- Wet storage leading to molding.

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 into rotting.
Storage areas should be free of high humidity, tight from rodents and well ventilated. Depending on farmer's capacity, storage facilities can be;

a) Open and naturally ventilated granary

This includes the traditional granaries or stores. As long as there is no roof leakage and the area is dry with structures to reduce rodents. Most suited for short period storage since its condition is uncontrolled especially humidity fluctuations.

Traditional granary

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

b) Conditioned storage facilities/stores/structures.

These are storage that allows control of environmental factors such as humidity, temperature, wind etc. Used for commercial seed production and requires high capital investment. This system may contain refrigeration facility to keep seeds at lower temperature and seed moisture is controlled using dehumidifiers.

A pasture seed storage store with air conditioning

1.9.3 Grass seed packaging and storage containers

The need for storage or transportation of seeds needs proper packaging. The packaging material should be ideal, with less exposure to environmental factors like high temperatures and humidity as well as protection from pests. 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. Many forms of packages are traditionally available. This includes;

- Aluminum tins
- Woven material bags
- Brown paper bags- bought or other products package
- Nylon high density transparent bags
- Nylon sacks
- Sisal sacks

It has been reported that metallic aluminum containers with tight fitting lids tend to store seed for a longer period than the other types of containers while allowing the seed to remain viable. They are largely recommended. Photos of a few storage packages/containers are presented below.

Nylon high density transparent bags

Aluminum tins

Brown paper bags

Nylon scack, brown papers, aluminium tin (picture source-Mnene 2006)

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

1.9.4 Seed Quality testing

There are international seed testing standards that are supposed to be adhered to for international trade and marketing. This includes check 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 test from time to time and relate to the required standards. The standards that are known for seed quality control may include a few or more of the following;

- Analytical seed purity (physical)
- Germination rate or index for (% of pure seed)
- Seed moisture content (% by weight)
- Seed physical appearance
- Contamination/Incidence of noxious weed seed
- Seed infection – fungal, mould
- Genetic purity
- Vigor (Sum total of those properties of the seed which determine the potential level of activity and performance of the seed)

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

1.10 Fodder storage and conservation

1.10.1 Pasture storage

The increasing need to bridge the gap between fodder seasonality in drylands is increasing, 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 methods.

Factors that may affect the quality of pasture under preservation include;

- Type of pasture species,
- period of harvest,
- post harvest handling and storage conditions and
- prevailing weather conditions may determine the end products.

Pastures have been conserved in various forms in the drylands, some have been highlighted below.

a) Silage

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

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

Silage making pits

Round silage bags

Silage bag type

Silage bag type

Manual silage chopping

Automated silager chopping

b) Cut Hay

Hay is grass, legumes, or other herbaceous plants that have been cut and dried to be stored for use as livestock fodder. Hay bales are easiest and quick, especially when mechanization can be used. Storage of hay is easy and the end product will be determined by stage of maturity at harvest, pasture species used and a blend with leguminous for pasture can increase quality tremendously.

The storage condition is important. Dry, well ventilated and clean environment preserve hay better. Hay can be easy to manage and use, especially when standard seizes are used, unlike in silage bales of bigger bunches or rolls. Hay can also be made locally using handmade balers by small scale farmers. Hay bales are easy to transport and easy to store for future use. Large hay bales can also be done using machinery when in large scale fodder banks.

When hay is first baled and 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.

Home made bale box and baling of hay

Tractor making square hay bales

Tractor making round hay bales

Lage machine made box hay bale

Storage of hay

Traditional silos used for the storage of pasture in Turkana (Image 1) and Isiolo (Image 2)

c) Standing hay

Forage can also be preserved on farm has standing hay. 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. 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. However, for animals' maintenance during the dry seasons or droughts, this is still an important source of forage for sustenance.

2.0 Summary

	1. Selection of pasture species for reseeding should consider the prevailing climatic conditions and soil types 2. Legumes are an important feed resource in the drylands. The CP supply to livestock is mainly supplied by tree or shrub leguminous plant species. However, legumes have challenges where short days and stress often control flowering. Reduction in rainfall or irrigation frequency is 3. Land preparation for reseeding or pasture establishment is very critical for the success of sward establishment 4. 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.

3.0 Activities

	1. Discuss the challenges facing pasture production in the drylands 2. Discribe the various pasture reseeding technologies 3. Expalin the importance of pasture conservation 4. What are the considerations for pasture seed storage 5. Why is land preparation important before pasture establishment

5.0 Suggestion for further reading

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6.0 Practical and group work

Plan to design a fodder production and conservation strategy for a community conservancy or community group to help cushion the households from feed/fodder shortages during the dry

seasons. How can this be done at community level and what are the key resources and inputs needed? How can that be actualized at the community level.

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