AGRICULTURE EXTENSION OFFICER

TRAINING MANUAL

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TABLE OF CONTENTS

INTRODUCTION

Focus area

This manual has been designed to guide extension support to farming communities adjacent to: Ol Pejeta Conservancy; Mutara Conservation Area; Mutara and Sugurio- Sub catchments in Laikipia County. The area lies in a semi-arid ecological zone with low and unpredictable rainfall averaging 400-900 mm per year. Water is a key and limiting yet a key resource for livelihood development. High dependence on Mutara and Suguroi rivers mostly done unsustainably has fuelled water access conflicts. Agriculture is one of main livelihoods, but farmers are faced with problems of low yields, climate change, impoverished soils, lack of capital, and poor market access.

The manual

This manual is designed to facilitate awareness and promote adoption of Good Agricultural Practices that promote sustainable natural resources to: improve ecological integrity and to safeguard smallholder farmer's livelihoods. The manual has six modules addressing farmers' prioritized needs and environmental challenges in the area: conservation agriculture, fodder production, on farm water harvesting; Kitchen gardening, record keeping and market oriented farming. It is a living document which will be reviewed and updated continually to capture the changing needs.

Methodologies & approaches for training

Benchmarking: Exchange learning visits to farmers who have adopted good agricultural practices.

Demonstrations and on-farm trials: on-farm trials to facilitate demonstrations by agricultural specialists/ service providers to encourage active participation of farmers in technology development and transfer.

Farmer field days: Bring together farmers, agricultural specialists, agricultural inputs and service providers and the media to: demonstrate specific management practices and equipment and/or highlight on-farm trials and results.

Extension support groups: formation of farmer groups for the purpose of extension training.

Organizing farmers: Encourage farmers to form producer groups / co-operatives and link them to: jointly market farm produce; bulk purchase inputs to lower costs; and establish external networks with service providers and financial actors

Facilitator's note: Data to collect from demonstration and on farm trials

Background data: Land use or field history on farming practices for the crops (land preparation practices, yields, fertility management, crop rotations, residue management, soil type, texture, slope, terrain, vegetation, system of water control, fallow periods).

Technical input date: Type of inputs used, rate of application, method of production, family and hired labour requirements.

Input-output response data: Crop performance under different systems

Product price and input cost data: Input and output prices, individual farmers, groups of farmers. Input suppliers, and buyers among others.

Farmer assessment date-farmers own observations on crop growth and quality of the produce

Record-keeping: Develop and share a simple record-keeping booklet to be used by farmers to record. Monitor and analyze results of enterprises and technologies which they have tried (Annex 1).

Regular monitoring visits to famers to support them with their record-keeping and to collect the date.

MODULE 1: CONSERVATION AGRICULTURE

Methodologies for training Conservation Agriculture (CA)

I. identify a farm where CA is being practiced for farmers to observe as you take them through different features of CA (Training duration-one day)

II. Field visits/days to Link farmers with the CA agriculture inputs suppliers (Seeds & equipment) and service providers (Activity duration-one day)

III. Establish farmer-managed demonstration plots at village level where you can take the learners through the CA journey.

IV. Organize farmers into groups and guide each group to identify and set up a demo where farmers can Learn by doing to :

a. identify appropriate CA technologies to mitigate identified agricultural problems
a. Identify options for adoption based on tested technologies and knowledge
b. Develop a way forward on what to upscale/promote.(Training duration-The entire planting season (approximately 3-6 months) to take farmers through the CA agriculture cycle in the demo plot which is dependent on the local farming calendar and variety of crops used: i)CA 1st phase training: February to April ii) CA 2nd phase training: July to September

Demo Plot requirements: Demo site; Labour; Farm inputs; Record keeping book (Annex 1); Sharing of results [consider specifying how and to whom]

Introduction to conservation agriculture

Conservation Agriculture (CA):

1. conserves, improves, and ensures efficient use of natural resources
2. ensures sustained production while conserving the environment
3. maximizes production in a small area
4. Stops and reverses land degradation.

Conservation Agriculture guiding principles

Principle 1: Minimum Soil Disturbance

Only disturb the soil where the seed, fertilizer and manure are to be placed to:

1. Allow organic matter build up to promote better drainage, water storage, aeration, and soil nutrient retention

2. Decrease soil erosion by wind and water runoff
3. Minimize disruption to the organisms (worms, millipedes, bacteria, fungus etc.) that live in the soil and important for soil texture and nutrient uptake
4. Save time, energy, and money

Principle 2: Permanent Soil Cover

Tillage/burning destroy soil life- always strive to have a permanent soil cover to:

1. Reduces soil erosion
2. Moderate runoff and increase water infiltration in the soil
3. Conserve soil moisture
4. Suppress weeds
5. Moderate soil temperatures

Principle 3: Crop rotation and intercropping

Intercrop non-leguminous with nitrogen-fixing legumes to:

1. Improve soil structure and fertility
2. Facilitate efficient use of nutrients through exploitation of different soil layers
3. Break life cycles of weeds, diseases and pests through introduction of new crops
4. Minimize risk of total crop failure in cases of drought and disease outbreak/
5. Encourages household dietary diversity
6. Helps to minimize financial risk

Poster 1: Conservation Agriculture farming Vis a Vis conventional farming methods

Factors to consider to succeed in Conservation Agriculture

1. Timely Implementation

- Prepare before the rains
- Plant immediately after an effective rainfall occurrence
- Weed at appropriate times and intervals
- Control pest and disease before they spread

2. Accurate Operations

- Precise measurements of row and plant spacing
- Plant on the same lines each season (compaction of the soil by feet, hooves and wheels will only occur in the inter-row spaces and not on crop lines-residual fertility builds up in the rows and the crop roots of each consecutive crop provide organic matter)

Activity 1: How to make a CA teren rope

A teren rope is a measuring rope used in Conservation Agriculture to ensure the correct spacing of plants. You can make your own following the steps below:

- Select a long, non-stretch, hardy rope, which can be made out of nylon, cable, material rope, woven grass braid and even stiff wire segment.
- Cut a stick that represents the required distance between rows of plants; this will be used.to mark the rope with the appropriate spacing
- Tie loops in each end of the teren rope
- Peg it in on one side, pull the rope tight and peg it again on the other end.
- Then attach the markers by crimpling bottle tops or tying short strips of plastic or string on to the rope at the required intervals
- If you'd like a rope to aid with spacing between plants you can do the same thing again, except instead of cutting a stick that represents the required distance between rows, this time cut a stick that represents space between plants (e.g. often 15 cm for beans)
- The use of teren ropes is one of the easiest ways to increase your yield, as it will ensure that you maximize density while minimizing competition from weeds

3. Efficient Use of Inputs

- Precise application of soil improvements (reduces wastage as only the crops receive fertilizer and other soil improvements, and not the surrounding soil and weeds)
- Set timelines for planting and weeding to avoid additional effort needed if weeds get out of control.
- Start land preparation after harvesting as you wait for rains start (evenly distribute labor inputs over the farming season)

Weeds management in Conservation Agriculture

How CA reduces weed numbers

- Soil disturbance is minimal hence fewer seeds are brought to the surface where they can germinate
- Consistent soil cover (e.g. mulch) smothers weeds and prevents them from growing
- Rotating crops prevents certain types of weeds from multiplying

How can weeds be controlled in CA

i. Hand weeding

ii. Using equipment to cut or crush the weeds Hand shallow weeders

iii. Managing weeds with soil cover and cover crops by doing both or either of the following :

a. Crop spacing –

– plant crops closer together to shade weeds. The best spacing suppresses weeds but avoid competition between crop plants.

b. Cover crops-

Use cover crops that spread over the soil during the fallow season suppresses weeds before they can establish.

c. Mulch-

Use crop residue as mulch to suppress weeds. Use mulch that will not introduce weeds in your field.

d. Crop rotation –

Planting different crops helps break the life cycle of some weeds. A good crop rotation prevents the buildup of weed population.

e. Intercropping –

Helps cover the soil and smother weeds that grow between rows of the main crop. Choose a crop that spreads broadly and produces a lot of vegetation.

f. Use of herbicides:

This is only recommended in the first year of introducing CA/ when opening up a new area for farming.**(Only use herbicide the first year / or on a new field when starting CA practice in your farm)**

Why control weeds?

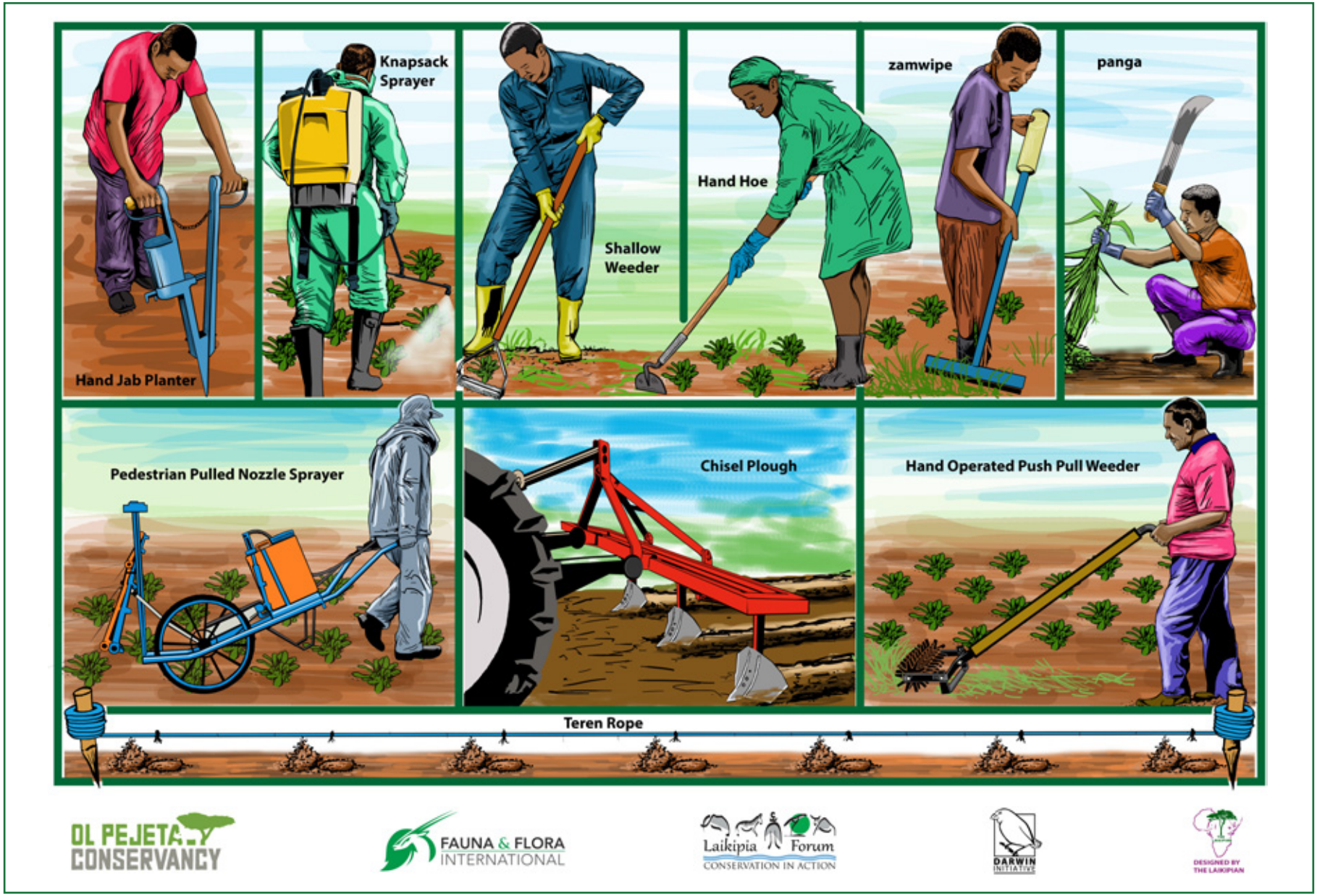
- Weeds compete with the cultivated crops for nutrients, moisture, sunlight and space
- Weeds shelter pests and diseases that attack the crops
- Weeds reduce farmers' income and crop yield
- Controlling weeds reduces the cost of production

When should weeding be done?

- Continually as long as there are weeds in your farm
- The longer you allow the weed to grow, the harder they are to control
- Weed before they set seeds

Herbicide use safety measures

- Always read the label carefully before using any herbicides.
- Check the date on the label to make sure the herbicides you buy is still effective.
- Buy only from a certified dealer.
- Mix the herbicide with clean water of drinking quality.
- Spray from the right height. This depends on the height of the weeds and the type of the nozzle.
- Use protective clothing when spaying to protect effects of the herbicide; protective clothing should include a mask and googles
- Rinse and clean spray equipment well away from water sources such as wells, ponds or rivers to prevent contamination of the water supply



Poster 2: Conservation Agriculture tools

The conservation Agriculture journey in summary

CA is a concept and a combination of many good practices that are good for our soil and environment.

The journey

1. STOP yourself, your neighbours and everyone from burning the bush, crop or weed residue, grasses, or any other types of vegetation. The material can be better used on your farm.
2. Note that soils with low fertility or degraded soils can be improved by planting special cover crops species such as legumes. After a period of 1-3 years the soil can attain better health.
3. When resources are available, have your soil tested for its chemical content and acidity and apply recommended fertilizers/ manure and or lime.
4. Plant more trees that fix nitrogen or produce plenty of biomass and place emphasis on better planning of your land in every possible way.
5. If you have an unused section of the farm, plant a nitrogen fixing (leguminous) cover crop on them without tilling the soil.
6. Reorganize your farm and graze your animals in a controlled manner. This will ensure you eliminate any compaction of the soil.
7. If the soil is compact, use proper tools like animal drawn subsoiler and leguminous crops with strong tap roots to help reduce compaction
8. If you have soil and water conservation terraces on your farm plant species such as vetiver grass, Napier, lemon grass, pigeon peas, glaricidia sepium, tephrosia vogelli and other strong deep rooted crops, these not only add nitrogen in your soil but break the hardpan.
9. Try and establish soil cover crops with native or improved exotic cover crops species. These can include leguminous plants.
10. Practice crop rotation, changing crop sequences or intercropping with cover crops eg. mukuna (velvet bean), Dolichos (lablab), pigeon peas intercropped with maize /sorghum/millet. This will decrease the occurrence of pests, diseases and weeds hence protecting your soil.
11. When you harvest, use appropriate mulch management. In all cases, start to practice CA on a small farm area, and gradually introduce the CA system to larger areas as you learn what is good for your ecology and as positive results are achieved.
12. In the first few years there will be a huge weed seed pool in your field. You may initially need to use herbicides to control these high populations. To weed, use an herbicide or simply slash the weeds and lay them to suppress further growth. If using an herbicide use protective gear when spraying. Gradually phase out herbicides by investing in cover crops seed to suppress weeds. Mulch can be used to help suppress weed growth.

MODULE2. FODDER PRODUCTION

The content of this session is mainly on establishment of Rhodes grass as it was identified as the most suited in the project area.

Fodder production training methodologies

i. To introduce fodder production to farmers organize village meetings where you can assess the current situation of fodder availability within the community (Training duration-3 hours)

ii. Carry out an on farm fodder production demonstration (can be done in one of the beneficiaries farms) at village level where you can take the learners through the different stages of fodder production.

Training duration - This will be spread over the entire planting season (approximately 3-6 months) to take farmers through the fodder production from land preparation, planting, weeding and post harvesting techniques)

Requirements:

a. Demo site
b. Labour
c. Farm inputs
d. Record keeping booklet (Annex?)
e. Sharing of results- Agree on how results will be disseminated to facilitate learning i.e. field visits

iii. Organize Field days to link farmers with fodder production inputs suppliers (Seeds & equipment) ,service providers and buyers (Activity duration-one day)

Introduction to Fodder Production

Keywords in fodder production

Fodder: A crop grown or preserved for livestock feeding e.g. Straw, silage, compressed and pelleted feeds, oils and mixed rations, and sprouted grains and legumes.

Silage: Fodder preserved by acids through a fermentation process.

Hay: Forage dried by sun and wind. It can be produced by leaving the crop to stand and dry, or by cutting and drying.

Legumes: nitrogen fixing plants that are richer in proteins than grasses and other fodder crop.

Types of hay

Grasses:

- Rhodes grass
- Napier grass
- Foxtail grass
- Forage sorghum

Legumes:

- Velvet beans
- Cowpea
- Sun hemp (Red)
- Dolichos (lablab bean)

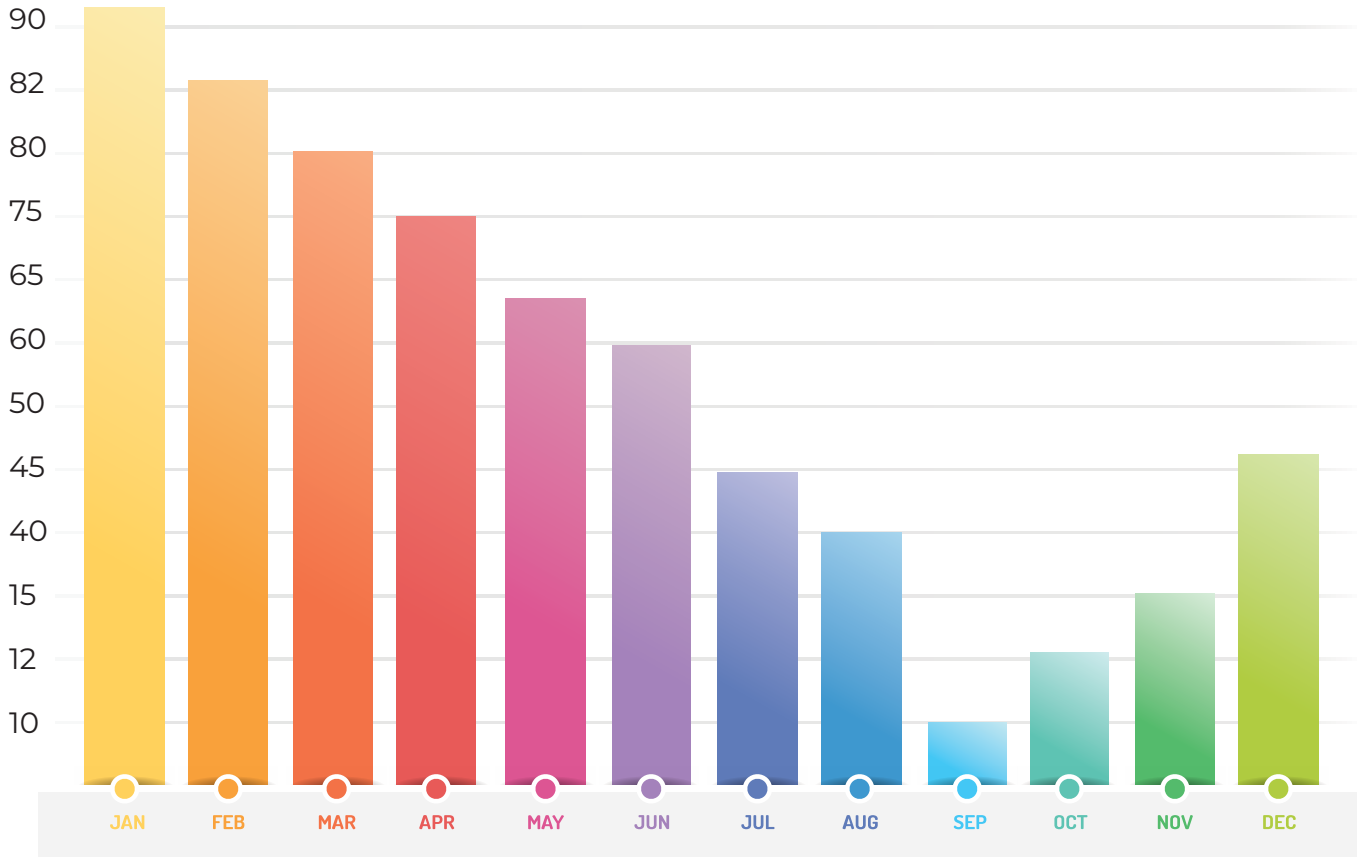
Benefits of fodder production

- Availability of livestock feed during dry seasons
- Improve livestock production and profitability.
- Prevents soil erosion when introduced in crop farming systems.
- Alternative source of income
- Easy to grow and uses fewer resources
- Fodder crops can be used in crop rotation practices

Activity 1: Understanding fodder / forage situation in the targeted communities
Purpose: To understand:

- Fodder availability / demand / prices by month
- The best time to produce, store and preserve fodder for scarce periods/ sell fodder when prices are at the peak

Facilitator guiding notes: Guide the participants to plot fodder availability and fodder prices by month



Note to facilitator: Review module 1 on conservation agriculture, and encourage farmers to use conservation agriculture to establish their hay crop. Conservation Agriculture practices can be integrated in fodder production of leguminous species through crop rotations and/or by using inter-cropping farming techniques, such as having cowpeas or other fodder-based legumes intercropped with maize and/or other human foods

Fodder Crop production and management

Fodder Establishment

Give the farmers printed and laminated copies of Hand out on fodder varieties (Annex 6) and take them through: the requirements, inputs and important processes in the production of common fodder varieties

Fodder harvesting and post-harvesting techniques

The quality of fodder is greatly determined by harvesting time, method of harvesting, handling and storage.

How to make good quality hay

When to harvest

Harvest at the end of the rainy season, when there is plenty of sunshine and the grass fodder is still green and tender. As the fodder matures in the field, it becomes fibrous and loses almost all its feeding value.

How to Harvest Hay

Step 1: Cut the fodder with a sickle or specially made fodder cutter when half the fodder has started to flower to optimize both quality and quantity of grasses and legume.

Step 2: Dry the fodder as quickly as possible. Spread the fodder in the field to dry for about 4 hours. Once the top is dry, turn the fodder and dry again for approximately 4 – 5 hours. Follow the same process the following day, provided there has not been rain. The hay can be removed from the field for storage the second day. Hay is ready to store when no sap (moisture) can be drawn from the stem when pressed with the fingernail.

Curing and Storing Hay (handling, bailing, storing and feeding)

1. Handling

a. Handle gently after drying especially with legumes to avoid breakage and loss of nutrients
b. Drying period should be as short as possible to prevent loss of feeding value
c. Handle hay as little as possible after drying
d. Bale your hay for easy storage and transport

2. Storage

Store under a roof and on raised wooden structures to keep dry.

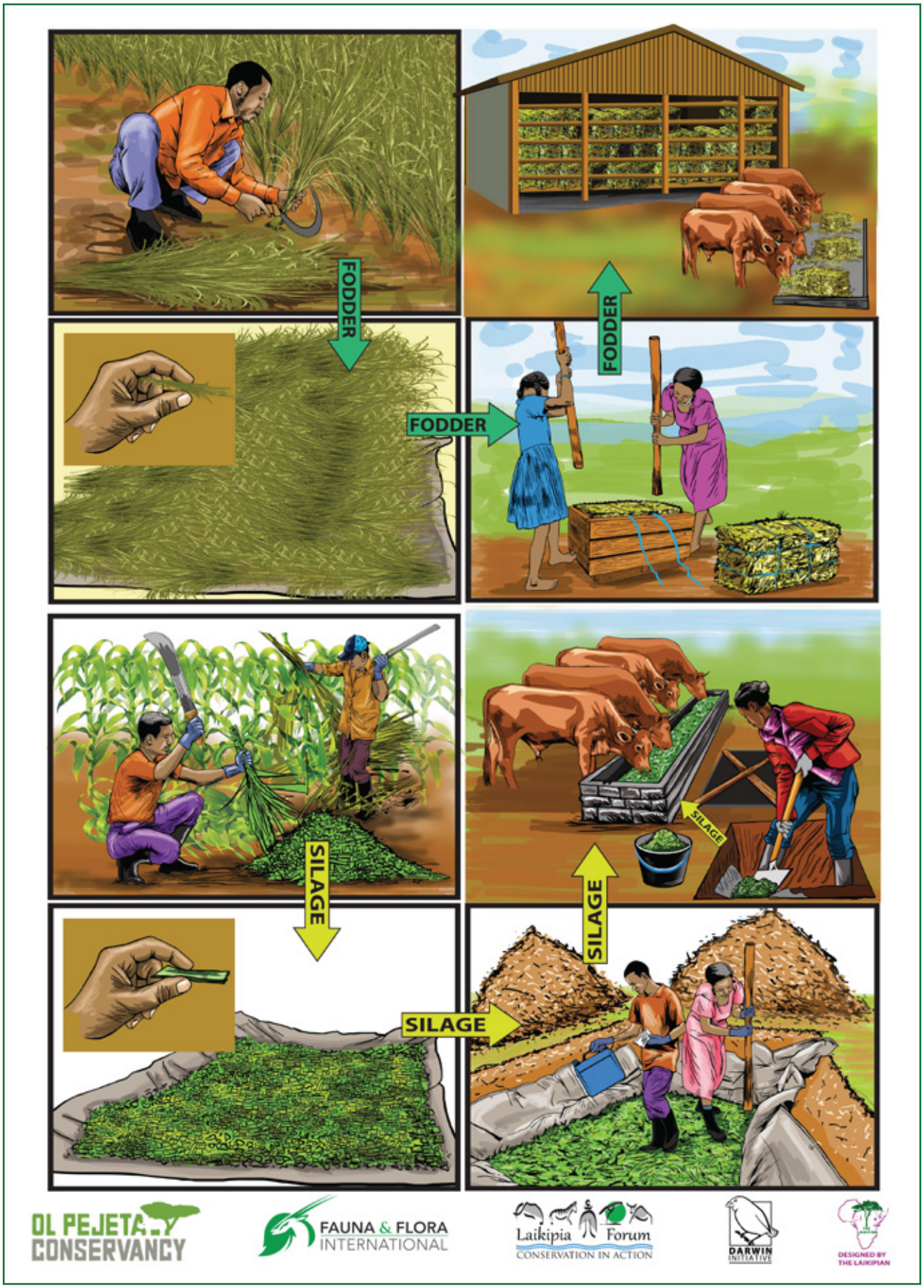
How to hand bale your own hay (show the image of handmade baler in poster 2)

Requirements

A simple rectangular wooden box measuring 100 x 60 x 60cm (Length, width and height) open both sides.
A string.

Steps

- Fill a wooden box and press the hay tightly in the box by standing on it or using any heavy object, such as a metal bar, to compress the hay.
- Once the box is full, tie the bale with the string.
  Lift the box to release the bale.



Poster 2: fodder harvesting and post harvesting

Fodder Seed Harvesting

- Harvest when the seed is fully formed.

  Grasses: Harvest immediately if seed heads shatter when gently struck against the palm.
  Legumes: For legume seeds, harvest them when the seeds rattle in the pods and the pods turn from green to brown (do not wait until the pods start shattering)

- Ensure the seed is completely dry before storage. When properly dry:

  Grasses: Grass seeds will not leave moisture when put in a plastic bag overnight.
  Legumes: Legume seeds will feel hard when pressed between the thumb and fingernails.

Fodder Harvesting and storage Tools

Facilitators note: Where appropriate fodder tools are limited, encourage farmers to engage experienced skilled local artisans to provide locally manufactured tools eg. Choppers, chopping boxes and chopper grinders. They should be designed to reduce the amount of labour and time used in fodder production, especially for women.

Fodder Harvesting and Storage Tools

- Scythe: Used to cut large amounts of fodder in a short period of time. This tool is especially suitable for women as it eliminates bending (as in the case of the traditional sickle).
- Pitch fork: Used for lifting hay.
- Metal rake: Used for gathering hay. This tool is stronger and more durable than a wooden rake.
- Wooden rake: Used for gathering hay. If a farmer can't afford a metal rake, the farmer can make a wooden rake

Step by step small-scale silage making

Step 1.

- Prepare a shallow pit on slightly sloping ground. The depth of the pit should decrease from the higher side of the sloping ground to the lower side giving a wedge-like shape. Dimensions of the pit depend on the amount of forage to be stored.
- As a rule of thumb 72 cubic feet (2 cubic meters) holds 1000 kg (or 20 bags) of fresh, chopped material. 1 m3 holds 500 kg of silage. Evenly apply molasses. Use 11 liters molasses for every 560 kg of fresh material (1 liter molasses per bag of 50 kg fresh material)

Step 2.

- Chop the forage to be ensiled to lengths of about 1-inch tong using either a panga or a chaff cutter.

Step 3.

- Spread polythene sheets over the sides and floor of the pit so that the forage does not come into contact with soil.

Step 4.

- Empty 1 bag of about 50 kg of chopped material into the plastic lined pit and spread into a thin layer. Repeat this till the pit is filled to 1/3 (6 bags).

Step 5.

- Dilute 1 liter of molasses that is about 1 kg with 3 liters of water. Sprinkle this mixture over the layer of chopped forage. Use a garden sprayer to distribute the solution evenly.
- This helps to feed the micro-organisms to make, the silage acid quickly, which will prevent rotting.

Step 6.

- Press the forage down with your feet or a suitable weight (e.g. a drum full of water) to force out as much air as possible. This will prevent fungi attacking and destroying the forage.

Step 7.

- Add another bag of the chopped feed, sprinkle diluted molasses and compact the forage again. Repeat this process of adding forage, diluted molasses and compacting until the pit filled in a doom shape.

Step 8.

- Cover the pit after a final pressing with polythene sheeting to prevent water seeping into the silage and dig a small trench around the sides of the pit.

Step 9.

- Then, cover the pit with soil: a layer of 24 inches (in the case of wet, fresh fodder) up to 36 inches (in the case of more dry forage) of soil to keep the air out and to prevent damage of the polythene by rain, birds and rodents.

Step 10.

- The conservation of the material by microorganisms takes a couple of weeks. Thereafter, it can be fed, but you better leave it until a time of feed shortage. With good sheeting and enough soil on it, the silage can be kept well for 1 – 2 years.

Step 11.

- Open the pit from the lower side of the slope. Remove enough material for one day's feeding, and then cover the open end again.

How much to feed?

- A grade cow may eat up to 30 kg of silage per day.
- To ensure that the milk has no silage smell, feed after milking or at least 3 hours before milking.

Poster 2: fodder harvesting and post harvesting

MODULE 3: ONFARM WATER HARVESTING

Methodologies for training

1. Demonstration: organize farmers into groups and do demonstration on the various water harvesting techniques

The techniques described in this booklet aim to maximize the available water through Water harvesting and conservation. Water harvesting techniques gather water from an area termed the **'catchment area'** and channel it to the cropping area or wherever it is required. Conservation techniques conserve water within the biomass and the soil by reducing run-off and keeping the water where it falls, as much as possible.

This practical on farm water harvesting and conservation techniques recommended are locally adapted and developed to suit specific conditions.

Principles of on farm Water Harvesting and Conservation

In deciding which techniques to use to make more efficient use of the available water, it is important to consider how crops receive or lose water. Crops receive water through rainfall, irrigation and stored soil water. They lose it through run off, evaporation and drainage. Some key principles on effective water management are:

1 Use rainwater effectively.

- Store water during rainy seasons using external catchments, roof top collection to increase water availability in the drier seasons.
- Harvest water from a wider area if you plan water available to irrigate your crop in the dry season
- Take Measures to avoid run off the surface during intense rainfall (explained below).

2 Make effective use of soil water reserves.

- The soil stores water from rainfall providing a reserve that is available to the crop.
- Deeper rooting crops, such as grasses or cereals will exploit soil water reserves more effectively than shallower rooting crops such as vegetable crops and therefore can be grown in drier periods.
- Good cultivation practices (e.g. not ploughing too deep or when the soil is wet) that result in a soft, friable soil will also promote deep rooting and eff iciest use of soil water reserves.

3 Take measures to avoid run off

- Use Structures such as contour schemes, terracing, pits and bunds to reduce run-off.
- Add mulch to your farm to break up the intensity of rainfall
- Add Manure, compost or plant residues to reduce the tendency of the soil to form a crust.

4 Avoid wasting water through evaporation

- Maintain full ground cover for as much of the time as practically possible
- Apply mulch to the soil to reduce evaporation.
- Use drip irrigation
- Irrigate in the evening to reduce the amount of water lost through evaporation

6 Plan your irrigation

- Only irrigate when necessary (when the crop needs water).
- If water is scarce, restrict irrigation to the most critical periods (germination and fruit set).
- Use drip irrigation instead of overhead systems as it is targeted to the roots rather than sprayed up into the air

On farm water harvesting and conservation techniques

In deciding which techniques to use to make more efficient use of the available water, it is important to consider how crops receive or lose water. Crops receive water through rainfall, irrigation and stored soil water. They lose it through run off, evaporation and drainage. Some key principles on effective water management are:

1 Contour farming

- Ploughing and furrow along contours rather than up and down the slope- this will conserve water by reducing surface run off and encouraging infiltration of water into the crop area.
- Use appropriate water harvesting techniques along the contours: contour ploughing; contour ridges; stone lines; grass strips and terraces.
- The technique used depends on the steepness of the slope, soil type, conditions, crops grown and availability of labour.

2 Contour Furrows

- Do small earthen banks that run along a contour.
- Dig a furrow next to each bank on the upper side of the slope.
- Vary the distance between the ridges between 1 - 2 m depending on the rainfall and the slope. Contour furrows concentrate moisture into the ridge and furrow area where the crops are planted by trapping run off water from the catchment area between them.
- Plant crops with higher water requirements, such as peas or beans, on the higher side of the furrow
- Plant cereal crops which require less water, such as sorghum or millet, on the ridges.
- Leave the catchment area between the ridges uncultivated and clear of vegetation so that run off into the ridges is maximized.
- Under drier conditions, space furrows further apart to harvest water from a larger catchment area.
- Contour furrows are suitable for areas with lower rainfall (350 - 700 mm).
- However, the amount of water harvested is limited, so they are not suitable for very dry areas. Extreme rainfall may cause the ditches to overflow and break. This is more likely to occur on heavier soils with a lower infiltration rate, or on steeper slopes. The risk can be reduced by building higher ridges, although this increases the labor requirement.

3 Bench Terraces

- Create ridges and furrows along contours on a slope.
- The ridges hold back water and soil runoff and eventually turn the hillside into a number of terraces.
- Stabilize the ridges by planting grasses or shrubs on them.
- Use terraces on steeper slopes
- Building them requires high labor input.
- Form terraces by digging a ditch along a contour and throwing the earth either uphill or downhill to form a ridge.
- Water is stored behind the ridge

4 Grass Strips

- Plant Strips of grass (up to 1m wide) along a contour to reduce soil erosion and runoff. Silt will builds up in front of the strip over time to form benches.
- On gentle slopes, wildly space the strips (20-30m apart), and on steeper slopes narrowly space (I0-I5m apart).
- Trim the grass regularly, to prevent it competing with crops.
  Grass varieties you can use, depending on what is available locally include Sudan, Napier, Guinea and columbus grasses.
- Alternatively a local Veld grass can be used.
- Maintain strips to prevent the grass from spreading and becoming a weed problem or becoming a refuge for rodents and other pests.
- Grass strips cutting can be used as fodder or mulch.

5 Retention Ditches

- Retention ditches work on a similar principle to contour furrows but on a larger scale.
- Design large ditches, to catch and retain all incoming run-off and hold it until it infiltrates into the ground, increasing the supply of water to crops planted in the ditch and reducing soil erosion.
- Use retention ditches to grow crops that have high water requirements such as bananas.
- Use on lighter, free draining soils that are deep, stable and not prone to landslides.

6 Planting pits

- Dig small pits in which you can plant individual or small groups of plants.
- Pits catch run off and concentrate soil moisture around the roots.
- Suitable for crops with low water demand such as sorghum or millet.
- Suitable for heavier clay soils, which tend to form a cap and have poor infiltration.

7 Earth dams

- Design earth basins by hand to collect and hold rainfall.
- Make square or diamond shaped basins with earth ridges on all sides.
  Channel runoff water to the lowest point and store in an infiltration pit.
- The lowest point of the basin might be located in one of the corners (on sloping land) or in the middle (on flat land).
- Use Earth basins for fruit crops and the seedling is planted in or on the side of the infiltration pit.
  Customize size of the basin depending on local rainfall and the water requirements of the trees.
- Add compost or manure to the basin to improve fertility and water-holding capacity.

8 Semi-circular bunds

- Dig Semi-circular (U-shaped) earth bunds on a slope.
- The uppermost tips of the U lie on a contour so that run off is collected in the lowest section of the U. Do a shallow pit in lowest section to help concentrate moisture

9 Cover crops/green manures

- Grow Cover crops to protect the soil from leaching, erosion and to improve fertility.
- They organic build up in the soil, improves soil structure, suppresses weed growth and increase soil fertility through nitrogen fixation.
- Use Legumes, such as beans and peas as a cover crop.
- Plant cover crop; after tillage; the same time as sowing the main crop, or after the main crop has established to avoid competition.
- Do not use cover crops on areas receiving annual rainfall of less than 5OOmm, as they might compete for water with the main crop. Instead use cut weeds and natural vegetation as cover.

10 Mulching

- Cover the soil between crop rows or around trees with a layer of loose material such as dry grass, straw, crop residues, leaves, manure or compost.
- This helps to retain soil moisture by limiting evaporation, suppressing weed growth and enhancing soil structure, reducing runoff, protecting the soil from splash erosion and limiting the formation of crust.
- It is recommended for areas affected by drought and weed infestation.

12 Conservation tillage

- Minimize soil cultivation to reduce the negative effects of conventional tillage; soil compaction, formation of pans, disturbance of soil fauna and moisture loss.
- Minimize cultivation by preparing the land without the use of a conventional plough.
  Use prong-based implements or hand hoes to open the soil just enough to allow a seed to be planted.
- Minimal cultivations reduce water losses because of a reduction in soil disturbance from tillage.
- In the long term the soil structure is improved. Less surface compaction and smearing at depth from the shares of the plough should increase rooting depth and therefore the drought tolerance of crops.

- Ensure a Permanent soil cover is commonly achieved by leaving crop residues on the ground as mulch after harvest
- Plant Seeds or plants directly into mulch using a prong based implement or hoe.
- In practice, it takes several years before the advantages are realized so it should be considered a long-term project

Water harvesting from external catchment

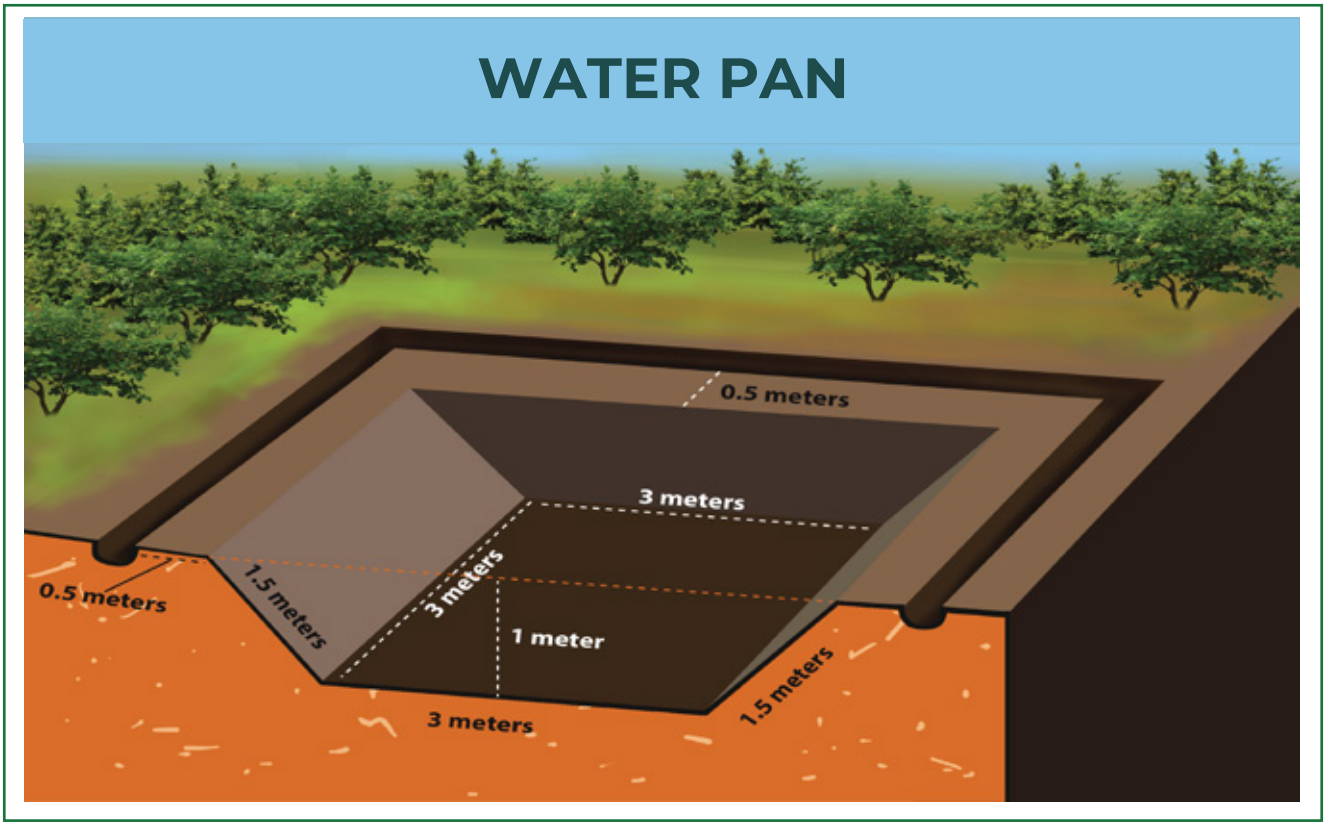
- Divert runoff water from an area that is not cropped to the area where crops are grown or in a lined water pan.
- Store water in the pan to apply to the crops when it is needed.
- The flow of water from the reservoir into the cropped area can be controlled using tied bunds that can be built up or dismantled as required.
- Do not cultivate the external catchment area and may include rough grazing areas, roads or homesteads.
- The soil should have a low infiltration rate in order to maximize runoff and therefore vegetation should be restricted to a minimum.
- The stored water will be lost gradually through evaporation and seepage, this can be reduced on silt or clay soils by capping the soil using puddling boards (used to encourage flooding in rice cultivation).

Roof top harvesting

- A simple technique that can store large amounts of water from the rainy season for later use in the dry season.
- Although frequently used for domestic use, you can also use stored water for small scale growing of high value horticultural crops which can be particularly drought sensitive.
- It works well in conjunction with drip irrigation.

Activity 3: How to construct a simple and cost effective household water pan

Description: small reservoirs about 1m to 3m deep usually dug of a stream wit raised and compacted banks all around. They are designed to collect and store runoff water from various surfaces including hillside, roofs, roads, rocky areas and open rangelands.



Deciding on the size of the pan

- Determine the volume of water required determined by the: land size; dry season duration and availability of alternative sources and crop choice.
- Source of water for storage e.g. flood flows, roof rain water catchment.
- Determine the quality of water depending on the intended use i.e. livestock use, household use and irrigation. This will guide if you will have an open or a closed water pan.
- Cost, efficiency and availability of the dam liner
- Knowledge of the water pan excavation, availability of the lining material.

Pond lining

- The pond liner is a geomembrane material used to prevent water loss through seepage in ponds.
- It holds water in the pond to meet future water demand.

Properties of pond liner

- Gauge 0.5mm and 1mm
  Widths available :
  - 0.5mm – 8m
  - 1mm – 7m

  Warranty is above 10 years
- High resistance to puncture, tearing and is treated against solar degradation.

Pond excavation

- Can be done manually or by use of a tractor
- Organize farmer groups who can do rotational excavation in every household within the group if it is done manually.
- It takes 5 people 2 days to scoop a 4m by 1m pan with a slope of 1.5 meters(Organized groups can do rotational excavation in every household within the group).
- After confirming the dimension of the pan as per the liner measurement, hold the liner at the corners as you lower it down. Align the liner and make sure it's in contact with the ground cover.
- To support the liner the farmer will trench at a distance of 1M around it foot deep and a foot wide. The liner edges are tucked in this trench and covered.

Figure 3: A lined water pan; it took this group 8 hours to excavate the pan

Dos for the farmer

- Water pan should be fenced for security purposes.
- Flood flow should be filtered in stages before going into the dam
- Locate the pan where it would serve the major purposes e.g for irrigation should be above the irrigated field.

MODULE 4: FARM RECORD KEEPING

Module sessions:

i. Introduction to record keeping

ii. Participatory development of record keeping systems

iii. Demonstration on using record keeping systems

Methodologies for training on record keeping

i. Meetings with farmers to introduce record keeping, design record keeping booklet and demonstrate the use of the crop record book.

Introduction to record keeping

Why keep farm records?

- To track your farm production levels and expenditure
- To know if you are benefiting from your efforts and make any necessary changes.
- To evaluate your financial position and measure the outcome of your decisions, and upscale/ evaluate alternative strategies based on your results
- To keep track of activities and expenses

Why keep farm records?

1. Accurate and complete
2. Done as soon as possible after operation.
3. Simple in design, easy to keep and retrieve.
4. Appropriate.
5. Easy to analyze.

Types of crop records recommended (Annex 1):

1. Field preparation practices
2. Yield or production records
3. Cultivation practices
4. Disease monitoring
5. Harvesting monitoring

MODULE 4: MARKET ORIENTED FARMING

Methodologies for training market oriented farming

1. Community dialogue meetings
2. Field days to link farmers with suppliers, processors and buyers

Introduction to market oriented farming and farm management

Exercise: Facilitate the participants to brainstorm changes affecting farming in their locality. This could include changing policies, urbanization, population growth, climate change, the technological revolution /financial crisis. They can then discuss and agree if these changes have presented opportunities and/or constraints. List down their responses and guide them to discuss possible strategies to address emerging challenges and maximize on opportunities.

Farm management

- Make decisions on your farm with the objective of making profits.
- Be aware of your available resources, farm products to produce, and available markets for your products.
- To farm profitably as a farmer, make good decisions based on the following;
  - Select technologies that address your resource constraints (land, capital, labour and knowledge)
  - Knowledge on operating the new technologies and optimal use of inputs
  - Changes on the farm to diversify crop production
  - Select of products that have a high demand in the market
  - Understand the quality specifications needed to get good prices for your produce
  - How, when and where should you buy inputs and sell products
  - How you can make decisions collectively on resource use and marketing
  - Access to reliable knowledge and information sources

Market-oriented farming

- Produce what the market wants and what satisfies the consumer
- Make good decisions by making efforts to access information and better skills
- Take advantage of market opportunities
- Be aware of different market channels and input suppliers, the differences in prices and costs, and other conditions of buying and selling

Why market oriented farming / farm management?

Awareness of changes that could occur helps you to adapt and respond to reduce risks by considering the following:

- **Selection of technologies:** adopt the most economical and sustainable method.
- **Selection of enterprises:** Choose the most profitable enterprise.
- **Managing risk:** keep good farm records to provide data on past performance to estimate the risk that you are able to take.
- **Profitability:** To be competitive, you should be able to sell at prices lower than your competitors and still make a profit. To do this you must become more efficient in the use of resources and inputs.

Market chain

- Steps and costs involved in moving produce from the farm to the buyer:
  - Time taken to walk to a nearby market
  - Time it takes until your product is sold,
  - Storage of product until it is most profitable to sell,
  - Transportation,
  - Packaging and processing.
- You can directly sell to the end buyer, to receive the full market price but you will also pay all the marketing costs
- Weigh which option will bring you the best returns depending on your available skills and resources.

KITCHEN GARDEN ESTABLISHMENT

Introduction

- Kitchen garden is the growing of vegetables/ herbs/fruits in the backyard of the house by using kitchen wastewater.
- Advantages of Kitchen garden include:
  - Fresh supply of vegetables high in nutritive value also free from toxic chemicals.
  - Expenditure saving on the purchase of household vegetables and fruits.
  - Potential income generation by selling to neighbors or on the market.
  - You can grow 100% organic vegetables that have high nutritional and healthy.
  - It is not labour intensive and Women groups can be able to invest in other micro enterprise activities.

Making a gunny sack garden

- A sack garden is simple and cheap to build.
- It requires a small space and little water to manage.
- A sack garden holds up to 150 plants.
- Requirements
  - A big polythene bag or sack
  - 4 wooden stakes (to support the sack)
  - Ballast/medium-sized stones
  - A hollow tin or pipe.
  - Manure and soil.

Procedure

- Choose a location for the sack as close as possible to your kitchen or can be watered easily without interference from animals, children and visitors.
- Choose a spot where it will receive as much sunlight as possible.
- Mix manure and soil in the ratio of 1:1 near the site of the sack garden.
- Measure a space 2 feet by 2 feet.
- Dig holes 1 foot deep in each corner
- Put the wooden stakes/poles into the holes
- Insert the sack over the 4 stakes then fold to allow easy filling. The sack and stakes should make a square or round.
- Put a hollow tin in the middle of the sack at the bottom
- Fill the hollow tin with ballast and the space between the tin and the sack with a mix of manure and the topsoil
- Do not put any soil in the tin, unfold the sack as you fill the soil and ballast.
- Once you fill the tin with ballast to the top, pull it out and fill the new space with ballast/kokoto

- Repeat this process until the whole sack is filled with soil and you have a ballast tunnel down the middle
- Make holes the size of a coin on the bag wall using a sharp stick. Leave 15 cm between each hole. Ensure the holes are not in the same vertical line to prevent blocking some from getting direct sunlight.
- Plant seedlings in the holes carefully so as not to damage the roots. Press the soil around the seedlings using the fingers to make it firm.
- If planting different types of crops, plant root crops (e.g., bulb onions) at the top and leafy vegetables (spinach or kales Mfalme F1 which will have a long production period) on the sides.
- Pour water down the ballast tunnel (you will need to use 20 liters (1 jerry can) of water for 2 days depending on the season).
- you can use recycle kitchen water to water your kales by:
    - Have a 110 liter tank depending on how you use the water and size of the kitchen garden.
    - Pour the waste water to settle in the tank
    - remove the solid particles
    - put a handful of ash and let the water settle before usage
    - Water will be clean for use and ash also contains calcium, magnesium and potassium among other micro and macro nutrients needed by plants

Making a gunny sack garden

* Dig holes 1 foot deep in each corner

* Put the wooden stakes/poles into the holes
* Insert the sack over the 4 stakes then fold to allow easy filling. The sack and stakes should make a square or round.

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* If planting different types of crops, plant root crops (e.g., bulb onions) at the top and leafy vegetables (spinach or kales Mfalme F1 which will have a long production period) on the sides.
* Pour water down the ballast tunnel- you will need to use 20 liters (1 jerry can) of water for 2 days depending on the season.

Making a vertical garden

- Use geomembrane polythene 0.5mm sold in local agro vet shops which is cut into different sizes then arranged from the largest at the bottom and the smallest at the top. One can arrange 5 to six polythene depending on the height one requires.

- Similar to the polythene vertical garden you can use old car tires of different sizes and arrange from the biggest in the bottom and smallest at the top.

  Different types of crops can be grown in this model of vertical garden depending on the choice of the farmer.

- Follow the process similar to making a sack garden that is soil mixing with manure and arrangement of gravels in the middle .Tires, if available is the most affordable than the geomembrane polythene

Picture 4: vertical using geomembrane polythene

FARMERS HANDOUTS

1. Crop Record keeping booklet

Farm management

a. Field preparation-list date and activity i.e. ploughing, Herbicides application, harrowing.

Date	Activity

b. Planting

Crop and variety planted: _____ Date _____

Expected yield: _____

Final stand: _____

Monitoring when planting: Describe soil tilth, moisture, seeding problems, or any other observation you have:

_____

_____

_____

_____

c. Cultivation practices :List date and cultivation activity

Date	Activity	Crop Growth

d. disease monitoring

Date	Disease	Type of crop	Damage assessment		
			Low	Medium	High

e. harvesting Monitoring

Yield per plot	weight	Price/kg	Total income

Dates	Crop planted	Field activities	Total cost	Harvesting dates	Quantity Harvested	Crop used for subsistence(kg)	Crop sold (kg)

2.Recommended crop rotations for Conservation agriculture

HNDOUT 1: RECOMMENDED CROP ROTATIONS FOR CONSERVATION AGRICALTURE IN THE AREA IN REFERENCE TO THE STAPLE FOOD AND CLIMATE

Rotations

- Do rotation every 3rd year.
- Allocate 1/3rd of the land area to be under rotation.
- Divide your crop lands into 3 equal proportions and allocate the 1st two for the staple crop, example maize and 3rd crop portion to the rotation crop, for example green beans.

Year	1	2	3
Portion 1	**Maize**	**Beans**	**Maize**
Portion 2	**Maize**	**Maize**	**Beans**
Portion 3	**Beans**	**Maize**	**Maize**

General Guidelines

- Change from non-leguminous (Maize, sun flower, wheat, sorghum, millet etc.) to leguminous (beans, soya beans, pigeon peas, cowpeas, lablab, lentils etc.)plants
- The 3rd rotation portion can be subdivided further to include a variety of vegetables for a family nutritional supplement

Recommended rotation crops for semi-arid areas

Leguminous varieties: Dolichos lablab (lablab), Desmodium Canavalia (jack beans) and Mukuna (velvet beans)

Staple crop which is also non-leguminous: Maize

3: Recommended common beans for semi-arid areas

Bean variety	Characteristics
Katumani Bean 1(KAT B1)	1. Flowers within 30-40 days 2. Matures within 60-65 days 3. Potential yield ranges from 7-9 90 kg bags per acre (1400- 1900 kg per hectare) 4. Tolerant to rust, common bean mosaic virus (CBMV), angular leaf spot and bacterial blight 5. Drought tolerant 6. Performs well in areas between 900- 1600 M above sea level 7. Seed are greenish yellowish, taste sweet and have flatulence than common rose coco and mwezi moja variety. 8. Grows well under trees and banana shades.
Katumani Bean 9(**KAT B9)**	1. Flowers in 30 -40 days 2. Matures within 60-65 days Potential yields is 7-9 90 kg bags per acre (1400- 1900 kg per hectare) 3. Drought tolerant 4. Tolerant to common bean mosaic virus and rust; and has field tolerance to several fungal diseases 5. Suitable for lower altitude areas of 1000 M and below where the average rainfall season is more than 200mm.
Katumani x56 **(KAT X56)**	1. Flowers in 30-35 days 2. Matures within 60- 65 days 3. Potential yields are 7-10 bags per acre (1400- 2000 kg per hectare) 4. Under good growing conditions, the variety yields more than KAT B1 and KAT B9 5. Has tolerance to rust, charcoal rot, common bean mosaic virus (CBMV) and tolerance to angular leaf spot 6. The grain cooks fast and tastes sweet
Katumani x69(**KATX69**	1. Flowers in 30-35 days and 2. Matures within 60-65 days 3. Grains long, oblong and rose coco type in colour but 4. with dark red background 5. Potential yields range between 1400-2000kg/ha or 6. 7-10 bags/acre 7. Is susceptible to lodging due to heavy bearing and tall plants

4. Bean management in Conservation agriculture, and Conservation agriculture equipment

TABLE 1:BEAN MANAGEMENT IN CONSERVATION AGRICALTURE	
Activity	**Time/ specifications**
Land preparation	Before onset of rains
Time of planting	Onset of the rains when the soil is wet enough
Seed rate	40-50 kgs /ha (16-20kgs/acre)
Spacing	Mono-cropping – 45x 15cm for non-spreading varieties and 45-60x15-25 cm for spreading varieties.
	Intercropping – two equal distance bean rows between main rows at 15cm within the row.
Depth of planting	Plant at a depth of 4-5cm and sow 2-3 seeds per hill.
Fertilizer application	DAP fertilizer should be applied at the rate of 2000kg/ha. If applied in furrows or planting holes, mix the fertilizer and the soil thoroughly before covering the seed.
	Manure application: 15-20 tons/ha (6-8 tons/acre)
Weeding	The first weeding should be done two weeks after emergence and the second one must be done before flowering.

TABLE 2: CA TOOLS		
minimum tillage equipment		
CA Equipment	Function	Source/contacts
Rippers	Shallow ground breaking with minimal soil distraction, needs proper soil moisture when in crumbling or dry form is better.	Lengetia farm,Lamuria location,Laikipia county Phone: 0722332647
Sub soiler	Break hardpans and compacted soil layers ,used in dry soil only	Ndume limited, Nakuru town, Nakuru county Phone no: 02021866668/9
Chisel plough	Break hardpan and compacted soil ,tractor driven machine	Ndume limited,Nakuru town, Nakuru county Phone no-02021866668/9
Direct seeding equipment/tools		
Planting stick/CA teren rope	Making of planting holes	Locally made
Hand hoe/ panga	Making of planting holes	Local blacksmiths
ripper	Planting holes	Local blacksmiths
Hand jab planter	For precision seed and fertilizer placement	Sunrise agro vet, Nanyuki 0723057972
Animal drawn direct seeder	Planting	Ndume limited,Nakuru town, Nakuru county Phone no-02021866668/9
Tractor powered row planter.	Planting and fertilizer placement.	Lengetia farm (for hire services only),Lamuria location,Laikipia county Phone: 0722332647
Zamwipe	Herbicide applicator	Sunrise agro vet nanyuki Phone :0723057972
Knapsack sprayer	Spraying the herbicides	Available in all agro vets
Shallow weeders	Shallow weeding without disturbing the soil.	Lengetia farm,Lamuria location,Laikipia county Phone: 0722332647

5. Good Agricultural Practices

Practice	Details
Enterprise selection	1. Available market for the crop 2. Resistant to pest and diseases/ availability of control measures 3. Fits the area climate conditions and soil adaptation etc. 4. profitability 5. Availability and access of inputs. 6. Farmer's preference for food crops.
Land preparation	1. Timely land preparation 2. No till 3. Crop rotation 4. Use of mulch and cover crops during fallow season
Soil and water conservation	1. Terracing – Fanya Juu, retention ditches, semicircular bunds, cut off drains-reduce water speed and cut off excess water. 2. Water harvesting. 3. Strip cropping - grass striping / non target crop planted along the contour between target crops. 4. Mulching – use of inorganic or dry plant materials. 5. Increasing use of organic manure. 6. Sub soiling 7. Pitting techniques. 8. Maintaining permanent crop cover. 9. Crop rotation – legume / cereal rotation, deep rooted and shallow rooted. 10. Contouring – planting crop along the contour to slow moving water speed and reduce soil erosion. 11. Weed control – shallow weeding. 12. High density planting – closed spacing to reduce impact on rain, but making sure the density of planting does not affect crop growth
Planting and crop husbandry.	1. Seed selection 2. Plant population – spacing, gapping, thinning. 3. Weeding – timely weeding. 4. Soil fertility management – soil testing, proper fertilizer/manure and proper application rate.
	5. Pest and disease management – scouting, identification of pest and diseases, critical stage of attack, integrated control methods, right dosage of pesticide. 6. Harvesting – maturity indices, physiological maturity.
Timely harvesting of the produce.	1. Following relevant pre harvest intervals and withholding periods 2. Moisture management of dry produce through efficient drying. 3. Clean and safe handling for on farm processing of products. 4. Store food products under hygienic and appropriate environmental conditions.

6. Fodder varieties

	Rhodes Grass	
GRASSES	Soil Types	○ Tolerant to a wide range of soils from light sandy to clays (GART Manual, 2011) which is suitable for the Laikipia region
	Land Preparation	○ Plough and harrow the land
	Planting	○ Broadcast at the rate of 3 – 7 kg per hectare. Sow at the onset of reliable rains
	Fertilizer	○ Use inorganic fertilizers to boost the growth of Rhodes grass- to reduce costs and conserve environment, Organic fertilizer is recommended, such as cattle or goat manure. ○ Apply organic manure before planting in the dry season.
	Weeding	○ Manual weeding (Uprooting weeds using your hand) or use herbicides with appropriate protection
	Harvesting	○ Allow new strands of Rhodes grass to set seed before cutting, particularly if the stand was poorly established. ○ Peak grass production is usually obtained in the first two seasons. ○ Then allow the stand to flower, and shed seed before harvesting ○ Plough and replant after 3 – 5 years.
	Velvet Beans[1]	
	Soil Types	Velvet beans are tolerant to a wide range of soils, but are susceptible to water logging. This crop is fairly drought resistant and requires a long warm growing season.
	Land Preparation	Using CA practices such as ripping and potholing.
	Planting	Planting should be done at the rate of 40 -50kg seed per ha in rows of 0.5 to 1m apart when the crop is planted for its leafy material as fodder. The depth of the seeds should not exceed 2 to 3 cm. When intercropped with maize or sorghum as a mixture to make silage, the seed rate should be 15 - 20kg per ha.
	Weeding	Velvet beans require regular weeding in the first weeks because the initial growth is slow. Later, it effectively overcomes all weed competition.
	Diseases	Suffers from root rot in high rainfall areas.
	Harvesting	Velvet beans are an excellent silage crop when intercropped with cereal crops like maize and sorghum. When feeding fresh to livestock (cattle and goats), they should be combined with hay or a cereal fodder in a ratio of 1 part velvet beans to 3 parts cereal.
	Cowpeas [2]	
	Soil Types	Cowpeas should be planted in well-drained soils that are weed free.
	Land Preparation	Using CA practices such as ripping and potholing.
	Planting	Cowpeas should be planted at a seed rate of 15-20kg/ha
	Weeding	Cowpeas should be kept weed free in the first four weeks after which it outgrows the weeds.
	Pests and Diseases	Cowpeas are susceptible to fungal attacks. Though fungicides can be sprayed, the best control is crop rotation. It is also attacked by blister beetles, which eat the flowers. These beetles can be killed manually or with a suitable insecticide.
	Harvesting	The complete crop can be incorporated in silage or be dried as hay. The seeds can be dried and ground and fed as a meal. As a fresh feed for livestock, the green leaves can be plucked regularly or the whole crop can be harvested when the pods are green. Cowpeas are an excellent fodder crop for smallholder dairy farmers.

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