SUSTAINABLE FARMING TRAINING GUIDE

Agroforestry

Crop Rotation

Cover Crops

Organic Farming

Recycle and compost waste material

IPM Methods

AGRA
Sustainably Growing Africa's Food Systems

CGA
CEREAL GROWERS ASSOCIATION

ACKNOWLEDGEMENTS

The Cereal Gowers Association appreciate AGRA for the funding towards the Sustainable Farming and Inclusive Markets (SFIM) project implemented in Kisumu, Kakamega, Vihiga, Nandi and Machakos counties which enabled the development of this manual.

DISCLAIMER

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FOREWORD

The Cereal Growers Association (CGA), incorporated in August 1996, is a non-profit member-based organisation that brings together Kenyan farmers to promote collective action and builds their capacities towards the attainment of food and nutrition security.

Climate change has greatly undermined food and nutrition security in Kenya, and this is evidenced by prolonged droughts, floods and irregular rainfall patterns.
Additionally, the prolonged use of chemicals on farms has resulted in declining soil fertility and low agricultural production.

This manual serves as a guide for farmers to adopt sustainable farming practices and how to make their farming enterprises profitable.

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TOPIC 1

INTRODUCTION TO CLIMATE CHANGE

1.1 Definition of climate change

Climate change is defined by the United Nations Framework Convention on Climate Change (UNFCCC) as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural variability observed over comparable time periods."

1.2 Effects of climate change

The effects of climate change in agriculture are numerous and they include;

- Increased surface run-off leading to washing away of fertile top soil
- Increased pest and disease outbreak
- Loss and degradation of agricultural fields
- Excessive growth of weeds and invasive species competing with crops
- Prolonged periods of drought and floods
- Heatwaves that affect plant growth reducing crop productivity

1.3 Climate change adaptation and mitigation

Adaptation means anticipating the adverse effects of climate change and adjusting accordingly to minimise the risks and vulnerabilities that may arise. Mitigation refers to reducing emission of GHGs into the atmosphere such as embracing renewable energy and establishing forests to increase carbon sinks.

Table 1. Climate change adaptation and mitigation strategies

Adaptation strategies	Mitigation strategies
• Embrace crop and farm enterprise diversification. • Adjust crop cycle and planting time to the prevalent rainfall pattern • Water harvesting and conservation methods • Use of irrigation technologies • Use of climate-resistant and pest and disease resistant crop varieties. • Use of manure and environmentally friendly inputs • Empowering communities and building their capacities to adapt through creation of awareness and training	• Reduced use of chemical fertilisers • Afforestation and reafforestation • Use of renewable energy such as solar energy and electric motor vehicles.

TOPIC 2

SUSTAINABLE FARMING PRACTICES

2.1 Introduction to sustainable farming

Sustainable farming or agriculture is a farming system that aims to produce food in a way that preserves the environment, supports social well-being, and economic viability. It is an approach that takes into account the long-term impact of farming practices on the environment, society, and economy.

Sustainable agriculture should meet the following elements:

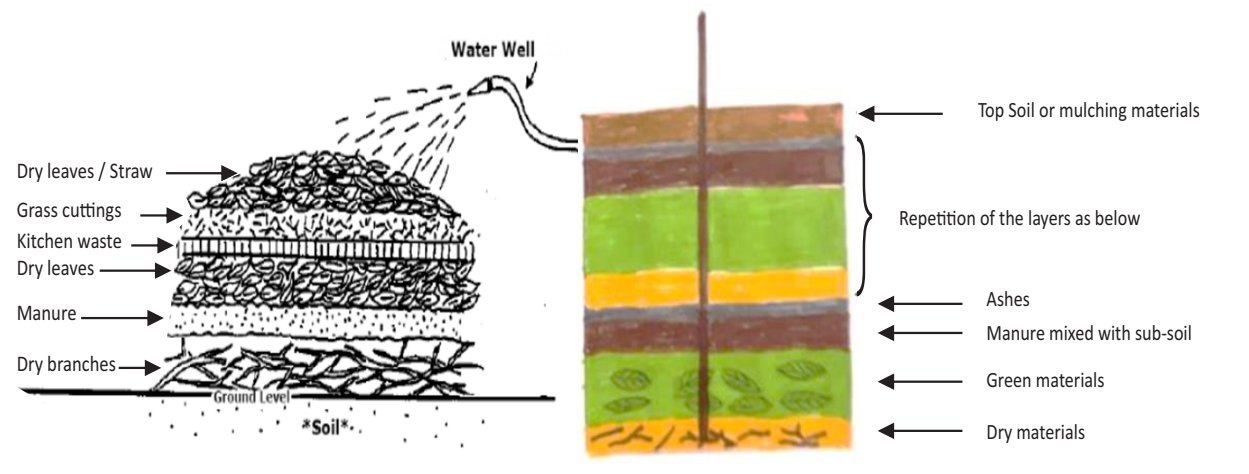
- Self-sustaining – reduced losses and all by-products recycled.
- Diversified – an appropriate of humans, animals and plants/crops
- The net yield per unit area must be maximized – appropriate tillage practices and soil fertility management techniques should be applied.
- Economically viable – real profits should be realised from adopted practices
  Aesthetically, socially and ethically acceptable

2.2 Sustainable farming practices

Sustainable farming practices include the following:

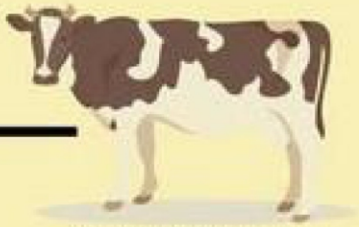
i. Soil fertility management

a) Compost or farm yard manure application – A compost is decomposed organic matter such as crop residue and/or animal manure that is used as "SOIL AMENDMENT". It improves the physical properties of the soil such as water retention rate, permeability of the soil, water infiltration rate, drainage rate, aeration rate and soil structure. All of these provide a better environment for roots of plants. Compost is already mineralized organic manure which makes the nutrient readily available for the plants to absorb.



1. Farmyard Manure (FYM)

Farmyard manure consists of dung, urine, and bedding material from livestock. It is rich in nutrients and improves soil fertility and structure.



-0,5% N, 0,2% P, 0,5% K

-0,5-1.5% N, 0,1-0,3% P, 0,3-1,2% K

2. Green Manure

Green manure refers to crops grown and plowed into the soil while still green. These crops add organic matter and nutrients to soil.

3. Compost

Compost is decomposed organic matter such as plant residues, kitchen waste, and yard debris. It improves soil structure and provides nutrients.

-1.3% N, 0,3-1% P, 1,2% K

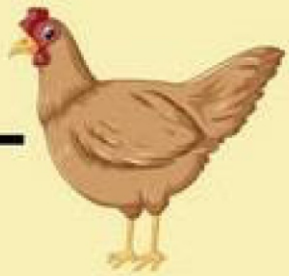
-1.5-2% N, 0,9-1,2% P, 1,2-1,5% K

4. Vermicompost

Vermicompost is produced through the breakdown of organic matter by earthworms. It enhances soil, aeration, drainage and nutrient

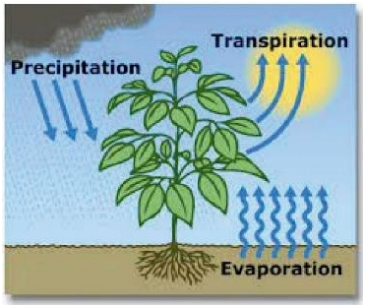
5. Poultry Manure

Poultry manure is the waste from chickens, including droppings and bedding material. It is high in nitrogen and phosphorus, benefiting soil andplants.



b) Mulching – covering of topsoil with plant materials such as leaves, grass and crop residues to control soil erosion, conserve soil moisture and as they decompose add organic matter into the soil.

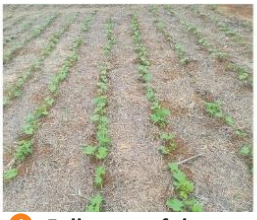
WHY?



Mulch

- Prevents evaporation of water
  - Preservation of soil moisture
  - Relevant in dryland environments
- Can prevent weed emergence
- Prevents surface run-off
- Increases soil organic matter when decomposed

HOW?



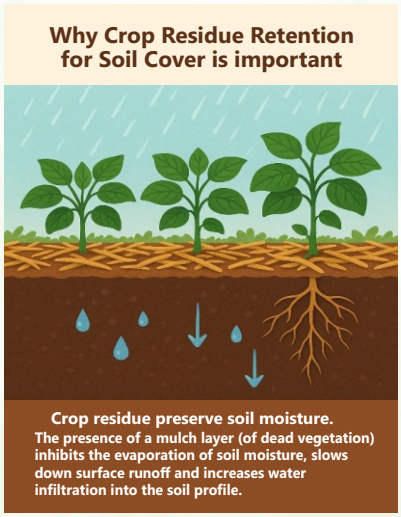
1 **Full cover of the ground**

2 **Mulch concentrated on the planting line**

WHAT TO USE?

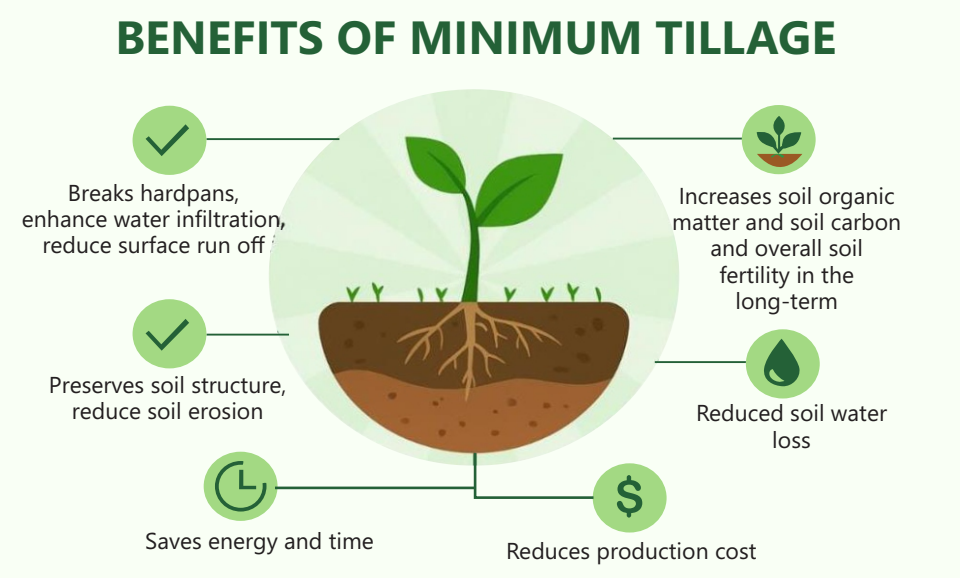
- Crop residues, especially from legumes (beans, peas, groundnuts ...)
- Branches and leaves from trees, shrubs Ex: Grevillea, Tithonia, Calliandra etc
- Grass
- Killed weeds
- ⚠ Don't use Eucalyptus or Pine

c) Crop residue retention – at harvest, leaves, stalks and straw are left on the field surface to protect the soil from erosion, retain moisture and suppress weeds



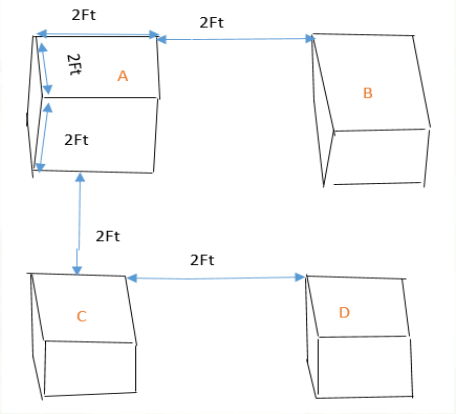
d) Minimum tillage – cultivation activities that cause minimum inversion of soil practices that keep the disturbance of the soil and loss of organic matter to a minimum, reducing soil and water losses. This principle focuses on minimal or little soil disturbance such that the soil is not ploughed or turned.

Continuous turning of the soil destroys its structure, eventually forming a hard pan that prevents water infiltration and proper crop root development.



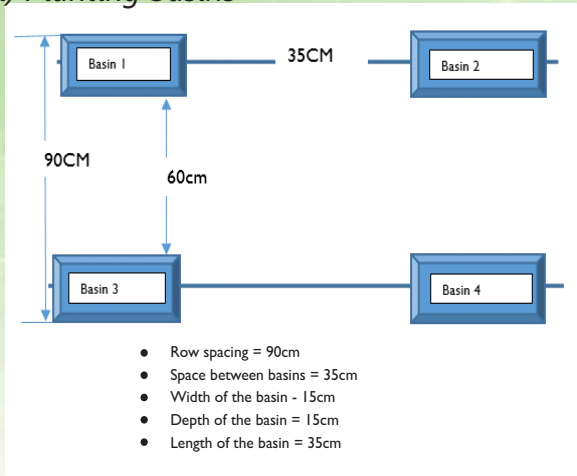
Example of minimum tillage cultivation activities

I) Zai Pits

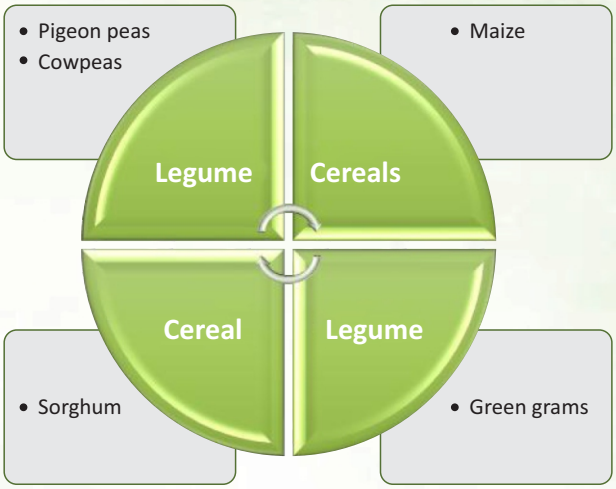


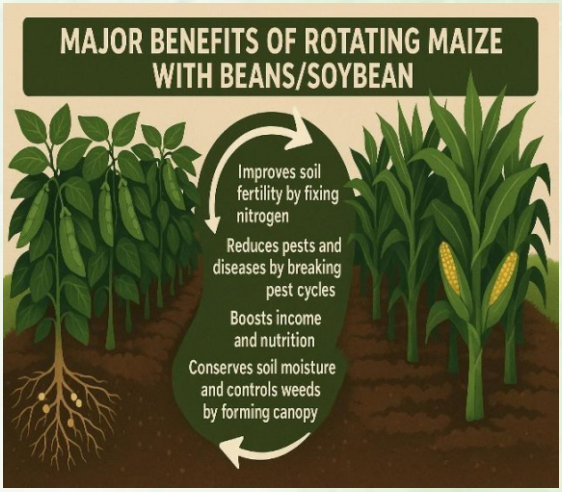
ii) Ripping

iii) Planting basins



e) Crop rotation – growing different crops sequentially on the same piece of land to optimize nutrient uptake and break pest and disease build-up



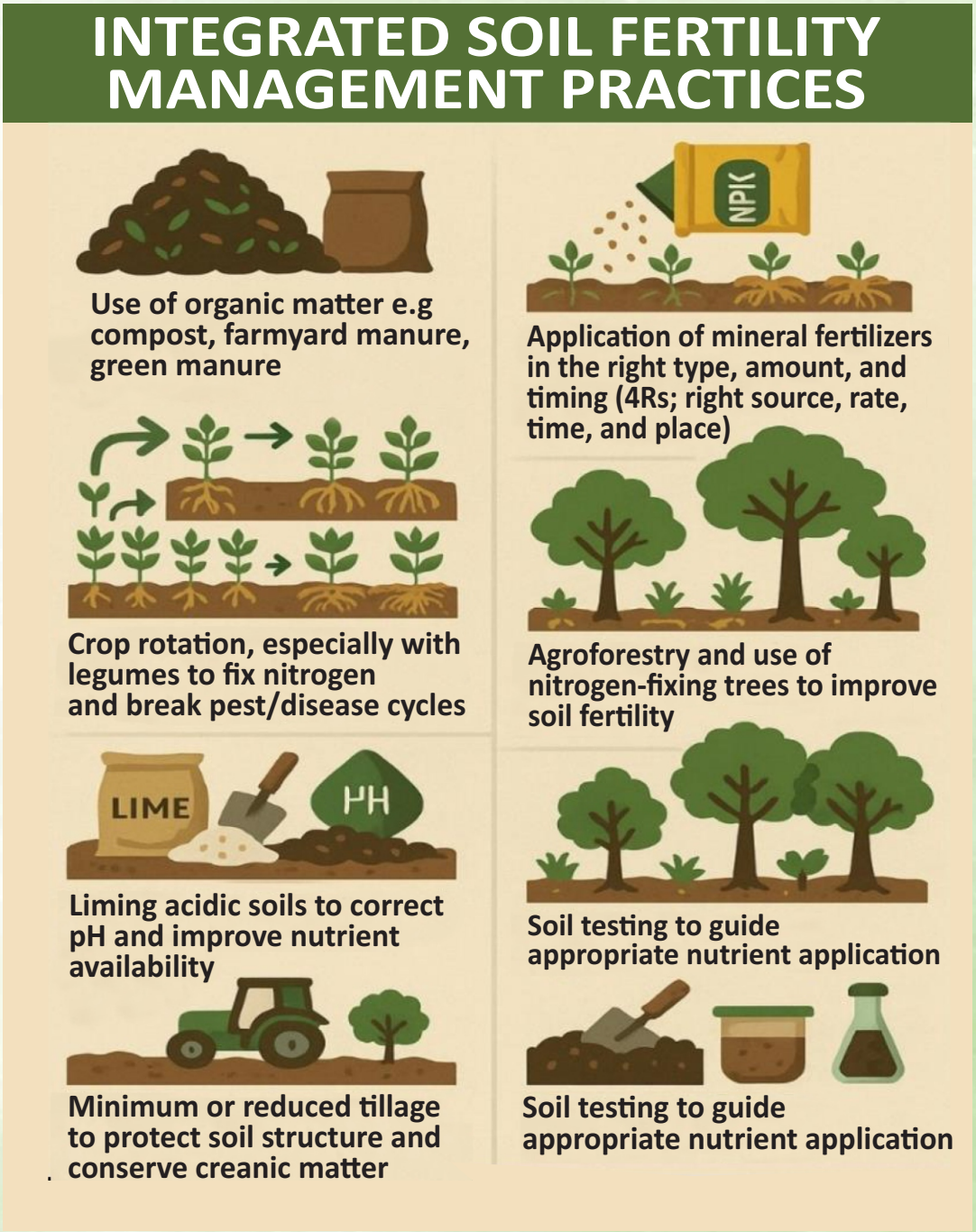


f) Intercropping – growing two or more crops on the same piece of land

g) Cover cropping – growing crops such as legumes and grasses to control soil erosion, weeds and pests rather than for harvest

Brachiaria grass – hailed as a climate smart wonder grass – makes a good cover crop and a highly nutritious "cut and carry" fodder

h) Integrated soil fertility management – combination of organic and inorganic soil fertility practices



ii. Soil and water management conservation structures

Practices that improve water conservation, efficiency, and availability in farming systems.

a) Terracing - establishment of step-like platforms on steep slopes to intercept runoff water, reduce soil erosion, and increase in situ water infiltration.

b) Contour farming – the practice of growing crops across the contours to reduce soil erosion

c) Water harvesting such as trenches/retention ditches - They catch and retain incoming runoff and hold it, enabling seepage into the ground.

Half-moon bunds (before intervention)

After Intervention

iii. Integrated Pest and Disease Management

Practices that manage pests and diseases using ecological and preventive approaches.

- Biological pest control – crop pests are managed using their natural predators instead of chemical pesticides.
- Use of resistant crop varieties – are tolerant to pests, diseases and drought
- Cultural pest management practices – involves interfering with pests and their life cycle through hand weeding, pruning, trapping and handpicking.

TOPIC 3
HOME GARDEN ESTABLISHMENT

3.1 Introduction to home gardens

A home garden is a plot of land located in or near a homestead, where a variety of crops are grown mostly for home consumption and generating income from sale of surplus produce. Common examples of African leafy vegetables include; black nightshade, amaranth spp., cowpeas, Ethiopian kales, spider plant, pumpkin, and jute mallow.

Importance of home gardens

- A reliable source of green leafy vegetables.
- Production of safe, fresh and affordable foods that is easily accessible at household level.
- Generates income from the sale of surplus produce.
- They act as a safety net during lean season when staple foods are depleted and before new crop is ready.
- It strengthens family bonds i.e. shared space and physical activity that encourage both children and adults to spend time together.
- Helps to save expenditure on the purchase of vegetables.
- Home gardening technologies use recycled materials like plastic containers hence contribute to environmental conservation

3.2 Types of home gardens

Home gardens can be set up in the following ways; sack mound, mandala garden/key hole garden, hanging garden, cone garden, banana trunk garden, tire garden, among others.

3.3 Nursery establishment and management

When establishing a vegetable nursery consider the following:

- Choose a well-drained, fertile, and sunny location with protection from strong winds and heavy rain.
- Loosen the soil to a fine texture for easy root penetration.
- Create raised nursery beds (1 meter wide, 3-5 meters long, and 15 cm high) by a mixture of soil and manure. The raised bed ensures proper drainage.
- Use high-quality, disease-free, and certified seeds.
- Sow seeds at the recommended depth and spacing for each crop.

Figure 3. Tire and mandala garden

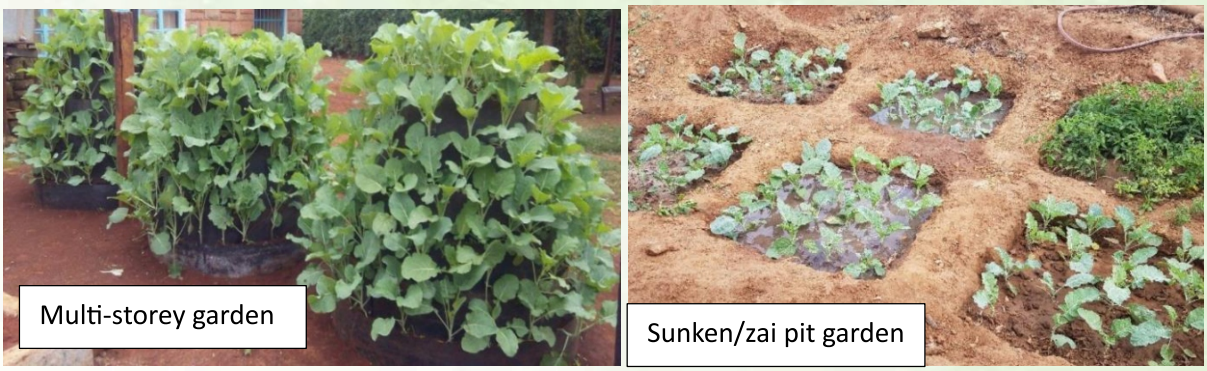


Figure 4. **Multistorey garden**

- Cover with a thin layer of soil and mulch with dry grass or straw to maintain moisture. Remove the cover upon germination of the seeds.
- Use a fine mist sprayer to avoid disturbing the seeds. Avoid water logging to prevent seed rotting.
- When seedlings reach the right size (4-6 weeks), carefully uproot and transplant them into the main field or containers

Additionally, the following measures should be maintained for optimum germination and healthy vegetable seedlings

- Use shade nets or poly tunnels to protect young seedlings from excessive sunlight, heavy rain, and pests. The site should be protected from animals by fencing.
- Use organic pesticides like neem oil to control pests.
- Remove any infected plants to prevent disease spread.
- Maintain proper air circulation to avoid fungal infections.
- Before transplanting, gradually expose seedlings to direct sunlight for a few hours daily.

TOPIC 4

AGROFORESTRY

4.1 Definition of agroforestry

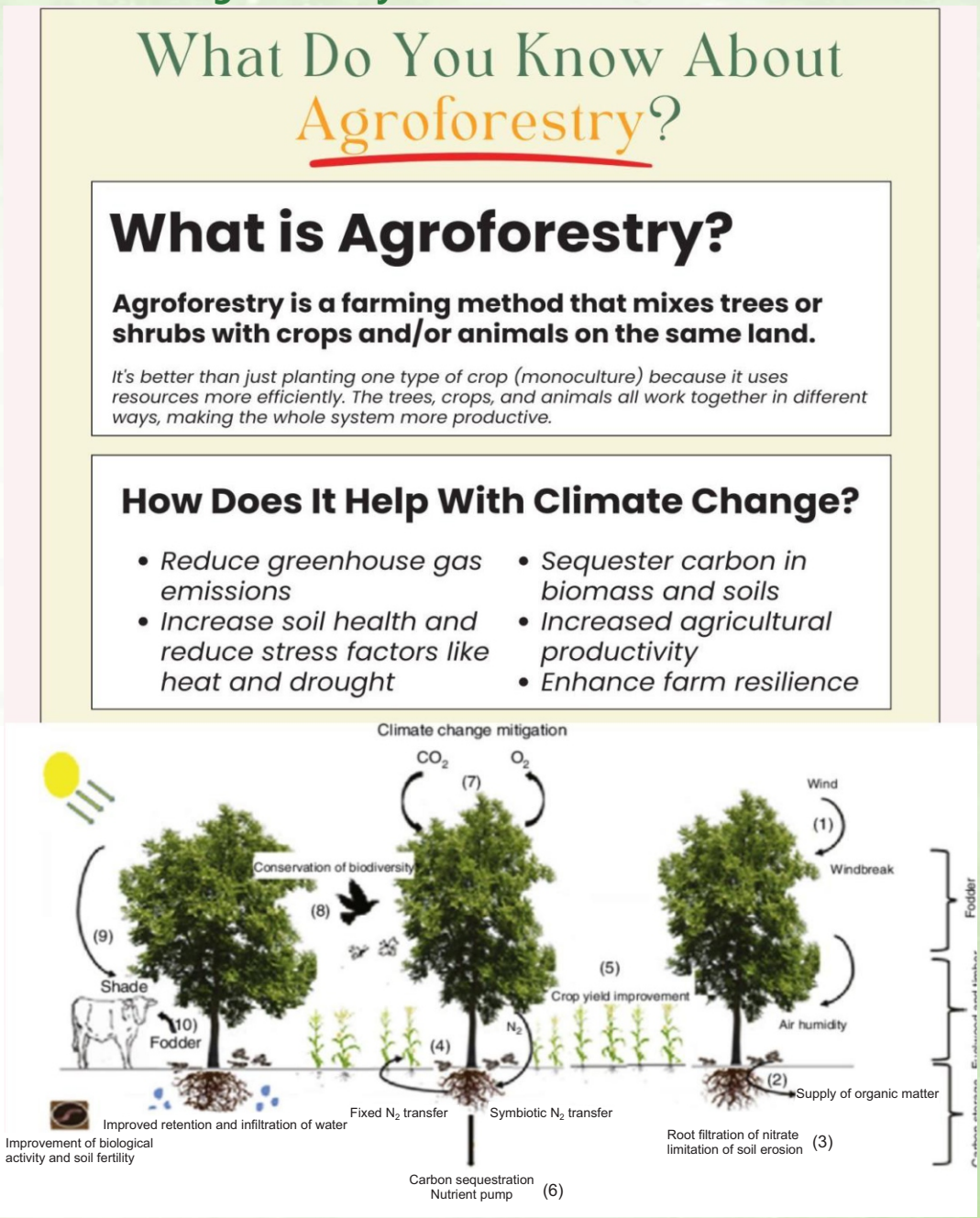


Figure 5. Diagram showing Agroforestry Systems

4.2 Selection of agroforestry trees

Trees are planted for various reasons and the choice of the agroforestry trees depends on;

i. The purpose – fruits, fodder, firewood and charcoal, timber, green manure or shade.
ii. The climatic conditions, soil type and altitude: different agroforestry trees are suited for various agroecological zones.
iii. The utility provided – the tree grown should have more than one use and offer a range of benefits.

4.3 Types of agroforestry trees

Common agroforestry trees include the following:

Table 2 . Common agroforestry trees

Tree Species	Common Name	Primary Uses in Agroforestry
Grevillea robusta	Silky Oak	Timber, poles, firewood, charcoal, furniture, shade, windbreaks, bee forage, mulch, soil conservation, fodder (low quality)
Sesbania sesban	Sesbania	Nitrogen fixation (soil fertility), fodder, firewood, poles, shade, soil conservation, medicine, veterinary uses, fibre, soap from leaves
Calliandra calothyrsus	Calliandra	Soil fertility improvement (leaf mulch), fodder, fuelwood, soil conservation (contour planting)
Gliricidia sepium	Gliricidia	Nitrogen fixation, green manure, fodder, biomass for mulch, shade, soil and water conservation
Leucaena leucocephala	Lead tree	Fodder, green manure, shade, biomass production (high nitrogen content)
Citrus spp., Mangifera indica, Persea americana	Citrus (oranges/ lemons), Mango, Avocado	Fodder, green manure, shade, biomass production (high nitrogen content)
Croton megalocarpus	Croton	Firewood, charcoal, poles, fuelwood, mulch, soil protection, boundary planting

4.4 Establishment of agroforestry tree nurseries

4.4.1 Site selection

The following factors should be considered when setting up a tree nursery: the number of plants to be grown, availability of market, accessibility for ease of transportation, the demand period, availability of water and availability labour (skilled and casual).

The ideal site should be:

- Gently sloping and well drained soil
- Easily accessible
- Constant supply of water
- Adequate supply of soil materials

NB: Avoid swampy areas, clay soils and hilltops

4.4.2 Tree nursery establishment

The following steps should be taken when establishing a tree nursery:

- Dig thoroughly the selected area (destroying any termite mounds), level and firm the soil.
- Mark out the shape and sizes of the beds
- Erect the beds using durable poles
- For the shade, one can use any local material available
- Erect rivets (sawn timber or poles) around the beds

4.4.3 Nursery management practices

The following are routine management practices recommended for a tree nursery:

i. **Watering** – regular water supply of clean water is required for optimum growth (avoid dirty and salty water as it may carry diseases). The amount of water required depends on the age of the seedlings, sunlight and wind exposure and the soil type.
ii. **Pot filling** – soil used to fill polythene tube should be moist and easily firmed. The activity should be done under a shade close to the site where the nursey bed shall be established.
iii. **Pricking out** – is the process of transferring young tender seedlings from a seedbed to polythene tubes or potting containers. Newly potted plants require full shade for 2 – 3 weeks and adequate watering
iv. **Weeding** – is the process of removing weeds to reduce competition for water and nutrients.
v. **Root pruning** – is cutting back actively growing roots of potted plants to avoid root inter-twining and establishment of the root system in the nursery.
vi. **Hardening off** – is the process of preparing seedlings for the planting season by reducing watering for 4 weeks prior to transplanting.
vii. Maintain good hygiene practices of the nursery site for heathy and high-quality seedlings.
viii. **Pest and disease management** – common pests and diseases are gall flies and damping off respectively. These can be controlled by providing adequate water to the seedlings. Timely control of any pests and diseases is also crucial to minimize spread and losses.

TOPIC 5

CROP PESTS AND DISEASE MANAGEMENT

5.1 Common pests and diseases in maize

5.1.1 Common pests in maize

The most common pests in maize include fall army worm, stem borers, cutworms, maize weevil and termites. Sustainable pests control measures include field hygiene, early planting, seed treatment, crop rotation, use of appropriate insecticides, and timely harvesting.

Figure 6. Common pests in maize

Figure 7. Common diseases in maize

5.2 Common pests and diseases in beans

5.2.1 Common pests in beans and their control measures

Common beans pests, shown in the figure below include bean fly, aphids, looper caterpillar, flower thrips, webworms, stink bug, and leaf beetle, among others. Control measures include appropriate synthetic and bio-pesticides, planting tolerant varieties, crop rotation, use of yellow stick traps, as well as use of neem products.

5.2.2 Common diseases in beans

Bean diseases include anthracnose, halo blight, web blight, Ascochyta leaf spot, septoria brown spot, fusarium rot, fusarium wilt, white mold, rust, target spot, among others.

Control and management measures include use of resistant varieties, certified seeds, crop rotation, seed dressing, reduce movement in the farm when the plants are wet, removal of infected plants/parts, proper spacing, mulching to reduce moisture stress, timely planting, and timely harvesting.

Figure 8. Common bean pests

5.3 Integrated pest and disease management

These involve the combination of cultural, biological, mechanical and chemical methods. They include;

- Planting pest and disease resistant varieties of crops.
- Diversification by planting more than one crop type/species on the farm to reduce build-up of pest and diseases.
- Use of cultural pest and disease control methods through crop rotation and mulching to break pest and disease cycle.
- Biological pest and disease control methods in the form of parasites or predators as natural enemies as well as repellent plants and organic chemical that are environment friendly.
- Scouting and mechanical destruction of pest and disease-infestation.
  Application of environmentally friendly pesticides for pest and disease control (bio-pesticides use).

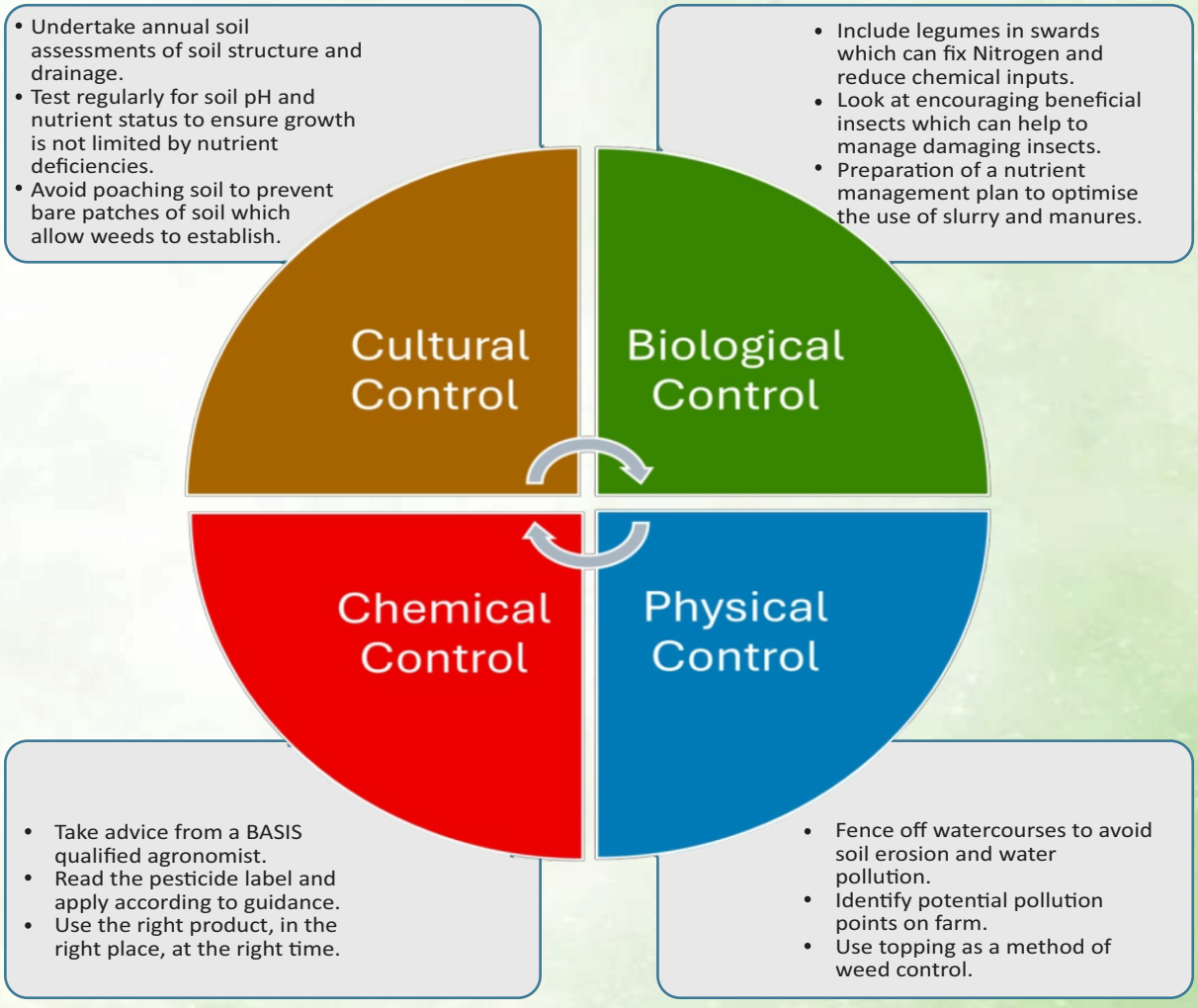


Figure 9. Benefits of Agroforestry

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