FORM THREE AGRICULTURE NOTES

CROP PRODUCTION IV

{FIELD PRACTICES (II)}

- There are many food crops grown in Kenya. These crops require different environmental conditions and are therefore found in different ecological zones in the country.
- Crops such as maize, beans and rice are grown as staple food crops. Other like millet, sorghum, cassava and sweet potatoes are mostly grown for food security.
  Examples of food crops grown in Kenya

I) MAIZE (*Zea Mays*)

-It is the staple food in most areas in Kenya. Maize is also a livestock food and produces oil and starch when processed in industries.

Ecological Requirements

- Altitude-2200m above sea level
- Temperature-medium
- Rainfall-medium

Maize is drought tolerant during the early stages of growth but must have enough rain during silking stage.

- Soil-maize prefers fertile alluvial or loam soils since maize cannot tolerate water logging.
  Soil pH should be neutral to alkaline.

Maize Varieties

Few pure varieties exist because farmers tend to grow the Hybrids and Composites, which are more productive. The Kenya Flat Complex is an example of the few pure varieties. It is however low yielding.

Hybrids are bred by crossing two pure lines or varieties under conditions of controlled pollination.

Composites are bred by growing a number of varieties together under uncontrolled pollination i.e. there is free inter pollination.

The hybrids and composites are produced for specific altitudes in the country. E.g.

- Kitale Hybrids-614, 622, 625, 626, 627 and 628 are grown in medium to high altitude zones.
- Embu Hybrids-511 & 513 are best for medium altitude zones.
- Katumani Composites- for lower altitude zones
- Coast Hybrids- Pwani Hybrid 1and Pwani Hybrid 4 for Coast Province.
- Others –Double cob DH01 & DH02

Selection and preparation of planting materials
Kenya Seed Company contracts specific farmers to grow maize for seeds. The maize is harvested and treated using *Thiram-dindane* to prevent post attack. Its then sold to farmers as seeds. Farmers should buy fresh seeds every planting season to escape the problem of reduced hybrid vigor.

Land Preparation

Land should be prepared early to allow the previous crop incorporated into the soil to rot. Disc or mould board ploughs are used to plough. Harrowing is done to obtain a fine tilth. Continuous cropping of maize should be avoided. It should be rotated with other crops such as beans, cotton, tobacco, Irish potatoes or groundnuts.

Field Operations

a) Planting

-Should be done early so that the crop can utilize the available moisture. Dry planting should be practiced in areas with short rainy seasons. Early planting increases yields and reduces attack by stalk borers. Seeds are planted shallowly in moist soils-2.5cm and deeply in dry soils-10cm.
Spacing is 20-30cm x 75-90cm where one or two seeds are placed per hole. However, spacing depends on the ecological conditions and the variety to be planted.
Small-scale farmers use hands to plant while tractor drawn planters are used on large scale.

b) Fertilizer Application.

100-150kg or DSP or DAP per hectare is applied during planting.

Top dressing is done when the crop is about 45cm high where 200kg of ASN or CAN is applied per hectare.

Top dressing can be done twice i.e. first when 45cm high and second one just before selling.

c) Weed Control.

Weeds should be controlled to reduce competition for moisture and nutrients. Two to three weeding are required during the growing period of the crop. Hand weeding is the commonest herbicides can also be used e.g. *Simazine, and Triazine* which are applied before the crop germinates and *MCPA & 2,4-D* which are applied after the crop has emerged.

d) **Pest and Disease Control**

1. PESTS

a) Field Pests

i) Maize stalk borer (***Buseola fusca***)

It's the larval stage of the moth and attacks maize from the early stages of growth by making holes in leaves. In older plants, caterpillars bore into the stem and cobs.

Control

-Early planting

-Rogueing

-Burning infected maize crop remains

-Use of pesticides e.g. *Endosulfan, Diazinon, Dipterex, Malathion and Stalk borer dust*

ii) Army worm ***(Spodoptera exempta*)**

They are also larvae of the moths. The caterpillars are greyish-green in colour with black stripes at the back and both sides. They eat the leaves causing defoliation such that only the midribs are left.

Control

-Use of chemicals e.g. *Malathion, Diazinon*

iii) Aphids **(*Rhopalosiphum maidis)***

The pest sucks sap from the green husks of cobs and leaves. Attacked husks and leaves appear blackish.

Control

Use of chemicals e.g. *Diazinon, Malathion* etc.

iv) Birds.

Mainly they eat the grains at the milking stage.

Control

-Scaring them away.

b) Storage Pests

i) Maize Weavi**l (*Sitophilus zeamais)***

It's the most serious storage pest of maize. It may also attack maize while still in the field. They make tunnels beneath the seed coat and circular holes on the surface of the grain.

Control

-Dusting with *Malathion.*

-Spraying methyl bromide onto the shelled maize

-Proper storage hygiene ie sweeping and removing old crop.

ii) Red flour Beetle **(*Tribolium castaneuum)***

Are small reddish-brown beetles, which feeds on flour and broken grains.

Control

-Proper storage hygiene

iii) Rats ***(Rattus rattus)***

-They attack fallen or stoked maize in the field. They are more serious however in the store.

Control

-Use of rat proof stores

-Use of cats.

-Use of traps

-Use of poisoned baits

-Bush clearing around the store.

2. DISEASES

i) White Leaf Blight**.**

It's a fungal disease caused by a fungus called *Helminthosporium turcicum*

It causes oval gray and thin lesions on the leaves.

Control

-Planting resistant varieties**.**

ii) Maize streak

-Caused by virus spread by grasshoppers. The disease causes yellow longitudinal stripes, which run parallel to the mid rib.

Control

-Use of certified seeds

-Early planting

-rogueing

iii) Rust

Disease is caused by *Puccinia sorghi* and *Puccinia polysora*

The disease forms red or brown spots on the leaves.

Control

-Planting resistant varieties

ii) Smut

-It's a fungal disease caused by *Ustilago zeas*. The disease destroys grains and tassels causing masses of black powder.

Control

-Crop rotation.

HARVESTING MAIZE

-The period between planting and harvesting varies depending on the variety and altitude.

-The stalks are cut and stoked in the field to allow the cobs to dry properly.

-Cobs are then removed by hand and placed in the store.

-Harvesting can also be done using combine harvesters.

-The grains should be dried completely to 12% moisture content before storage.

-Yields-3,00kg-4,500kg/hectare.

Storage

-Maize can be stored on cobs or it can be shelled and stored in bags

-The store should be properly constructed to keep out moisture and pests.

-Proper store hygiene should be observed to prevent losses through pests, diseases and other damages.

-Proper drying of the grains reduces chances of the grains rotting and minimizes the extent of insect damage.

Marketing

-Farmers sell their maize grains through the National Cereals and Produce Board.

-Local trading in green and dry maize is also common.

II) FINGER MILLET (*Eleusine coranaca*)

Finger millet has small seeds which dry out quickly and insects cannot fit inside them.
It's an important cereal crop in Western Kenya and Uganda.

Ecological Requirements

-Rainfall-about 900mm annually. Millet can tolerate drought in the early stages of growth but after the first month it requires a good supply of moisture.
-Altitude-0-2400m above sea level.
-Soils-should be fertile and well drained.

Varieties

-Ultra lupin
-5.18 OATS. Both are high yielding and resistant to lodging and blast.

Selection and Preparation of Planting Materials

-Harvested grains are sun dried, threshed, winnowed and then stored for use as seeds
-Certified seeds can also be bought from the Kenya seed Company.

Land Preparation

-Seedbed should be thoroughly prepared to obtain a fine tilth since the seeds are very tiny.
-Weed control is also very difficult in millet hence thorough seedbed preparation reduces weed competition.

Field Operations

a) Planting

-Should be done as early as possible in the season. The earlier it is sown the higher the yields.
-Planting is usually done broadcasting hand.
-If planted by rows, the furrows should be 30cm apart and the plants should be thinned to 5 cm apart within the rows.

b) Weed Control.

-This is done manually because finger millet is very close and jembe cannot be used.

-Thorough seedbed preparation reduces the labour required for weeding
-The most common weeds are the *Eleusine africana* and *Eleusine indica* (wild finger millet). They are difficult to distinguish from the crop in the early stages of growth.

c) Fertiliser application.

-125kg of Sulphate of Ammonia is applied when the crop is 15cm high.

d) Pest and Disease Control

i) Pests

-Finger millet is rarely destroyed by pests in the store because of the small size of the grains.
-Major pests in the field are the birds and are controlled by scaring them.

ii) Diseases

-Most serious disease is the head blast caused by a fungus called *Pericularia oryzae*
-The disease is common under hot and humid conditions e.g. in Western Kenya.
-The disease cause brown spots with grey centres on the leaves and the stems just below the inflorescence.

Control

-Planting resistant varieties.

Harvesting

-Hand knives are used for cutting individual heads. Heads are then dried, threshed and winnowed.

Yields

-1650kg/hectare can be obtained with good management practices.

Storage and Marketing

-Grains are dried and stored in bags.
-Mainly it's grown for subsistence and only a little is sold in local markets.

III) BULRUSH MILLET ***(Pennisetum typhoides)***

It's one of the small cereal crops cultivated in lower parts of Meru, Kirinyaga and Embu districts. Also cultivated in Kerio valley and parts of Machakos.

Ecological Requirements

Rainfall-500-600mm p.a. Bulrush millet is drought resistant and takes a short time to mature.
Altitude-1200m above sea level hence warm climate.
Soils-should be well drained.

Varieties

Severe 26/19, 17, 26/9, 6A, 2A and 3A.

Land Preparation

Land should be prepared early to give the soil enough time to settle and form a firm seedbed. A fine seedbed is required since the seeds are tiny.

Field Operations

a) Planting

-Planting is commonly done by broadcasting followed by a shallow cultivation before the onset of the rains.
-Spacing should be 60cm x 15cm where rows are used.

b) Weeding

The field should be maintained weed free until tillering occurs. Hand weeding is commonly done.

c) Fertiliser Application.

Sulphate of Ammonia can be applied at the rate of 200kg/hectare when the crop is 30cm high.

d) Pest and Disease Control

i) Pests**.**

-Main pests in the field are quelea, weaverbirds and bishop's birds.
-These destroy the grains when they are in the milking stage onwards.

Control

-Scaring them.

ii) Diseases.

- Downy Mildew

-A fungus called *Sclerospora graminicola* causes disease
-Causes whitish lines on the leaves

Control

-Planting resistant varieties.
-Destroying crop remains.
-Crop rotation.

- Rust.

-Caused by a fungus called *Puccinia penniseti*
-It causes pustules that develop on the leaves

Control

Planting resistant varieties

- Ergot

-Caused by a fungus called *Clavicepts microcephala*
-Affected heads become sticky

Control

-Planting certified seeds
-Crop rotation
-Destruction of infected crop residue.

Harvesting

-It's done by cutting the heads with a knife or sickle when they have dried.
-Threshing is done by beating the dry heads on the ground

Yields

Up to 1000kg/hectare can be obtained under good management**.**

Storage and marketing

-After threshing, the grains are winnowed and dried up to 14% moisture content and then stored in bags.
-Millet is mainly grown for subsistence and is sold locally.

IV) SORGHUM ***(Sorghum vulgare)***

-It is an important cereal crop in Kenya. It is grown in Western and Northern Rift Valley, Eastern and some parts of Central province.
-Sorghum can be rattooned. Sorghum grains are ground for flour, which is used for making porridge or for brewing.
-Young growing crop may be used as direct animal feed or may be used to make silage.

Ecological Requirements

-Rainfall-420-630mm p.a.
-Sorghum is drought resistant since it has a well-developed rooting system and has the ability to roll the leaves during hot weather.
-Altitude-0-1500m above sea level. At higher altitudes, poor yields are obtained and pests and diseases attack the crop.
-Soil-the crop requires fairly fertile and well-drained soils.

Varieties

i) Dobbs

It was selected in western Kenya. It's suitable for areas around Western Kenya. The seeds are brown and mature in about 4 months.

ii) Serena

Was obtained by crossing Dobbs with a variety from Swaziland. It has brown seeds and matures in about 3 ½ months.

Selection and Preparation of Planting Materials

Seeds are prepared by threshing the dry heads, winnowing and seed dressing.

Field Operations

a) Planting

–Normally done by broadcasting the seeds on a firmly prepared seedbed.

-Spacing is 60cm x 15cm if planted in rows.

b) Fertilizer Application.

-Fertilizers not commonly used. However, crop responds well to farmyard manure on moist soils

c) Weeding.

The field should be kept weed free.

d) Pest and Disease Control.

a. Pests

Birds

-Are the major pests e.g. *Quelea quelea aethiopica* (Sudan dioch), weaverbirds, bishop's bird, starling etc.

Control

-Planting resistant varieties, e.g. the Goose necked varieties.

-Killing the birds using flame throwers, explosives or poison sprays in their breeding colonies.

N/B some sorghum varieties have a natural quality, which keeps birds away such as persistent bitter tasting coats.

Sorghum shoot fly. (*Antherigona varia)*

The adult lays eggs on the underside on the leaves. The eggs hatch into larvae, which enter the funnel, and move down to feed on the young stem.

Control

-Early planting.

-Use of insecticides

-Closed season.

Stem borers

There 3 main species of stem borers attacking sorghum. These are:

Buseola fusca

Chillo zonellus

Sesamia calamistis.

Control.

-Use of insecticides.

-Proper disposal of crop residue/remains after harvesting.

b) Diseases

Sorghum is attacked by both leaf and inflorescence diseases.

Examples of leaf diseases

-Leaf blight *(Helminthosporium turcicum*.)

-Anthracnose *(Colletotricum graminicola)*

-Sooty stripe (*Ramulispora sorghi)*

General control

-Growing resistant varieties.

Examples of inflorescence diseases

Loose smut *(Sphacelotheca cruenta)*

Head smut *(Sphacelotheca reiliana)*

General control

Seed dressing.

Harvesting

-Sorghum is ready for harvesting 3-4 months after planting.

-Heads are cut off using a sharp knife after which they are sun dried.

-Dried sorghum is then threshed, winnowed and stored.

Yields

-500-1500kg/hectare and up to 3000kg under good husbandry.

-Sorghum can be rattooned for one or two seasons.

Marketing

-Crop is marketed through the National Cereals and Produce Board.

-Private buyers also purchase sorghum directly from farmers.

V)BEANS **(*Phaseolus vulgaris*)**

-Are used to provide with proteins. They are grown for the dry seeds or for the green pods. Beans can be intercropped with other crops like maize and cassava.
-Beans are annual legumes with varying growth habits. E.g. some varieties are determinate bush type (non-spreading) and others are indeterminate type (spreading type)
-Beans are about 99% self-pollinated.

Ecological Requirements

- Soil

-Should be well drained and rich in organic manure. Beans do not tolerate waterlogged soils.
-The soil should be moist.

- Rainfall

-Should be moderate. Heavy rainfall is destructive at the flowering stage. Rain should be present during harvesting time, as this would cause rotting and sprouting of the beans. Beans for green pods are produced under irrigation.

Varieties

-Varieties for production of dry bean seeds

- Rose coco, (GLP 2)
- Mwezi moja (GLP 1004)
- Canadian wonder (GLP 24)
- K 74
- Wairimu
- Mexican 142 developed in Tanzania. It is suitable for canning, drought resistant, rust resistant, early maturing and high yielding.

-Varieties for green pods production. (*French Beans)*

- Long tom
- Saxa
- Master piece
- Monel.

Selection and Preparation of Planting Materials

-Beans are established from seeds. The seeds should be dried before they are planted. Damaged and wrinkled seeds should be discarded during seed

selection. Selected seeds should be dressed with appropriate chemicals to control soil borne pests. Seeds should be inoculated with the right strain of *Rhizobium*.

Field Operations

a) Planting

-Beans should be planted at the onset of rains. 2-3 seeds are placed per hole at a spacing of 30cm x 15cm. DAP fertilizer should be applied at a rate of 200kg/hectare along the furrows before planting. The seed rate is 50-60kg/ha.

b) Weeding

-The field should be kept weed free by shallow weeding. Weeding should be done before flowering to avoid knocking down the flowers. Weeding is done when it is dry to avoid spreading diseases.

c) Irrigation.

-Beans for green pod production are grown during the dry months. They therefore need about 50mm of water per week. This is supplied through overhead irrigation or furrow system of irrigation.

d)Pest and Disease control.

i) Pests

-They include aphids, American bollworm, bean fly, spotted borer, golden ring moth etc.

Control

Spraying with insecticides such as *Dieldrin, Dimethoate, Diazinon, and Formathio*n etc.

ii) Diseases.

-They include Bean rust, Anthracnose, Halo blight and angular leaf spot.

- Bacterial (Halo) blight**.**

Caused by a bacteria called *Pseudomonas phaseolicola*

Disease causes brown water soaked lesions on the pods. Each brown spot is surrounded by a yellow band or 'halo'. The disease is seed borne and can be spread by rain, which could splash the bacteria on to the healthy plant parts.

Control

-Planting healthy seeds.

-Rogueing

-Crop rotation

-Spraying with *copper oxychloride.*

- Anthracnose.

Disease is caused by a fungus called *Colletotricum lindemuthianum.*
It causes brown lesions on pods and stems and brown spots on leaves.

Control

-Growing resistant varieties e.g. K74 and Wairimu.
-Use of clean seeds.
-Seed dressing with *Captan*
-destroying infected crop residues.
-Spraying with *Benomyl, Copper fungicide* or *Mancozeb* during the wet season.

Harvesting

Beans for seeds are harvested by uprooting the dry plants. Uprooted beans are gathered on tarpaulins/canvas, mats or sacks to allow them to dry further before threshing.
When the plants are dry enough, they are beaten with sticks to remove the seeds from the pods.
The stems and the pods are removed before winnowing. Sorting should be done after winnowing to remove damaged seeds.
Dry clean seeds are treated with appropriate pesticide and packed in bags.

Marketing

-Is done through NCPB

Yields

-2600kg/ha under good management
For the green beans (French beans), harvesting of the pods starts about 9 weeks after planting and continues for about two months.
Pods should be packed immediately after picking to avoid shrivelling.

Yields

-4-5 tones/ha under good management.

V) RICE ***(Oryza sativa)***

-Rice is a cereal crop and is used as a staple food in some parts of Kenya.
-It is grown at Mwea Tebere irrigation schemes in Kirinyaga district, Ahero irrigation scheme in Nyando district and Bura irrigation scheme in Tana River district and Yala swamp in Siaya district.

-Mwea is the largest rice-growing project in Kenya with over 5,600 hectares.

Land Preparation

-Rice growing fields are levelled and bunds constructed around them for controlling water.

-Tractor drawn rotavators are used to work the flooded fields before transplanting.

Field Operations

a) Water control.

The level of water is increased from the very low level of about 5cm at planting time gradually to a height of 15cm by the time the seedlings are fully grown. Water should be allowed to flow slowly through the fields.

b) Fertilizer Application

Sulphate of Ammonia should be applied at a rate of 25kg per each nursery unit measuring 18.5cm x 18.5cm before sowing.

DSP fertilizer is broadcasted in the field at a rate of 125kg/ha before transplanting and 125kg/ha 40 days after transplanting.

c) Weed Control.

Flooding easily controls weeds. Uprooting can be done on the few weeds that persist.

Herbicides can be used e.g. *Butachlor* and *Propanil.*

HARVESTING OF VARIOUS INDUSTRIAL CROPS

CROP	Method and Procedure of Harvesting	Precautions During Harvesting
Cotton (Matures 4 months after planting)	-Done by picking manually. -Seed cotton is sorted into 2 grades i.e. (Safi) & BR (fifi). -AR is free from insects and is clean white -BR may not have all the required qualities.	-Foreign matter e.g. leaves should not be mixed with seed cotton. -Picking shouldn't be done when its wet -Sisal bags should not be used as their fibres may mix with seed cotton.

Pyrethrum (Ready for picking 3-4 months after planting)	-Flowers are picked selectively. -Only those with horizontal petals are picked. -Picking interval is 14-21 days -Flowers are picked by twisting the head so that no stem is attached	-Picked flowers should be put in open woven baskets. -Wet flowers shouldn't be picked. -Tins and polythenes should not be used because they cause the flowers to ferment hence low *pyrethrin content*. -Flowers should not be compacted
Sugarcane (Takes 12-20 months to mature)	-Cane should be cut at the ground level. -Tops are removed and leaves are stripped. -Harvesting is done using the cane harvesting matchet. -Best quality cane should have uniform sugar distribution.	-Harvested cane should be delivered to factory within the first 24 hours. -Delay reduces the sugar content in the canes.
Coffee (Matures after 3-5years. It takes 8-9 months from flowering to the maturation of the berries)	-Red ripe berries are picked by hand. -Diseased ones are later sorted out. -Any dry, undersized or green ones are dried & are referred to as Buni. -During peak period, coffee is harvested once a week.	-Picked berries should be delivered to the factory immediately. -Delay leads to reduced quality.
Tea (Takes 2-4 years to	-The two top leaves and the bud are picked. ---These leaves have the highest caffeine content. -A plucking stick is used to	-Leaves should not be compressed. -Plucked tea must be kept cool under shade.

commence picking depending on how its brought to bearing and the altitude	maintain the plucking table. -Plucking interval is 5-14 days depending on the season. -Plucked tea is put in woven baskets, which allow free movement of air.	-Plucked tea should be taken to the factory the very day of plucking.

FORAGE CROPS

These are plants, which grow naturally or are planted by man and are used as livestock feed.

PASTURES

A pasture is the land on which the forage crops *are grazed on directly.*

Aspects of pasture

a) Pasture classification
b) Pasture establishment
c) Pasture management
d) Pasture utilization.

A) PASTURE CLASSIFICATION

Pasture can be classified in three main ways.

i) According to the pasture stand
ii) According to pasture establishment
iii) According to the Ecological zones.

i) Classification on Basis of Pasture Stands.

The pasture may be either pure stand or mixed stand.

Pure stand pastures have either grass or legumes on them. In mixed pastures, grasses and legumes are grown together.

ii) Classification based on Establishment.

Under this category, pastures are classified as Natural and Artificial.

- Natural pastures.

These are grasses and legumes grow naturally and extensively for both domestic and wild animals. Over 80% of Kenyan pastures are natural. They are mainly mixed stand pastures.

- Artificial pastures.

These are pasture grasses and legumes planted by man purposely for livestock feeds. Mostly they are of high quality.

iii) Classification on the basis of Altitude (zones)

Under this category, pastures can be classified as:

- High altitude pastures (grasses & legumes)
- Medium altitude pastures
- Low altitude pastures.

High Altitude Pastures

They are found at high altitudes of 25500m above sea level and above. They are green showing vigorous growth throughout the year. They are suitable for dairy and sheep farming. Examples:

Grasses

Common Name	Botanical Name
1. Kikuyu grass	*Pennisetum clandestinum*
2. Nandi setaria	*Setaria sphacelata*
3. Molasses grass	*Molinis minutiflora*
4. Giant setaria	*Setaria splendida*
5. Rhodes grass	*Chloris gayana*

Legumes

Common Name	Botanical Name
1. Kenya white clover	*Trifolium repers*
2. Louisiana white clover	*Trifolium semipilosum*
3. Subterranean clover	*Trifolium subterrianeum*
4. Lucerne	*Medicago sativa*

Medium Altitude Pastures

These are pastures found between 1500-2500m above sea level. This altitude favours beef, goat, sheep and dairy farming.

Examples of grasses in this zone.

Common name	Botanical Name
1. Rhodes grass	*Chloris gayana*
2. Nandi setaria	
3. Star grass	*Cynodon dactylon*
4. Makueni guinea	*Panicum maximum*
5. Congo signal	*Branchiaria yuziziiensis*
6. Malara guinea	*Panicum coloratum*
7. Giant Setaria	
8. Guatemala grass	*Trysacum laxum*

Examples of legumes in this zone.

Common Name	Botanical Name
1. Lucerne	***Medicago sativa***
2. Silver leaf desmodium	***Desmodium uncinatum*.**
3. Green leaf desmodium	***Desmodium intortum.***
4. Siratro	***Macroptilium atropurpureum***
5. Stylo	***Stylosanthes guiyanensis***

Low Altitude Pastures

These are pastures found in marginal areas of Kenya below 1500m above sea level which receive little rainfall. In such areas, indigenous livestock such as camels, donkeys, cattle, sheep and goats are kept.

Examples of grass pastures in this zone include:

Common Name	Botanical Name
1. African fox tail	*Cenchrus ciliaris*
2. Maasai love grass	*Eragrostis superba*
3. Likoni guinea	*Panicum maximum*
4. Makarikari grass	*Panicum coloratum*
5. Red oat grass	*Themeda triandra*
6. Hyparrhenia (thatch grass)	*Hyparrhenia rufa*
7. Giant star grass	*Cynodon plectostadyns*
8. Bothriochloa	*Bothriochloa insulpa*
9. Para grass	*Branchiaria mutica*
10. Andropogon	*Andropogon spp*
11. Cymbogon	*Digitaria decumbeus*

Examples of legumes found in this zone.

Common Name	Botanical Name
1. Stylo	*Stylosanthes searbra*
2. Glycine	*Glycine wightii*
3. Centro	*Cenrosema pubescens*

OTHER PASTURE CROPS

Weed Grasses

Common Name	Botanical Name
1. Couch grass	*Digitaria scalarum*
2. Nut sedges	*Cyperus species*
3. Sporobolus	*Sporobolus spp.*

Fodder shrubs

1. Leucaenia *Leucaenia leucocephala*
2. Atriplex *Atriplex spp*.

B) PASTURE ESTABLISHMENT

Pasture can be established by use of seeds, rhizomes or splits.

i) Selection of Planting Materials.

Planting materials selected should be;

- Of high nutritive value.
- Adapted to the prevailing environmental conditions.
- Fast growing in order to give a good ground cover which will help to control soil erosion.
- Able to give high herbage yield per unit area.

ii) Land Preparation.

- Land should be ploughed and harrowed to a fine tilth.
- Land preparation should be done during the dry season before the onset of the rains.

iii) Seed Rates

Recommended seed rate for pasture grasses is 1.5-2.0kg/ha of pure germinating seeds. The seeds are produced by Kenya Seed Company. And are sold in two lots

- High quality seeds with 13-25% pure germinating seeds. (PGS)
- Standard quality seeds with 12.5% PGS.

Legume seed rate depends on the seed size i.e. 2-3kg/ha for medium sized seeds e.g. Desmodium and Lucerne and 2kg/ha for tiny seeds e.g. clovers.

iv) Fertilizer Application**.**

- SSP fertilizer is applied at a rate of 200kg/ha for grasses and legume mixtures
- For pure grasses, NPK 20:20:0 at a rate of 200kg/ha is recommended.

v) Legume Seed Inoculation

- This is the addition of effective Rhizobia to leguminous seeds before planting to promote nitrogen fixation.
- This is done in areas where soil is deficient of nitrogen.
- Some Rhizobia strains are naturally found in the soil at pH 5.5-8.0 with adequate calcium, phosphorous, potassium and rainfall.

Examples of Rhizobium strains.

Crop	Rhizobium Species
o Lucerne	Rhizobium melioti
o Clovers	Rhizobium trifoli
o Beans	Rhizobium phaseoli.

vi) Sowing.

Since most seeds are small, they should be covered lightly after broadcasting. The following are the methods of sowing.

- Direct sowing
- Under sowing
- Over sowing.

Direct Sowing.

>This is the establishment the pasture in a clean seed bed where no other crops are growing

Under Sowing

>This is the establishment of a pasture under a cover crop usually maize.

>Maize is planted and weeded 2-3 weeks after the onset of the rains.

>Pasture seeds are broadcasted with the recommended amount of fertilizer.

>No further weeding is done

>Maize is harvested early to expose the young seedlings to sunlight.

Over Sowing

>This is the establishment of a pasture legume in an existing grass pasture.

>The grass pasture is kept short until the pasture legume is well established.

>SSP fertilizer is applied at the rate of 200kg-400kg/ha.

>The mixed stand pasture should be ready for light grazing 4-5 months after planting.

C) MANAGEMENT OF PASTURES.

i) Weeding

Weeds should be controlled as they cause the following;

- Reduce the lifespan of pastures.
- Compete with forage crops for nutrients, moisture and sunlight.
- Reduce the quality of the Herbage yield.

- Some may be poisonous to the animals e.g. Datura.
- They interfere with forage fertilization.

Weed Control measures on pastures

- Timely land preparation which ensures clean seedbed with less subsequent weed problem.
- Slashing.
- Application of selective herbicides e.g. 2,4-D.
- Uprooting the weeds if scattered.

ii) Top Dressing.

This is the application of plant nutrients after the pasture has established for the following reasons.

- To add/replenish soil nutrients and ensure proper nutrient balance.
- To increase the herbage yield
- To improve the nutrient value of the crop.
- To enable the soil micro organisms to breakdown organic residues into available nutrients
- To correct or amend both physical and chemical properties such as soil structure and moisture holding capacity.

N/B The choice of topdressing fertilizer depends on the crop and soil nutrient status.

-Inorganic fertilizers are better for top dressing materials than organic manures because they release their nutrients faster.

-Pure grass pastures require large amounts of nitrogen and potassium.

-Grass-legume pastures require phosphorous, potassium, calcium and sulphur for nitrogen fixation.

iii) Topping**.**

-This is the removal of the stemmy fibrous material left over after a period of pasture grazing.

-The removal of such material stimulates fresh growth.

-Topping should be done at the onset of the rains and should be followed by topdressing.

-Topping is done through slashing, mowing or burning.

iv) Reseeding.

This is also called gapping and it's done when pasture is partially denuded or bare. Refilling the gaps does it.

v) Controlled Grazing**.**

Some pastures are seriously affected by heavy grazing such that herbage production is low. Grazing has therefore to be controlled through tethering, strip grazing or paddocking.

vi) Pest Control

Just like any other crop in the farm, pasture crops are also attacked by pests. The most common pest is the mole which makes underground tunnels destroying roots of pasture crops hence killing them. These are controlled by

- Use of cats (Biological method)
- Rodenticides (Chemical control)
- Traps (Physical/mechanical method)

D) **PASTURE UTILIZATION**

FORAGE QUALITY

- The quality of forage declines with age. I.e. there is gradual decline in the amount of soluble sugars, starch, proteins, organic matter and digestibility with age.
- Crude fibre is not digestible in the normal enzymatic process but only through the activities of microbes in the rumen.

Frequency of Defoliation.

- Defoliation refers to grazing in pastures and cutting for feed in fodder crops.
- Frequency of defoliation therefore refers to how often the forage stand is grazed or cut for feed.
- It's important to determine the proper defoliation frequency for a particular forage.

Effects of Very Early Defoliation (Less than Four weeks.)

- The forage has very high moisture content (90%)
- The forage has very high protein content on weight basis.
- Has very low Dry Matter content hence very low DM yield.
- It has high DM digestibility but low in digestible nutrients.
- Has low crude protein yield.

- Frequent early defoliation leads to a gradual weakening of the stand followed by empty patches, weed invasion and an eventual reduction in the productive life of the stand.

Effects of Late Defoliation. (More than Ten week

- The forage has high DM content hence high DM yield
- Has high cellulose content hence it's woody and fibrous.
- It has high lignin, cutin, tannin and silica content which are all insoluble.
- It has low crude protein content.
- It has low leaf: ratio
- It has low dry matter digestibility

NB/ during grazing, it's necessary to do paddocking for the following reasons.

- To control grazing and ensure sufficient re-growth before grazing is resumed.
- To ensure better forage utilization and less wastage by trampling, fouling and selective grazing.
- To facilitate conservation of excess pasture in form of hay or standing forage.
- To maintain a favourable grass-legume balance where applicable.

Carrying Capacity and Stocking Rate

Carrying capacity is the ability of the forage stand to maintain a particular number of livestock units per unit area. This depends on the herbage yield and the animals' daily requirements.

Stocking rate refers to the number of the animals maintained per unit area of land.

In order to determine the carrying capacity and the proper stocking rate for a particular forage stand, dry matter (DM) yields per unit area per unit time and live weight of the animals to be fed are considered.

Example

A dairy animal consumes 2.5kg dry matter for every 100kg body weight per day.

- The amount consumed by a jersey weighing 400kg live weight per year would be

2.5X 400/100 X 365/1000=3.65 tons DM

- A Guernsey weighing 450kg would consume
  2.5 X 450/100 X 365/1000=4.1 tons DM
- Likewise, an Ayrshire weighing 500kg live weight would consume,
  2.5 X 500/100 X 365/1000=4.65 tons DM.

NB/ when the stocking rate is above the carrying capacity of the pasture, it is referred to as overstocking. And when it is below the carrying capacity it is referred to as under stocking.

Some Recommended Stocking Rates on Different Pastures

Grass	Dm yield/ha/year (tonnes)	Carrying capacity (Livestock Units/Ha)
Napier grass	25 - 30.0	5 - 7
Rhodes grass	10.9 - 15.2	2.5 - 3.5
Nandi setaria	11.4 - 13.9	2.5 - 3.0
Makueni guinea	9.9 - 15.9	2.5 - 3.5
Star grass	5.3 - 9.1	1.3 - 2
Kikuyu grass	4.3 - 14.3	1.0 - 3.0

Effects of overstocking

a) Insufficient regrowth period for the forage hence effects similar to those of very early defoliation.
b) Overgrazing and loss of soil cover leading to soil erosion.
c) Invasion of undesirable plant species especially weeds and shrubs.

Intensity of defoliation

This refers to proportion of the herbage removed through grazing and that of the residual forage. Pastures should be grazed until about 70% of the aerial herbage is eaten up i.e. about 5cm is left.

GRAZING SYSTEMS

There are three main grazing systems

- Rotational grazing
- Continuous grazing

- Zero grazing

1) Rotational Grazing

This refers to practice of allowing livestock to feed on a part of pasture for a period down to certain level before they are moved to the next. This gives time for pasture to properly regenerate.

Advantages of Rotational Grazing

a) Livestock make maximum use of pasture
b) Reduces the buildup of parasites and diseases.
c) Animal waste is distributed evenly in all fields/paddocks.
d) Pasture area is given time to re-grow before its grazed on again.
e) Excess pasture can be harvested for conservation
f) Its possible to apply fertilizers in parts of the pastures are not in use
g) It facilitates reseeding and weeding.

The methods of rotational grazing include paddocking, strip grazing and tethering.

a) Paddocking

- A paddock is a fenced portion of a pasture in which animals are restricted for grazing.
- Paddocking means grazing livestock in one paddock for a short period and then moving to another.
- The size of the paddocks depends on the carrying capacity of the pasture.
- There should be a watering point at each paddock.
- A water trough is placed between two paddocks so that animals can drink water from either paddock.
- Paddocking saves herding labour. However, it is very expensive to construct.

b) Strip Grazing

-This is done by allowing livestock to graze on restricted portion of the pasture at a time then moving them to the next.

-It's done on very high quality pastures. Electric fences can be used to enclose animals in a given strip of pasture. -Where animals are not many

herding may be done to restrict them to stay within the strips. Temporary fences may also be used instead of the electric fences.
-However, the system is quite expensive.
c) Tethering.
-This involves tying the animal to a post with a rope such that it feeds within a restricted area.
-The rope may also have a metal ring that slides along a strong wire supported by strong poles.
2) Continuous Grazing (Herding)
In this type of grazing, the pasture is not allowed any resting period. This method can easily result in overgrazing if the stocking rate is not controlled. It's common in the semi-arid areas.
3) Zero Grazing (Stall Feeding)
-This is the practice of rearing animals in a permanent feeding enclosure known as the stall. Feed is cut and taken to the animals in the stalls.
-They are also provided with plenty of clean water and mineral licks.

Advantages

- There is quick accumulation of manure
- Animals make use of the feeds without wastage
- Animals produce high yields due to less wastage of energy.
- It's easy to control diseases and parasites
- It requires little land
- It allows higher stocking rate

Disadvantages

- High initial capital is required
- High management skills are needed
- Need a lot of labour
- Diseases can easily spread.

FODDER CROPS

-These are forage crops which are grown, allowed to mature the cut and given to livestock as feed. Animals are not allowed to graze on them directly because they easily degenerate.
-The fodder can also be conserved and sold if produced on large scale.

-They include; Napier grass, Guatemala grass, Sorghum, Columbus grass, Sudan grass, Edible Cana, Kales, Kenya white clover, Marigolds (Sugar beets), Lucerne, Desmodium and Agro-forestry trees and shrubs.

1.NAPIER GRASS. ***(Penisetum purpereum*)**

There are two main varieties of Napier grass i.e. The French Cameroon and Bana Grass.

- French Cameroon It has thin stems and less hairy
- Bana Grass Has thick stems and its hairy.

a) Ecological requirements.

i) Soils

-Should be well drained though it does well in a variety of soils**.**

ii) Rainfall

- 750 mm p.a which should be well distributed.

iii) Altitude.

-Preferably 2100m above sea level.

iv) Temperature

-Optimum 24ºC -29ºC

b) Establishment and management

i) Land preparation.

Should be done early during the dry season. Furrows are made at a spacing of 90-100cm. Alternatively; holes can be dug at a spacing of 90cm x 50cm. 7-10 tons of well decomposed organic manure is applied.

ii) Planting.

Planting materials should be selected from desirable varieties of napier grass. Materials should come from healthy and mature plants. Stem cuttings or splits are used. Stem cuttings should have 2-3 nodes.

-Stem cuttings should be placed in the furrows in a slopping manner.

-NPK (20:20:0:) should be applied at rate of 200kg/ha.

iii) Fertilizer application

Topdressing with nitrogen and potassium fertilizers should be done about 6-8 weeks after planting.

iv) Weed Control.

Weeds should be removed as early as possible during the early stages of development. Methods of control include,

- Use of herbicides e.g. 2,4-D

- Cultivation
- Slashing
- Up-rooting.

v) Defoliation.

French Cameroon matures in about 3 months. There after it should be cut every 6-8 weeks. The grass should be about 1.2-1.5m high at the time of harvesting.

Bana Grass grows up to 12 months without flowering. Defoliation should be done when there is high yield digestible matter.

vi) Utilisation.

Stems should be cut 2.5-5.0 cm abo0ve4 the soil surface to facilitate fast re-growth. A panga is used to cut. Excess napier is conserved as silage for future use. Cut forage is chopped into smaller pieces by use off a chaff cutter or a sharp panga.

vii) production per unit area.

Under good management, Napier grass gives a yield of up to 35 tons of dry matter (DM) per hectare per year. This contains 8-15% crude protein and this is enough to support 5 milking cows per year.

2. GUATEMALA GRASS **(*Trypsacum laxum).***

It's a tall hardy, broad leafed grass with a vigorous growth.

a) **Ecological Requirements.**

i) Altitude

-Up to 2000m above sea level.

ii) Soils

-Does well in a variety of soils.

iii) Rainfall.

-900mm p.a. that should be well distributed.

b) Establishment and management.

i) land preparation

-Should be done early before the start of the rains. Land is ploughed and harrowed to a medium soil tilth removing all the perennial weeds.

ii) Planting

-Its established from cuttings or from splits. Furrows are made at a spacing of 1m apart. Splits are planted at about 0.5m apart within the rows.

-Holes can also be used.

iii) Fertilizer application.
-During planting NPK (20:20:0) is applied at a rate of 150kg/ha.
Topdressing is done using nitrogenous fertilizers when the grass is 6-8 weeks old. Topdressing should be done after each harvesting subsequently.
iv) Weed Control**.**
The field should be kept weed free especially for the first few months of establishment. This is done by

- Uprooting
- Use selective herbicides
- Slashing
- Cultivation

v) Defoliation
It can be harvested at 8-12 weeks of age.
vi) Utilization.
Its chopped and fed to livestock as green fodder. Its suitable for stall feeding.
vii) Production per unit area
Yields are about 12 tons per hectare of dry matter per year. This can support 2-3 cows comfortably.

3. SORGHUM ***(Sorghum alum)***
There are two main varieties of sorghum grown in Kenya. i.e.

i) Columbus grass (*Sorghum alum)*
ii) Sudan grass (*Sorghum Sudanese*)

a) Ecological Requirements
i) Rainfall
650mm per annum which should be well distributed through the year.
ii) Altitude
Below 2100m above sea level.
iii) Soils
Grows in a wide range of soils
b) Establishment and Management
i) Land Preparation
Should be done early before the onset of the rains. A fine tilth should be obtained.

ii) Planting
Seeds are used and they are drilled or broadcasted. NPK (20:20:20) is applied at the rate of 200kg/ha during planting for proper root growth and development.
iii) Fertilizer Application.
CAN or ASN is top dressed at the rate of 125kg/ha
iv) Weed Control
Field should be kept weed free. This is done by hand cultivation, slashing or use of selective herbicides.
v) Utilisation.
Grass lasts in the field for 18 months. During this period, the grass is harvested several times. It regenerates after every cutting. Columbus grass should be left to dry for two days before feeding to the animals to avoid *Prussic and Hydro cyanic acid poisoning.* This poison is found in wet grass.
Production Per Unit Area
-20 tons per hectare of dry matter (DM) per year under in good management.

4.KALES **(*Brassica spp)***
They supply succulent nutritious stems and leaves for feeding livestock.
a) Ecological Requirement

- Soils should be loam or clay
- Rainfall > 1000mm
- Altitude prefer high altitude.

b) Establishment and Management.
Seeds are planted in nurseries 6 weeks before the rains. Land should be prepared to a fine tilth. Holes are dug at a spacing of 1mx0.3m.
Transplanting is done at the onset of rains. DSP fertilizer is applied at a rate of 150kg/ha when transplanting. The field should be kept weed free.
c) Utilisation
Leafy stems are cut, chopped and given to livestock. Kales should be fed to milking cows together with dry roughages since they are succulent. About 15kg of kale is needed by animal per day. It should be given to the milking cows after milking to avoid tainting the milk.
d) Production per unit area

Kales produce 35-50 tons fresh weight per hectares per year. Kales are quite rich in protein.

5. EDIBLE CANNA. (***Cana edulis***)
It's a fodder crop with broad shinny leaves which are used to feed livestock**.**
a) Ecological Requirement

- Rainfall-should be adequate
- Altitude-1500-200m above sea level
- Soils-should be fertile

b) Establishment and Management.
Land is cleared, ploughed and the harrowed. Holes are dug at a spacing of 1m x 1m. Farmyard manure is mixed thoroughly in holes before planting. Rhizomes are planted at the onset of rains. Early weeding is done. Crop is top dressed 4 weeks after planting with nitrogenous fertilizer at the rate of 100kgN/ha.
c) Utilisation
Edible canna is cut and fed to livestock when fresh. Each lactating cow should be given 4-7kg of canna per day during the dry seasons.
d) Production per unit area
Edible canna produces about 100tons DM/ha/year

6. SUGAR BEETS/MARIGOLDS ***(Beta vulgaris)***
These are root fodder crops that are quite nutritious.
a) Ecological Requirements.

- Rainfall-more than 1000mm
- Altitude- should be high
- Soils –should be well drained.

b) Establishment and Management
They are established through seeds. Seeds are planted in nurseries 6 weeks before the rains. Land is cleared, ploughed, and then harrowed to a medium tilth. Holes are dug 1.0m x 0.3m. DSP is applied at the rate of 150kg/ha at planting time. The field should be kept weed free through cultivation, uprooting, slashing or by use of appropriate herbicides. Topdressing is done using CAN or ASN at the rate of 100kg/ha.

c) Utilization.
They are used for feeding livestock during the dry season at the rate of 22-27kg/cow/day. They are chopped into small pieces. They should be wilted first because their fresh leaves have oxalic acid which can be poisonous.
d) Production per unit area.
Marigold produces between 30-40tons/ha of herbage under good management.

7. KENYA WHITE CLOVER ***(Trifolium semipilosum.)***
It has slender spreading stems which produce roots and underground rhizomes.
a) Ecological requirements
- Altitude-2500-3000m above sea level
- Soils- should be well drained with a pH of 5.5

b) Establishment and Management
It's established from seeds. Seed are mixed with a nitro-culture and broadcasted in moist soils. It can also be over- sown with other pastures e.g. Nandi setaria and Rhodes grass.
c) Over-sowing
Clovers can be over-sown as indicated above.
d) Inoculation
It's the addition of the effective bacteria to the clover seeds before planting to promote the nitrogen fixation especially when grown in mixed stands.
e) Fertilizer Application
Phosphatic fertilizers can be applied.
f) Utilization.
Pasture should be harvested and the taken to the animals. Direct grazing should not be done, as clovers do not withstand frequent heavy grazing.

8. LUCERNE ***(Medicago sativa)***
It's a leguminous plant. It is also known as alfalfa.
a) Ecological Requirements
- Soils – should be well drained with a pH of 5.5 and above.
- Altitude – should be high.

b) Establishment and Management
Lucerne is established through seeds. The land is cleared, ploughed, and harrowed to a fine tilth. The seeds are inoculated by coating them with Rhizobia. Seeds are broadcasted at the rate of 5-10kg/ha. DSP fertilizer should be applied at the rate of 125kg/ha during planting.
c) Utilization.
Lucerne is fed to livestock as hay since freshly harvested Lucerne causes bloat. It's fed in small quantities mixed with grass hay.
d) Production per unit area
Lucerne produces between 7-11tons DM per hectare with a crude protein of 17-20 %.

9. DESMODIUM.
It's a climbing perennial herb with slender stems and trifoliate leaves. It fixes nitrogen on its own.
There are two varieties of desmodium;

- Silver leaf desmodium (*Desmodium unicinatum*)
- Green leaf desmodium (*Desmodium intortum)*

a) Ecological Requirements.

- Altitude-1200-1800m above sea level
- Rainfall-should be adequate
- Soils-should be well drained

b) Establishment and Management
i) Land preparation
It should be done before the onset of the rains and all the perennial weeds should be removed. The land should be ploughed and harrowed to a fine tilth since the seeds are very tiny.
ii) Planting.
About 1kg of Desmodium seeds are planted per hectare.
iii) Weed Control
Seedbed should be kept weed free. Weeds can be controlled by cultivation, uprooting and use of selective herbicides.
Iv) Fertilizer application.
Phosphatic fertilizers are applied at the rate of 125kg/ha during planting.

d) Utilization.

When harvesting, about 25cm ground cover should be left. It should be cut and wilted before feeding to the livestock. It's used to feed animals in the gestation period because of high crude protein content.

10) AGRO-FORESTRY TREES/BUSHES USED AS FODDER CROPS.

There are several species of shrubs used as fodder crops. They include:

- Leucaenia
- Calliandra
- Atriplex
- Sesbania

Shrubs are either intercropped with other crops in the field or incorporated with pasture crops.

a) Ecological Requirements

- *Leucaenia leucocephala* prefers medium altitude and a rainfall of 1500mm p.a.
- *Calliandra calothyrasus* prefers high altitude areas.

b) Establishment and Management

They are established through seeds. Seeds are first raised in nurseries. Seedlings are transplanted at the onset of rains. Weeding should be done. Fertilizers can also be applied.

c) Utilization.

Leaves and branches are cut and given to the animals directly. Cutting should not be done until the shrubs are 3-4m in height. Shrubs are cut back to a height of 0.5m above the ground once per year and at the beginning of the rains. Green seeds pods produced are removed and fed to animals, as they are very rich in proteins.

Other importances of shrubs

- Improve the soil through nitrogen fixation e.g. leucaenia and calliandra
- Their roots hold soil particles together thus controlling soil erosion.
- Their fallen leaves decay adding organic matter into the soil.
- Some provide with wood fuel especially the tree species

d) Production.
Under good management, the shrubs give a considerable herbage yield for the livestock especially the browsers.

FORAGE CONSERVATION

In Kenya, there is always excess forage during the long and short rains (April to June and November to December) and a shortage during the dry months of January to March and September to October. There is therefore the need to conserve the excess forage as its often wasted or not fully utilized.

Reasons for conserving forage.

- To distribute available forage for animals throughout the year.
- To provide feed for the dry season.
- To ensure better and full utilization of available land.
- On a large scale, conserved forage can be sold as hay etc

Methods of conservation

a) Hay-this is dried forage mainly pasture grasses and legumes e.g. desmodium and Rhodes grass.
b) Silage-This is an-aerobically fermented forage mainly applicable to succulent fodders such as Napier grass, maize and sorghums.
c) Standing forage- Growing forage can be set aside for dry season feed and applicable for both pasture and fodders.

A) HAY MAKING

Hay refers to forage which has been dehydrated to about 15-20% moisture content. The forage should be cut when about 50% of plants have flowered.

Steps followed in hay making

i) The crop is cut when about 50% of the plants have flowered
ii) The crop is spread out evenly on the ground to dry for 2-3 days. It should be dried under controlled conditions in order to retain its nutritive value and the original crop colour.
iii) The hay is windrowed and the gathered or baled.
iv) The bales of hay are then stored in a shed out of reach of rainwater and sunshine.

NB/ Rapid drying is recommended to ensure high quality hay. Slow drying results in oxidation of soluble carbohydrates hence poor quality. Prolonged exposure to sun results in the breakdown of chlorophyll and carotene.

Factors determining the quality of hay.

- Forage species used.
- Stage of harvesting hence stem: leaf ratio.
- Length of the drying period
- Weather condition during the drying process
- Condition of the storage structure

B) **SILAGE MAKING**

Silage is a fodder crop harvested while green and kept succulent by partial fermentation in a silo. A silo is the structure used for fermenting. The process of silage making is called ensiling. The objective of ensiling green forage is to preserve the material with minimum loss of nutrients.

Advantages of silage making

- More nutrients are preserved
- It has few field losses
- It is less dependent o n weather conditions
- It can be preserved for prolonged periods with minimum loss of nutrients.
- Once ensiled, there are no storage problems.
- It can be fed directly without liquid additives.

Disadvantages of silage making

- Requires skills and much attention.
- Labour intensive hence expensive
- Bulky to store and handle
- Susceptible to ensiling losses
- Must be fed soon after removal
- Most farmers cannot spare sufficient forage for ensiling.

Types of Silos

i) Trench Silo

It is the most popular and applicable to small-scale farmers. It's a rectangular trench on a slightly slopping ground to ensure proper drainage.

ii) Clamp silo

It's constructed above the ground level in form of a trough with slanted sides for ease of compaction. Each side of the silo is made of a pair of timber walls. There is a gap between each pair of timber walls. Soil is put and compacted in these gaps. Between the two pairs of walls is the part where ensiling is done. A clamp may also be made of two stone walls and a cemented floor.

iii) Bunker/Tower silo

A bunker silo is made of concrete under the ground and has vertical walls suitable for mechanical ensiling. A tower is a tall round metallic structure for mechanical ensiling.

Steps followed in silage making

a) Silo is prepared before harvesting crop. The shape and size of the silo depends on the amount of forage to be ensiled.
b) The crop is cut at the appropriate stage and wilted for 6-12 hours to about 65-75% moisture content.
c) The crop is chopped up and put into the silo compacting it every 10-12cm layer.
d) Silo should be filled as rapidly as possible. The ensiled material should have a 'Ridge' or humped in appearance when ensiling is completed.
e) Temp in the silo should be checked regularly during the ensiling period. If the temperature is higher than 32.2^{o}c water should be added and compaction reduced. If temperature is below 32.2^{0}c, compaction should be increased and dry materials or molasses added.
f) The ensiled material is covered with a polythene sheet or a layer of dry grass to protect it from water and air.
g) The silo is covered with a thick layer of soil maintaining the 'ridge' appearance.
h) A trench is then dug all round the silo to drain off rainwater.

Principles of Conservation

Rapid ensiling and compaction reduces aerobic respiration in the ensiled material. When the silo is finally sealed, the oxygen is cut off and aerobic respiration gradually gives way to fermentation. This allows lactic acid bacteria (*Lactobacillus spp*) to increase very rapidly within the first three to four days after silo sealing. Lactic acid bacteria act on the readily available

carbohydrates to produce lactic acid and some amounts of Acetic, Propionic, Formic and Succinic acids. Lactic acid reduces the pH of forage from 4 to 2 or below. Low pH inhibits further bacterial growth and preserves the silage. The ensiling process is complete in 2-3 weeks depending on the quantity of ensiled material and may be preserved for many years provided the silo is water and airtight.

USES OF ADDITIVES

Maize and other cereal crops do not need additives if they are harvested at the right stage. (Soft dough stage). Other plants e.g. Napier grass and other grasses have low amounts of carbohydrates and often give poor quality silage. They therefore need additives of,

a) Crushed grains at a rate of 100kg per ton of silage or
b) Molasses at 20-40kg per ton of silage evenly distributed at the time of ensiling.

Silage Quality

The relative proportions of organic acids in the silage is an indication of its quality. In good quality silage, the order of predominance should be; lactic, acetic, succinic and formic acids. Poor silage compaction leads to low temperature which results in excessive production of Butyric acid instead of Lactic acid. Good quality silage should be,

a) Be from high quality forage cut at the proper stage of growth.
b) Have 5-9% lactic acid
c) Have a pH of 4.2 or below.
d) Be free from moulds and bad odour such as ammonia and butyric acid.
e) Be greenish to yellow in colour not brown or black
f) Have a fine texture with no sliminess.

Silage losses

- Surface spillage- up to 20% loss due to exposure and contact with soil.
- Seepage losses- extent of this loss increases with increase in herbage moisture. It can be up to 50% in very young and succulent forage.
- Gaseous losses- extended respiration results in loss of carbohydrates in form of carbon dioxide. The silo should be airtight.

How to Calculate Silage Requirement in Dry Matter

A cow requires 3kg of DM for every 100kg of body weight per day.
Therefore a cow weighing 400kg will require 400/100 x 3 = 12kg of DM per day Since Silage has 40% DM
Then for the cow to have 12kg DM it needs 12/40 x 100= 30kg of silage per day.
However, a cow should only get 50% of its daily Dm requirements from the silage.
It should get the other 50% from pastures and other feeds. It should therefore get only 15kg of silage per day.
If the silage is meant for the dry season, the farmer should estimate the length of the dry period. E.g. from January to March there are 90 days.
Therefore, silage required for one cow for 90 days will be;
90days x 15kg/day = 1350kg of silage (1.35 tons)
One hectare of Napier produces about 80 tonnes of forage harvested in five cuttings in the year. One cutting therefore yields
80tons/5 cuttings = 16 tonnes of forage.
If 1ha produces 16 tonnes of forage
Then x hectares produces 1.35 tonnes of silage
1 ha----------16 tonnes
X ha----------1.35 tonnes
X = 13.5/16
= 0.084 hectares (840m^2), approximately a space of 30mx30m
Silage density is about 500kg/m^3. If a farmer has two cows, the amount needed is
2cows x 15kg x 90 days = 2700kg
The volume of the silo to accommodate 2700kg would be approximately 6m^3
The silo would therefore have the following dimensions.

- 2.7m length x 1.5m width x 1.5m depth or
- 3m x 2m x 1m or
- 4m x 1.5m x 1m

C) **STANDING FORAGE**

This is the cheapest, easiest and most commonly used method of fodder conservation. This implies deferring cutting of the forage for the dry season

feed. It however produces herbage of low quality but it can be supplemented by addition of additives. The fodder or the legume should be cut, weeded, and top dressed in early November after which cutting is deferred until it is required.

LIVESTOCK HEALTH III

Introduction.

A disease is any alteration in the state of the animal or its organs which interferes with the proper [performance of its functions. The visible signs of a disease are called symptoms. There are specific conditions that help in observing the disease symptoms. They include:

- Pulse rate and respiration rate
- Temperature
- Body condition
- Visible mucous membranes
- Skin of the animal
- Defecation
- Urination
- Feeding habit. /appetite
- Level of production

Micro-organisms such a protozoa, bacteria, virus and fungi, cause diseases. Poor nutrition, physical injuries, chemical poisoning and parasite infestation cause other diseases. Organisms such as ticks and tsetse fly only help in spreading disease-causing organisms and are referred to as vectors.

Disease predisposing factors

These are conditions inside or outside the animals' body, which lead to the animal contracting a disease or injury. They include:

- Age of the animal
- Sex of the animal
- Colour of the animal
- Change of climate/environment
- Heredity
- Environment

- Overcrowding
- Physiological conditions such as fatigue, weakness, pregnancy etc.
- Animals encountering sick animals.

Terms used in livestock diseases

1.) Incubation period

It's the duration between the time of infection and the time the first symptoms show up.

2) Mortality

This is the likelihood of death occurring in case of a disease outbreak. It's expressed as a % of the affected animals and those which die.

3) Treatment

It's the application of physical and chemical means to an animal to help it recover from a disease or preventing it from getting a disease. There are two types of treatment.

- Preventive treatment
- Curative treatment

Preventive treatment

This involves administration of drugs to prevent the occurrence of a disease. This can be done through **vaccination** and **administration of prophylactic drugs** such as coccidiostats to prevent coccidiosis. The creation of immunity and resistance to diseases is under the preventive treatment.

Curative treatment

A curative treatment tries to restore a sick animal to good health. This can be done through:

- Good feeding
- Provision of clean environment
- Neutralizing the ill effects of the disease
- Inducing repair to damaged tissues
- Relieving discomfort or injury to the animal
- Preventing further spread of the disease.

4) Immunity

This is the ability of an animal to resist the infection of a disease.

There are two types of immunity –**natural** and **artificia**l immunities.

`a) Natural Immunity

It's the ability of an animal to maintain itself free from infection. It's the inborn immunity. It can further be divided into two.

- **Actively acquired immunity.** This immunity is acquired when an animal suffers from a disease. Such an animal is able to defend itself from the same disease in future.
- **Passively acquired immunity-** this is passed through the mothers blood to the foetus or through milk/ colostrums.
-

b) Artificial immunity

It can also be divided into active and passive

CLASSIFICATION OF LIVESTOCK DISEASES

Livestock diseases are classified into four major groups.

- Protozoan diseases
- Bacterial diseases
- Viral diseases
- Nutritional diseases

1. PROTOZOAN DISEASES

Diseases in this category include:

- East coast fever (ECF)
- Anaplasmosis
- Coccidiosis
- Trypanosomiasis (Nagana)

i) East Coast Fever

Animals attacked- mainly cattle

Causal organism-

Theirelia parva- a protozoan transmitted by the brown ear tick (Rhipicephalus appendiculatus).

The disease is also called *Theireliosis* its incubation period is 15 days.

Symptoms

- Swollen lymph nodes
- High temp-fever
- Excess salivation
- Lachrimation-a lot of tear production
- Difficulties in breathing due to fluid accumulation in the lungs.
- Coughing
- Sight impairment
- Haemorrhages in the vulva and the mouth.

Control and Treatment

- Ticks should be controlled through dipping, spraying or hand dressing regularly.
- Farm should be fenced to keep out strange animals and also to confine animals within.
- Treatment using appropriate drugs.

ii) Anasplasmosis (Gall sickness)

Animals attacked – cattle, sheep, goats,

Causal organism-

Anaplasma marginale, a protozoan transmitted by the blue tick (*Boophilus decolaratus)*

It can also be transmitted through contaminated surgical equipments, bleeding and hypodermic needles.

The incubation period is 3-4 weeks

Symptoms

- Fever
- Constipation-hard dung
- Paleness in the gums, eyes and lips. An indication of anaemia.
- Milk flow into the udder ceases.

Control and Treatment

- Tick control
- Control of biting insects e.g. mosquitoes
- Injection using antibiotics
- Iron injection.

iii) Coccidiosis

Animals attacked- poultry, calves, young rabbits, kids, lambs.

Causal organism

A protozoan called *Coccidia* of the *Eimeria species*

Each species of the animal is affected by specific coccidia. Coccidia infects the lining of the alimentary canal.

Incubation period in poultry is about 7 days but in cattle, it may take up to 4 weeks.

Symptoms

- Diarrhoea
- Dysentery- blood in the dung
- Emaciation
- Ruffled feathers in birds
- Birds become dull with drooping wings
- Sudden death

Control and Treatment

- Use of preventive drugs e.g. A*mprol and Furexol*. These coccidiostats are mixed with feeds or water.
- Isolating infected animals
- Practising hygiene- wet, filthy and unhygienic animal surroundings should be removed
- Cattle from different farms should not drink from a common watering point.
- Overcrowding in poultry houses should be avoided.

iv) Trypanosomiasis (Nagana)

Animals affected- sheep, goats, cattle, pigs and horses.

Causal organism

- a protozoan of the Trypanosome spp transmitted by the tsetse flies.

Incubation period is1-3 weeks

Symptoms

- Fever
- Animals become dull
- Loss of appetite
- General weakness of the body
- Swollen lymph nodes

- Lachrimation which leads to blindness
- Rough coat
- Swelling of parts of the belly
- Diarrhoea
- Reduced milk production
- Loss of hair at the tail end
- Anaemia
- Abortion may occur in pregnant females due to high temperature.

Control and Treatment

i) Use of trypanocidal drugs
ii) Effective control of the tse tse flies
iii) Confinement of game animals in game parks.

2. BACTERIAL DISEASES

They include the following

- Mastitis
- Foot rot
- Contagious abortion (Brucellosis)
- Scours
- Black quarter
- Anthrax
- Fowl typhoid
- Pneumonia

i) Mastitis

Animals affected- cattle sheep, goats, pigs, camels and horses.

Causal organism-

There are two types of mastitis

a) Streptococcal mastitis caused by a bacterium called *Streptococcus agalactiae.*
b) Staphylococcal mastitis caused by *Staphylococcus urens.*

Predisposing factors

a. Stage of lactation period- animals are likely to suffer from mastitis at the beginning and at the end of the lactation period

b. Udder attachment- those animals with a large loosely hanging udders and long teats are more susceptible to mastitis infection
c. Incomplete milking- when milk is left in the teat canal, it acts as a culture medium for bacteria.
d. Mechanical injuries- wounds on the teats or udder allow micro organisms entry into the udder.
e. Poor sanitation-
f. Poor milking techniques- this may result in mechanical injury of the teats and weakening of the sphincter muscles of the teats
g. Age- older animals are more likely to be infected compared to younger animals.

Symptoms

- Milk contains blood; pus, thick clots or turns watery.
- Udder and teats are swollen
- Animal rejects suckling or milking and also kicks due to pain
- Death of the infected area
- Milk has salty taste

Control and treatment

a. Infected area of the udder is emptied of milk and an antibiotic is instilled and left for 12 hours
b. After every milking use teat dip on every quarter
c. Strict cleanliness and use of disinfectants during milking.
d. Using the right milking technique
e. Dry cow therapy- this is the infusion of long acting antibiotics into the teat canal when drying off the cow.
f. Use of strip cup to detect mastitis. Infected cows should be milked last.
g. Separate udder clothes should be used for each animal.
h. Sharp objects should be removed from grazing and milking areas to prevent teat injuries.
i. Open wounds on the teats should be treated immediately.

ii) Fowl typhoid

Animals affected- poultry

Causal organism

- Bacterium called *Salmonella gallinarum*

Symptoms

- Birds are depressed
- Respiratory distress and birds are dull
- Drooping wings
- Combs and wattles become pale and shrunken due to anaemia.
- Greenish yellow diarrhoea
- Sudden death

Control and Treatment

a. All infected birds should be killed and properly disposed
b. Poultry house should be clean, dry and well ventilated.
c. Regular vaccination
d. Eggs for hatching and chicks should be obtained from reliable sources.
e. Sulphur drugs mixed with water or mash are used for treatment.

NB/ *Furazolidone* at the rate of 0.04% in mash for ten days treats the disease effectively.

iii) Foot rot (Foul - in- the - Foot)

Animals affected- all cloven animals e.g. cattle, goats, sheep (most Serious).

Causal organism

- caused by the following bacteria-*Fusiformis necrophorus and Fusiformis nodosus*

Predisposing factors

i) Filthy surroundings e.g. wet and muddy areas.
ii) Cracking of the hooves due to overgrowth.

Symptoms

- Animals foot become swollen
- Pus and rotten smell come out of the hoof
- Kneeling when grazing if front feet are affected
- Animals spend most of their time lying down when the hind feet are affected
- Emaciation due to lack of feeding.

Control and treatment

i) Provide clean environment i.e. avoid dampness and muddy conditions
ii) Practice regular foot examination and hoof trimming
iii) Practice a regular walk through a copper sulphate (Blue vitriol) footbath at 5-10% solution or Formalin at 2-5% solution.
iv) Wounds on the feet should be treated with antiseptics
v) Healthy sheep should be moved to dry clean areas.
vi) Separate healthy animals from sick ones.

iv) Contagious abortion

Its also called Brucellosis or Bang's disease .

NB/ This is a contagious and infectious disease.

Causal organism

Cattle-*Brucella abortus.*

Pigs- *Brucella suis*.

Goats and sheep- *Brucella malitensis*

Milk from an infected animal should not be drunk.

Symptoms

i) Abortion or a pre-mature birth of the young
ii) During later stages of pregnancy if abortion occurs, placenta is retained.
iii) The cow may become barren while bulls have low libido and have inflamed testes.
iv) A yellowish brown, slimy, odourless discharge from the vulva may occur after abortion.

Control

- Culling infected animals
- Vaccination against the disease
- The attendant should avoid contaminating his hands with the aborted foetus
- Cleanliness to be observed
- A blood test should be carried out for all the breeding animals in order to detect the infected ones.
- Use of artificial insemination.

NB/ There is no effective treatment.

v) Scours

Animals affected- young one of cattle, pigs, sheep, and goats.

Causal organism-

A bacterium called *Escherichia coli.*

Predisposing causes

i) Unhygienic conditions in the house of the young ones
ii) Overfeeding the calf with milk or feeding it with very cold milk
iii) Lack of colostrums
iv) Feeding young ones at irregular intervals
v) Absence of green fodder in the mothers diet which causes lack of vit A

Symptoms

- White or yellowish diarrhoea in calves
- Faeces have a pungent smell
- High temp
- Animal becomes restless
- Loss of appetite
- Sunken eyes
- Undigested milk and mucus with blood spots in faeces
- Sudden death if no treatment

vi) Black quarter

This is an acute disease, which is contagious.

Animals affected- all ruminants

Causal organism

Bacteria called *Clostridium chauvei*, which enters the body through contaminated water and wounds.

Symptoms

- Lameness in animals
- Affected parts of the body become swollen immediately
- High temperature-fever
- The animal breathes heavily and fast
- The animal is dull and losses appetite

- There is grunting and grinding of teeth
- Sudden death
- Blood oozes from the anus and nose
- Animal stops chewing the cud
- If the cut muscles are cut they appear dark

Control

i) Affected animals may be treated with antibiotics e.g. *penicillin, oxytetracycline and sulphathiazole.*

ii) Vaccination using black quarter vaccine

iii) The carcass should be buried deep or burnt completely.

vii) Anthrax

This is an acute infectious and notifiable disease.

Animals affected- cattle, sheep, goats, man, and wild animals.

Causal organism

Bacteria called *Bacillus anthracis.* Animals get anthrax through

- Grazing in infected pastures as the bacteria is found in the soil.
- Bites by insects
- Open wounds
- Bone meal from infected animals.

The bacterium is capable of forming spores outside the animal body.

Symptoms

- Extensive bloating of the stomach after death.
- Fever
- Blood stains in the faeces and milk
- In pigs the throat swells and this may cause death due to suffocation
- Carcasses of an anthrax attack lack *rigor mortis* i.e. the carcass is not stiff as in other animals.
- In the dead animal, a tar-like watery blood comes off the orifices e.g. nose, anus and mouth. Blood does not clot quickly.

Control

- Treatment of wounds.
- Giving large doses of anti-anthrax serum for curative treatment

- The carcass must not be opened
- Vaccination using Blanthax in areas where the disease is prevalent
- Imposing quarantine in case of disease outbreak.
- Dead animal must be disposed off properly by burning or deep burying.

viii) Pneumonia

This is an infectious lung fever.

Animals affected- calves, kid, lambs, piglets and poultry.

Causal organism

Bacterium called *Mycoplasma mycoides.* Dust or worms in the lungs could cause the disease.

Predisposing causes

- Poor ventilation
- Lack of enough oxygen
- Overcrowding
- Age- young animals are more prone to the disease
- Effects of diarrhoea and other illnesses
- Dampness and chilliness.

Symptoms

i) The animal becomes dull and reluctant to move
ii) Loss of appetite
iii) There is a rough hair coat
iv) Emaciation
v) Animal breathes rapidly
vi) Abnormal lung sounds i.e. bubbling
vii) If the chest is pressed the animal starts coughing
viii) Fluctuating temperatures
ix) Nasal mucous discharge.

Control and treatment

i) Young animals should be kept in warm pens.
ii) Use of antibiotics
iii) Isolating the infected animals

iv) Proper sanitation

3. VIRAL DISEASES

i) Rinderpest

This is a highly contagious and infectious disease. It's notifiable.
Animals affected- cattle, sheep, goats, pigs and wild animals with cloven hoofs.

Causal organism-

Virus

Incubation period- 3-8 days

Symptoms

- High temperature
- Staring coat
- Discharges in the mouth and nose
- Diarrhoea and dysentery
- Mucous membranes of the mouth and nose become red and they develop ulcers.
- Emaciation
- Grinding of the teeth
- Death in 2-10 days after incubation.

Control

- Vaccination annually
- Culling the infected animals
- Notify the authorities in case of an outbreak
- Quarantine in case of the disease
- Separate sick animals from healthy ones.

ii) Foot and Mouth Disease

It is a highly contagious and infectious disease. It is notifiable.
Animals affected- cattle sheep, goats, some wild animals.

Causal organism

Virus types A, C, and D
The virus can be transmitted by contaminated litter, feet, garbage and infected saliva.

Symptoms

- Sharp rise in temperature lasting only for a few hours

- Blisters or wounds appear on the mouth and feet.
- The tongue, lips and gums are inflamed. This makes eating difficult
- Lameness due to lesions between the skin and hoof
- There is profuse salivation
- Vesicles may appear on teats and udders
- The animal becomes weak and thin very fast
- There is drop in milk production

Control

- Vaccination every six months
- Quarantine in case of outbreak
- Culling
- Use of disinfectants on wounds.

iii) Newcastle Disease

It's a notifiable disease, very contagious and highly infectious disease.
Animals affected- poultry especially three months to one year.

Causal organism

Virus

Symptoms

- Birds have difficulty in breathing
- Beaks remain wide open and the necks are strained
- The bird is dull
- The bird stands with eyes closed all the time
- Loss of appetite
- Nasal discharges, which force the birds to shake heads to clear.
- Birds stagger in motion
- Watery yellow diarrhoea
- The birds have their beaks and wings down

Control

1. Quarantine
2. Culling
3. Cleaning and disinfecting the houses before bringing in new stock

4. Vaccination during the first six weeks and two to three months later

iv) Fowl pox

Animals affected- all poultry

Causal organism

Virus

Predisposing factors

- Presence of wounds
- Presence of mosquitoes, ticks, lice and other biting insects that spread the disease.

Symptoms

- Lesions on the combs and wattles
- Lesions on legs, vent, feet and under the wings.
- Lose of appetite hence emaciation and death
- Difficulty in breathing and swallowing.
- A watery discharge from the eyes in the early stages of the disease
- The bird become dull

Control

1. Remove all infected birds and kill them
2. Vaccinate remaining healthy birds.

4. NUTRITIONAL DISEASES

i) Milk Fever

This is a non infectious disease.

Animals affected-cows, goats, and pigs that have recently given birth.

Cause

This is due to loss of calcium and phosphorous through milk secretion. There is also an increase in the level of magnesium and sugar in the blood.

Symptoms

- Dullness
- Muscular twitching causing the animal to tremble
- Staggering as the animal moves
- Animal falls down and becomes unconscious
- The animal lies down on its side and the whole body stiffens

- Body functions such as urination, defecation and milk secretion stop.
- Sudden death if the animal is not treated immediately
- Stomach contents are drawn into the mouth
- Complete loss of appetite

Control

i) Treatment

Intravenous injection of soluble calcium salt in form of *calcium borogluconate* 60gms. Dissolved in 500cc of water that is boiled and cooled

ii) Nursing care

The sick animal should be kept in a comfortable position. Fresh water should be given. Mechanical removal of urine speeds up recovery.

Prevention

- Partial milking of cows with past cases of milk fever is done for the first ten days
- Providing sufficient amounts of calcium and phosphorous in the diet
- High doses of vit D and parathyroid extractions

NB/ the animal suffering from milk fever should never be given medicine through the mouth because,

1. *It will not be able to swallow the medicine*
2. *The medicine may get into the lungs thereby promoting lung fever speeding up death.*

ii) Bloat

Animals affected- mainly cattle and sheep. Goats may also be affected

Causes

-Accumulation of gases as a result of food fermentation in the rumen. This is caused by:

- Obstruction of the oesophagus due to bulky food particles such as potatoes, carrots etc
- Abnormal pressure exerted on the oesophagus by a swelling in the wall of the chest

- Indigestion caused by accumulation of gases due to paralysis of the rumen and the valve at its entrance. This may be due to the animal eating poisonous herbs or due to sudden change of feeds especially soft green forage, which is taken in large quantities. E.g. Beans, cabbage leaves, lush grass Lucerne etc

Symptoms

- The left side of the abdomen is excessively distended.
- Death may occur within hours due to too much pressure exerted on blood vessels, lungs and heart.

Control

Feed ruminants with dry roughage during the wet season.

Treatment

This involves the release of accumulated gases through.

- **Manual means.** - Exercising the animal and rubbing its abdomen with both hands
- **Surgical means**- this is though piercing the abdominal wall directly over the blown up part of the rumen using trocar and cannula. A stomach pump can also be used to eject the excess gases through the oesophagus.
- **Chemical** –this can be done through,

1. Drenching of the animal using suitable oils such as turpentine oil mixed with vegetable oil
2. Administering Epsom salt to clear the rumen contents. Drenching does this.
3. Administration of methyl silicone as an injection directly into the rumen. This prevents the frothy type of bloat.

Parturition in Goats (kidding)

Gestation period is 150 days or 143-153 days. Nannies carrying twins kid a few days earlier.

- Put nannies in a dry place under a shade or shelter to prevent kids from wet, cold and exposure to intensive heat that can cause death of kids..
- Keep nanny and another female to avoid nervousness at kidding time.
- Do not disturb the animal.

- Seek for professional help if mulpresentation occurs or kidding delays for 3 hours.
- If placenta is retained, move the goat out with the others for physical exercise. This activates expulsion.

Kidding Signs

(i) Under firms and teats enlarge.
(ii) The muscles at either side of the tail slacken or relax.
(iii) Restlessness; pawing the ground, rise up, lie down frequently.
(iv) Separate itself from the rest of the flock.
(v) A clear discharge from the vulva.

Parturition in Pigs (farrowing)

Gestation period is 4 months or 113-117 days.

- Clear and disinfect the farrowing pen.
- Introduce dry warm beddings with a farrowing crate 7-10 days prior to farrowing.
- Drench the pig to control internal parasites.
- Clean the skin with soap and water to remove external parasites, remove oil exudates from their skin which reduce effectiveness of acaricides and to remove mud and dirt.
- Bring the sow to the farrowing pen 3 days to the expected date. This helps the sow to;
  I)Familiarize herself with the new environment to reduce nervousness.
  ii) Avoid inconveniences of transferring the piglets in case of early farrowing.
- Ensure the removal of afterbirth to prevent eating it. Sows which eat afterbirth eat piglets too.
- Remove afterbirth from the pen because it decomposes causing infections to the piglets.
- Feed the sow generously and give plenty of clean water.

Farrowing signs

i) Restlessness.
ii) Enlargement of vulva.
iii) Muscles on each side of the tail slacken.
iv) Loss of appetite.
v) Udder and teats enlarge.
vi) Sows collect beddings at one corner to build a nest.
vii) 24 hours before farrowing, milk is present in the teats.

Management practices carried out to the piglets immediately after birth

- Ensure they are breathing.
- Ensure they are warm or put them in a warm place.
- Ensure they suckle colostrums within 6-12 hours of life.
- Disinfect the naval cord to avoid naval illness.
- Clip the sharp teeth of the piglets to avoid injury to the mother's teats.
- Tail clip to control cannibalism.

Parturition in Rabbits (kindling)

Place a nest box and provide plenty of dry, soft bedding in the hutch from 4th week of gestation.

Kindling signs

- Doe plucks off fur from her belly.
- Uses the fur to build a nest about 3-10 days earlier.
- Goes off feed.

BEE KEEPING (APICULTURE)

Apiculture is the science of keeping bees.

Importance

a) Production of honey;

- Has high energy value
- Is a sweetener for beverage and soft drinks.
- Is medicinal---Used to dress fresh wounds.

b) Honey and bees wax are sold to earn income.

c) Require little capital and land to keep.
d) Bees are good pollinators for many crops.

Types of Bees

1. African wild bee

Characteristics

i) **W**ell adapted to local conditions e.g. high temperatures.
ii) High flying power –Fly for long distances.
iii) More active in search of food and water and hive protection.
iv) Fairly resistant to diseases e.g. Acarive and American foul brood disease..
v) Vicious if manhandled.

2. European Bee

Characteristics

i) More gentle and larger than African bee.
ii) Less active and vicious.
iii) Susceptible to bee diseases.

The Bee Colony

A bee is a social insect that lives in a colony

There are three types of bees in a colony. I.e. the queen, Drone and worker bee.

a) The Queen

One queen in a colony

Functions:

i) Lay fertile eggs.
ii) Keeping the colony together by production of a pheromone (queen substance) for identification.

b) The Drone

About 300 in number in a colony.

Functions:

i) Fertilize the queen.

ii) Control temperature or cool the hive. i.e. by flapping their wide wings at a very high speed.

N.B The drones are killed by worker bees after fertilizing the queen.

c) The worker bees

-About 60,000 in number in a colony. Smallest and normally female bees.

Functions;

i) Feed queen, drones, and brood 9 young bees).
ii) Protect hive from intruders.
iii) Collect nectar, pollen, tree resins, gums and water.
iv) Build combs and seal the cracks and crevices in the hive.
v) Make honey and bee wax.

Life cycle of a bee

1. Fertilized queen move from one cell to another laying an egg in each.
2. Eggs hatch after three days into larvae due to the warmth and temperature generated by the worker bees.
3. Larvae are fed by the nurse bees on special honey. Each larva spins a cocoon and after 2 days moults into a pupa.
4. Pupa become young bees after 10 days and emerges from the cocoon.

Eggs, larvae and pupa form the brood.

Siting the Apiary

Apiary: Is a place where bees are kept.

Factors considered on siting an Apiary:

1. Availability of water: where water is not within 3 km radius, sugar solution or syrup is placed close to the hives.
2. Availability of flowers: To provide nectar and pollen.
3. A sheltered place: e.g. a forest to protect bees from sun and wind.
4. Quiet place: Free from noise and other disturbances.
5. Away from human beings and livestock: i.e. away from homesteads, pastures and busy roads. Bees sting.

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Types of bee hives

1. Log Hive; Made of log. Log is split into 2-the larger part is made into a trough- shaped structure. The smaller part (floor board) is removed after suspension during harvesting without damaging the combs and brood.
   Diagram
2. Box hive: sown timber cut to a length of 1m. Diagram.
3. The Langstroth hive; Like a box hive but separated into chambers for the brood and the honey. To separate brood and honey chambers, a queen excluder is placed between the two chambers. The top board acts as the roof and the bottom board as the floor.
4. Kenya top Bar Hive (KTBH); moveable frame hive. Bees attach their combs on the top bars which can be removed for examination.

Advantages of KTBH

a) Top bar can be removed for inspection of combs and replaced.
b) Honey combs can be removed without damaging the brood.
c) Honey is of high quality since it is harvested without the brood.
d) More wax is harvested as honey combs are not returned to the hive.
e) The hive is easy to construct and repair.
f) Hive is cheap to build and no expensive equipment is required to extract honey.
g) A queen excluder is used in the centre of the hive to separate honey from the brood so as to further increase the honey quality.

LIVECTOCK PRODUCTION III
(SELECTION AND BREEDING)

Reproduction and reproductive system

Reproduction is the process by which off springs are reproduced. Sexual reproduction involves the union of the female and male gametes. Female

gametes and the male gametes fuse to form the zygote. Fertilization takes place in the body of the female. Embryo formed develops inside the body of the mother where its fed and protected until the end of the gestation period.

In poultry, however eggs are fertilized internally but the development of the chicks takes place outside during **incubation**.

Reproduction in cattle

Male reproductive system produces the male gametes called spermatozoa's, which are introduced into the female reproductive system.

The male reproductive system

It's composed of the following:

- Testes
- Epididymis
- Sperm ducts
- Accessory glands (seminal vesicles and the prostate glands)
- Penis

Testes

They produce sperms and they hang outside loosely between the hind legs. Each testis is enclosed in a loose skin called scrotum. Scrotum regulates the temperature of the sperms so that they don't die.

Epididymis

These are coiled tubes that store the sperms

Sperm ducts

They carry sperms to the urethra. Urethra also forms a part of he urinary system. Urethra expels the sperms through the penis. Urine and semen cannot be expelled at the same time due to presence of sphincter muscles which contract allowing either urine or sperms to pass.

Accessory glands

Prostate gland produces some fluid that neutralizes the acidic effects of the urine in the urethra hence preventing the death of the sperms. Seminal vesicles produce clear sticky fluid called semen. Semen carries the sperms

out of the penis in fluid form. One ejaculation of sperms has many sperms but only one is required for fertilization

Penis

In bull, its long and muscular structure carried on the underside. It's surrounded by a sheath which is an extension of the skin. Penis introduces sperms into the vagina of the cow during mating. At the time of mating the penis protrudes outside the sheath.

Female Reproductive system

It's composed of:

- Ovaries
- Fallopian tubes
- Uterus
- Vagina and vulva

Ovaries

Are two located in the abdominal cavity near the kidneys, one on the right and one on the left... ovaries produce ova which is the female gamete. They also produce the female hormones. A hormone oestrogen is produced under the influence of another hormone called Follicle stimulating hormone (FSH). Oestrogen is produced by the Graafian follicle located in the ovary. Oestrogen induces Oestrus which is the heat period so that the cow shows signs of heat. After every 21 days, the ovary releases a mature ovum and the cow comes on heat.

Fallopian Tubes (oviduct)

Ovum travels through the fallopian tubes to the uterus. The release and movement of the ovum down to the uterus is called ovulation. If mating is done at this time fertilization occurs.

Uterus

This is where fertilization takes place. The fertilized egg implants itself on to the walls of the uterus and develops into the foetus.

Vagina and Vulva

Vulva is the external opening of the cow's reproductive system. It allows mating to take place so that the sperms are deposited into the vagina. The vagina acts as the birth canal-

Pregnancy/Gestation Period

This is the normal period between fertilization and the expulsion of the foetus through the vulva. The gestation period varies with different animals.e.g

Animal	Length in days
Cow	270-285
Sow	113-117
Ewe/Goat	150
Rabbit	28-31

During pregnancy a hormone called progesterone is produced by the placenta to maintain pregnancy. After birth, the reproductive tract undergoes a period of healing (Rest) during which it's repaired and returns to normal.

Parturition/Birth

This is the act of giving birth. This is the time when the foetus is expelled through the birth canal. The following signs are expressed by a cow that is about to give birth.

1. Distended udder which produces a thick milky fluid (Colostrums)
2. Swollen vulva producing a thick mucus like discharge
3. General restlessness
4. Loose and slackened pelvic girdle
5. Visible pin bones
6. A water bag appears and bursts just before calving

After these signs are seen the animal parturates normally within 2-3 hours. The correct presentation is with the front feet first and the head resting between the feet. Any other presentation is called ***Malpresentation or Breech Presentation*** especially when the hind legs come out first.

Reproduction in Poultry

The cock has no penis but a small opening near the vent through which sperms are emitted. It has testis within its body. Hens have an elongated oviduct necessary for the formation of the egg. Fertilization takes place internally. During mating the hens cloaca (vent) protrudes so that the vent of the cock fits into it. The vent of a hen sucks the sperms which flow to the uterus through the oviduct of a hen.

Reproductive system of the hen consists of the following.

1. Ovary
2. Funnel (infundibulum)
3. Magnum
4. Uterus
5. Vagina
6. Cloaca

Ovary

A hen has two ovaries and only the left one is functional. Eggs or ova are formed in the ovary. A hen has 3,500-4,000 ova. Each ovum is contained in a follicle. When the ovum or yolk is mature, its released from the ovary by the rupture of the follicle. It moves into the oviduct where its received by the funnel.

Funnel

Its 11.6cm long and fertilization takes place here.

Chalazae are added to hold the yolk

Ovum stays here for about ¼ hour

Magnum

It's 33cm long. Yolk moves down the magnum where thick albumen is added. It stays here for 3 hours.

Isthmus

It's 10.6 cm long. Shell membranes are added. Water mineral salts and vitamins are also added. The egg takes about ¼ hour to move from this region.

Uterus (shell gland)

The region has calcium deposits

Shell is added round the egg

Egg stays here for about 18-22

Vagina (6.9 cm)

Egg is temporarily stored before it's laid

Cloaca

The egg moves out of the cloaca through the vent. Cloaca extends out to prevent the egg from breaking.

NB/ whether fertilization takes place or not the egg will have to be formed. Fertilization doesn't take place the egg cannot hatch. The process of egg formation in a hen takes about 24-26 hours. Therefore, a hen is able to lay only one egg in a day. The components of an egg are obtained from the body reserves of a hen.

SELECTION

Selection is a process of allowing certain animals to be the parents of the future generations while culling others. The animals retained in the herd have certain desirable characteristics which make them produce more. The selected animals males and females make up the *Breeding stock.* Breeding stock is used to produce offspring's with the same qualities or better than their parents. Breeding stock should therefore pass the good traits of quality to their offspring for better performance thus improving the livestock. Selection process repeated for many generations increases the *Gene Frequency* i.e. occurrence of the genes that carry desirable characteristics. Selection therefore increases the occurrences of desirable genes and reduces the undesirable genes.

Heritability

This refers to the likelihood of a particular trait to be transmitted to the offspring. E.g. in dairy cattle the characteristics which are highly heritable include butter fat content, growth rate, and mortality rate at birth.

A character like milk yield is lowly heritable. Such a character is environmental i.e. weakly inherited and selection will not improve it. The degree to selection affects a character depends on the following factors;

1. heritability of the character
2. intensity within which selection is done
3. interval between generations and kind of selection being practiced

Factors to Consider When Selecting a Breeding Stock

1. **Age** - young animals should be selected because such animals have a longer productive life. Very old animals are low producers and poor breeders.
2. **Level of performance -** only animals with the highest production level should be selected.. Performance is best determined by use of records. Performance of the relatives such as ancestors should be checked to ascertain whether the animal belongs to a high producing family. The ability of the parents to pass good qualities to their offspring's ii referred to as ***prepotency.***
3. **Physical fitness** – animas selected should be free from ay physical defects such as limping, irregular number of teats, mono eyed and weak back line etc.
4. **Health** – Animals selected should be healthy. Sick animals do not breed well and those falling sick often are expensive to keep.
5. **Body conformation -** Animals for breeding should be selected according to their proper body conformation. E.g. Dairy cows should be wedge shaped with a large udder
6. **Animal behaviour/ Temperament –** Animals with undesirable behaviours e.g. cannibalism in poultry and aggressiveness in dairy cattle should be culled.
7. **Quality of Products** – animals that give products of high quality should be selected. E.g. in wool production breeds that produce fine, long elastic and pure white wool should be selected.
8. **Mothering ability** – Animals selected should have a natural instinct towards their young ones. This enables them to rear the young ones up to weaning.

9. **Adaptability** – Animals selected should be well adapted to the prevailing climatic conditions in the area.
10. **Prolificacy** – Animals selected should be highly prolific. i.e. have the ability to give birth to many off springs at a time.

Methods of Selection

- **Mass selection**

This is the choosing of animals for breeding on the basis of their own performance and the mating them at random. Offsprings of these animals are expected to show higher performance than the previous herd. This is because mass selection increases the occurrence of the desirable genes in a population.

- **Progeny testing**

Progeny is the offspring resulting from selected parents. In this method a group of progenies are used to as an aid to increase the accuracy in the selection of the breeding stock.

It's used when the character is expressed by one sex only. Progeny testing takes a long time for the results to be realized. E.g. it may take a bull 8-9 years before the progeny testing results are out.

- **Contemporary comparison**

This method involves the comparison of the average production of the daughters of each bull with that of the other heifer referred to as **Contemporaries** in the herd. The method assumes that the differences between the herds of the same breed are non-genetic in origin.

Advantages

- It's possible to compare animals of different age groups
- Accurate due to presence of comparison
- Eliminates differences brought about by environment since average performance of the herd is used.
- It's possible to make direct comparison of the bulls at different A.I Centers.

BREEDING

Selection increases the gene frequency and ensures that the desirable genes are concentrated in the offspring thus performing better than the parents. Selection therefore doesn't introduce or create new genes in an animal but uses the existing ones.

Breeding is the process of mating selected females and males to produce offsprings of the required characteristics.

Reasons for Breeding

1. to expand the inherited potential of the animal
2. To introduce new genes to improve animals productivity.
3. To produce animals those are resistant to diseases and other environmental hazards.
4. To satisfy consumers taste e.g. tender meat, fast growth rate etc.
5. Economic reasons; breeding animals with high growth rate means that these animals acquire market weight very fast.

NB/ Genetic factors play a big role and therefore proper methods should be adopted. These genetic factors include;

Inheritance

This is the genetic transmission of traits from the parents to the offsprings. These traits are carried by the male and female gametes. An animal's body has two types of cells, ***sex cells called the gametes and the somatic cells called the body cells*.** Sex cells have chromosomes that contain genes.

Chromosomes

They carry gene which determine the specific characteristics in an individual animal. They exist in pairs in the nucleus of the body cells and are always constant in number. In the sex cells the genes are found in single units. i.e.

Animal	No. of x-somes in body cell	No. of x-somes in sex cells
Cow	60	30
Sheep	54	27
Chicken	78	39

Pig	38	19

Genes

These are very tiny units of inheritance carrying particular traits found in animals e.g. Body shape, disease resistance, prolificacy, colour etc. they are found in specific points in chromosomes called the gene loci (locus). They look like beads on a string.

Diagram

Genes occurs in pairs on the chromosome called alleles. Alleles form *allelomorphic genes*. If the members of an allele have the same effect or quality, the character is said to be homozygous. If these genes have different effect that carries different qualities the resulting character will be heterozygous.

Cell Division

The two types in animal multiply themselves through the process of cell division.

Body cells – *somatic cells* divide by a process called *mitosis*. In mitosis each parent cell produces two daughter cells having the same number of chromosomes as the parent cell.

Sex cells- gametes divide and reproduce through a process called *meiosis*. The process results in four daughter cells having half the number of chromosomes as was in the parent cells.

During fertilization when the sperm joins with the ovum (each having half the number of chromosomes), the full chromosome number is restored.

Terms used in Breeding

Dominant and Recessive Traits

Dominant means to suppress the other. Recessive means suppressed or dominated by the other characters. If the dominant and the recessive traits are brought together, the offspring shows the dominant trait e.g. the gene for horns is dominant over the gene for hornless. Therefore if a polled bull

(hornless) is mated with a horned cow, the offspring produced will be horned.
Sometimes there is partial dominance (incomplete dominance) where the offspring do not resemble either parent exactly.
Hybrid and Hybrid Vigor
An animal is a hybrid if it possesses a dominant characteristic and the other one is recessive. If two hybrids are crossed, the offsprings will attain 75% dominance and 25% recessive ness.
If two superior animals of different breeds are mated, the offspring that results is highly productive and has a higher growth rate and an improved body conformation. Such an animal has hybrid vigor or *heterosis*. Hybrid vigor is increased vigor and performance resulting from crossing two unrelated *superior animals*. The genes that produce vigor are dominant are while those that lack vigor are recessive.

Epistasis
It's the combination of genes which individually could have been undesirable or inferior. This way, the effects of some recessive genes are masked such that they cannot be expressed.
Breeding Systems

- Inbreeding
- Out breeding

1. Inbreeding
This is the mating of animals which are closely related to each other.
Reasons for Inbreeding

1. To increase the genetic uniformity in a herd – increasing homozygosity.
2. Fixing required characteristics in the new breeds.

3. Increasing phenotypic uniformity. This helps to describe the external characteristics of a certain breed for example the colour of Friesians is black.
4. Used to test whether an animal has high prepotency.
5. To get proven sires i.e. males which have been confirmed and proven to have high qualities through backcrossing.

Disadvantages

1. loss of hybrid vigor
2. high rate of pre-natal mortality
3. may lead to decline in fertility hence species extinction

Systems of Inbreeding

a) Close Breeding: this is the breeding of very closely related animals. i.e. sib mating- between brothers and sisters and parent-sib mating – between parents and offsprings.
b) Line Breeding- this is the mating of distantly related animals that share a common ancestor. E.g. Cousins and cousins, granddaughters versus grand sires etc. the system aims at preserving good qualities of superior ancestors.

2) Out Breeding

This is the mating of animals that are not related.

Reasons for Out Breeding

a) To introduce new desirable genes
b) To exploit heterosis (hybrid vigor). A cross breed performs better than the average of the two parents
c) To establish a new breed or a grade animal.

Systems of Out Breeding

- Out crossing
- Cross breeding
- Upgrading (grading up)

Out Crossing

This is the mating of unrelated animals but within the same breed e.g. serving a Friesian cow in Nakuru with semen from a Friesian bull in Britain.

The system helps to overcome weaknesses obtained through inbreeding. It also maintains the characteristics of a pure breed such as colour.

Cross Breeding

This is the mating of two animals from two different breeds. This creates hybrid vigor. The system helps to upgrade the local animals by crossing them with exotic ones especially for better milk production.

Upgrading or grading up

This is where the female of low grade stock is mated with a pure bred sire. The offspring gets half of the sire's genes. Such an offspring is referred to as a *Hygrade*. The system is commonly used in A.I to improve local cattle for milk production.

Mating in Livestock

a) Mating in Cattle

Oestrus (Heat Period)

A cow comes on heat every 21 days. The duration between one hate period and the next is called oestrus cycle. Heat period in a cow lasts for 18-30 hours. The cow should betaken for service 12-18 hors after showing the first heat signs for successful mating.

Signs of Heat

- Restlessness
- Mounting others and stands still when mounted on
- Rise in body temperature
- Milk yield drops slightly
- Vulva swells and reddens
- Clear slimy mucus from the vagina
- Bellowing and mooing frequently.

b) Mating in Pigs

Sows stay on heat for 2-3 days. The best time to serve is the second day of the heat period. The sow is taken to the boar and allowed to stay there for at least 2 days.

Signs of Heat

- Restlessness
- Frequent urination
- Swelling and reddening of the vulva
- Clear slimy mucus discharge from the vagina
- Frequent mounting on others
- Responds positively to the riding test

c) Mating in Rabbits.

The does are ready for mating at 6-7 months of age. Heat signs are repeated after 14 days.

Signs of heat

- Restlessness
- Frequent urination
- Swollen vulva
- Doe throws itself on its sides
- Doe tries to contact other rabbits in the next hutch by peeping
- The doe rubs itself against the wall or any solid object.

Methods of service in Livestock

- Natural mating
- Artificial Insemination (A.I)
- Embryo transplant

1. Natural Mating

This is the use of a male to serve a female. It is commonly practiced in sheep, pigs, goats and poultry. It can also be used in cattle but AI is now commonly used.

Advantages

- More accurate. The male can detect when the female is on heat.
- Less laborious. There is no need of checking the animals for heat signs.
- Useful when the heat periods of females cannot be easily detect.

Disadvantages

- Transmission of breeding diseases. E.g. brucellosis and trichomoniasis.
- There is a high chance of inbreeding
- Males will need extra pasture to eat that would have been used by the females.
- Large males can injure small females
- A lot of semen is wasted since a single ejaculation produces semen that can serve several females.
- It's cumbersome and expensive to transport a bull from to serve cows. Bulls moved from one area to another may not perform efficiently due to new environmental conditions. cannot

2. Artificial Insemination (A.I)

This is the introduction of semen into the female's reproductive system by hand using syringes or tube.

Semen is collected from a bull using an artificial vagina and a *teaser cow.*

Semen collected is then diluted and used to inseminate many cows. Diluted semen is stored in deep frozen state in liquid nitrogen at -1930C.

Special plastic straws called *Payets* are used to store semen for one insemination. Payets may have different colors indicating the breed for different bulls.

Collection of Semen

A teaser cow is restrained in a crush. A bull is brought to the teaser cow. When the bull mounts on the cow and directs the penis to the vulva, a person grabs the penis and directs it into an artificial vagina. Since there is warm water all around the artificial vagina, the bull will ejaculate and the semen is collected.

Advantages of A.I

i) Semen from one superior bull can be used to serve many cows.
ii) It controls the spread of and transmission of breeding diseases and parasites.

iii) Sires that are too heavy and that could injure cows only produce semen to serve the cows.
iv) Easy to control breeding i.e. one can time when to breed his animals.
v) It is easy to control inbreeding.
vi) Reduces the expenses of keeping a bull on pastures and also on drugs.
vii) Small scale farmers who cannot afford to buy a superior bull can have the cows served at a low cost.
viii) It eliminate dangerous and aggressive bulls on the farm
ix) It is easy to transport semen from one place to another.
x) It is a useful research tool as it helps to study a very large number of offsprings from a single sire.

Disadvantages

i) Harmful characteristics can be spread quickly by one bull to all the offsprings the bull sires.
ii) Skilled labour is required
iii) Requires more human labour than the natural method
iv) Low chances of conception because semen can die due to storage problems and also due to wrong timing of the heat period.

3. Embryo Transplant

In this method eggs (ova) are harvested from a high quality female, fertilized in tubes and the embryos that develop are transplanted into foster mothers. The female animal that produces the ova is referred to as *donor*. The one that receives is called the *recipient*. The donor female is injected with hormones to stimulate production off more than the normal rate at ago. On superior female can produce many offsprings using this method.

NB. / Whereas A.I increases the number of offsprings sired by one bull, Embryo transplant increases the number of offsprings produced by one female.

Advantages of Embryo Transplant

- Possible to implant embryo from a high quality female to a less superior female and obtain a high performing offspring.
- Stimulates milk production in females that were not ready to produce milk.
- A highly productive female can be spread over a large area to benefit many farmers.
- It is easier to transport embryos in test tubes than the whole animal.
- Embryos can be stored for long periods awaiting availability of a recipient female.

Disadvantages

- Technology is expensive
- Requires trained personnel to handle
- Requires special equipment for fertilization and storage of the embryos.

Signs of parturition in:

- *Cattle (270-285 days)*
- *Pigs (4 months- 3months, 3 weeks, 3 days.)*
  1. *Restlessness*
  2. *Vulva reddens and swells*
  3. *Udder becomes full with a milky fluid*
  4. *Sow builds a nest by collecting some bedding at the corner of the pen.*

Under normal circumstances, farrowing takes place within 4-6 hours of showing the above signs.

- *Rabbits/doe (29-33 days)*
  1. *The doe starts building a nest by plucking off hair from her belly*
  2. *Lack of appetite i.e. no feeding.*

Parturition in rabbits is called *Kindling*.

FISH FARMING (AQUACULTURE)

- This is the artificial rearing of fish in ponds.

Importance of fish farming

1. Cheap and good source of proteins.
2. Can be practiced on limited land.
3. Make fish available nearby when reared in ponds.
4. Source of income to fish farmers.

Species of fish farmed in Kenya

1. Fresh warm water fish(18^0c of water) e.g. tilapia, carps, black bass, striped bass, cat fish, blue gill, Nile perch etc.
2. Fresh cold water fish (10-15^0c water) such as trout.

Requirements for fish farming

i) Water supply – should be free flowing to ensure oxygen supply.
ii) Slope of land – gentle slope is suitable. In flat land there is no free flow of water.
iii) Soil – clay soil is best as it does not allow seepage.

Soil test procedure

Procedure A

i) Take a handful of wet soil.
ii) Knead in between fingers and roll into a ribbon.
iii) Throw it into the air and catch it.
iv)If the ribbon does not break, it is truly clay.

Procedure B

- Dig a hole 1m deep by 30cm wide.
- Fill it with water in the evening and leave overnight, and then fill again in the morning.
- Good soil should retain water up to the evening of the second day.

Establishing a fish pond

Procedure

i) *Site selection*: should meet the following;
   a) Topography ie a place where water flows gently from the source.
   b) Soil should be clay
   c) Water should be available.

d) Security.

ii) *Site marking*: use pegs to mark the channel from the river, the entrance and exit and channel to take water back to the river.

iii) *Clearing the land*.

iv) *Digging the pond*: dig up soil. Topsoil is separated from the other. Upper side is 0.5m deep and lower side is 1.5m deep.

v) *Construct the dyke*. This is a wall constructed round the pond.

vi) *Construct the fence round the pond*.

Constructing the Inlet, outlet and spillway

- *Inlet*: This canal or pipe at the entrance of the pond to bring in fresh water. It should be fitted with a screen to prevent entrance of undesirable fish species.
- *Outlet*: it is made at the deeper end of the pond. A screen is fitted at the mouth of the outlet to prevent fish swimming away.
- *Spillway*: this is channel to remove excess water back to the river. It is made at the top of the dyke at the lower side of the pond. It prevents water from overflowing on the dykes.

NB//

- Grass is planted on the dyke and land around it to stabilize the ground. This prevents dyke erosion.
- The pond is fenced to keep off predators and unauthorized persons.

Stocking the Pond

- Introduce fingerlings (young-fish) from hatcheries e.g. Sagana, Kiganjo, Kisumu fisheries, Bamburi etc.
- Transport them in oxygenated polythene bags, milk cans or drums.
- Provide clean water in the containers at 10 ^{0}C temperature.
- Take care not to injure the fingerlings.
- Ensure proper stocking space i.e. 5-10 fingerlings per 5m^2.

Feeding Fish

a) They feed On planktons

b) Ground nut cake, kitchen waste, slaughter house waste, leaves, grass and chicken manure.

- They should be given enough food. Excess foods pollute and rot the pond.
- Change of food should be gradual.
- Manure and fertilizer should be added to encourage growth of planktons.

Cropping and Harvesting of Fish

Cropping

This is the removal of marketable size of fish from the pond.

Methods used to catch fish

a) Baskets
b) Spears.
c) Hook and line.
d) Nets.
e) Draining

Advantages of using seine nets over hook and line

a) Only marketable sizes of fish are caught.
b) Fish are not injured in the mouth.
c) Ensure large number of fish is cropped.

Harvesting

- This is the removal of all the fish from the pond by draining the pond.

Procedure

a) The inlet is closed stopping water inflow.
b) Normal cropping is done using a sine net to remove all large fish.
c) Outlet is opened to allow water to flow out.
d) A scoop net is used to catch the fingerlings which are kept in holding pond.
e) Water is completely drained for the pond to dry up.

Maintenance of the pond

i) Repairing the dyke or any structure on it.
ii) Cleaning the pond and remove foreign materials.
iii) Plant grass where necessary.
iv)Remove undesirable vegetation.
v) Remove silt.

vi) Restock after 2-4 weeks by returning the fingerlings to the pond using a scoop net.
vii) Control predators.

Fish Preservation

Practices carried out on fish before preservation

i) Clean the fish to remove mud and worms.
ii) Remove scales and slime.
iii) Open the fish to remove the gut and intestines (gutting).
iv) Clean the abdominal cavity thoroughly.
v) Keep fish in open containers.

Preservation methods

i) Freezing using deep freezers.
ii) Salting; use of salt solution or salt is rubbed.
iii) Sun drying: fish are spread on a mat and exposed to strong sunlight.
iv) Smoking: they are subjected to a temperature of 70^0C in a smoking pit/house where wood is used as fuel.

NB//

- Fish are transported to the market in refrigerated containers to prevent rotting.
- Fish are exported or sold locally.

Appropriate Handling of Livestock During Routine Management

i) Carefully avoid inflicting pain on the animals e.g. avoid physical beating.
ii) Use of structures when handling animals e.g. crushes, head yoke etc.
iii) Use tools for handling e.g. ropes, halters, lead-stick and bull rings appropriately.
iv) Use correct method of securing and casting the animal
v) Use little force when casting animals to prevent bone fracturing.
vi) Administer drugs safely e.g. by mixing them with food and water e.g. cocciodiostats.
vii) Drench carefully for example do not raise the head too high as this could choke the animal.

viii) Test equipment for giving the drug to ensure they are working such as the drenching and bolus gun.
ix) When injecting, sterilize the equipment or use fresh needles per animal to avoid infection.
x) When spraying, spray in open air during a wind free day to avoid wind drift to unintended places or animas inhaling the chemical.

NB//

- Remove dead animals or carcasses from the herd or flock and dispose off properly through burning and disinfect the area in contact with the carcass properly.

Weeds and Weed Control

A weed: Any plant growing where it is not required and whose economic disadvantages outweigh the advantages.

It is a plant out of place. Or a crop that volunteers to grow without having been planted (self setter).

Noxious weeds: Dangerous weeds whose cultivation is prohibited by law e.g. bhang.

Weeds Identification and classification

Identification

Common name Vernacular Botanical name

Classification

Basis:

- **G**rowth cycle.
- Plant morphology.
- Habitat.

Growth cycle

a) Annual weeds: Complete their life cycle in the field within a period of one year or less e.g. Mexican marigold, Black jack, Pig weed, etc. Annual weeds are easily controlled especially before flowering.

b) Biennial weeds: Complete their life cycle in two years. Achieve vegetative growth in the first year and produce seeds in the second year e.g. American wild carrot, spear thistle, ragwort etc.
c) Perennial weeds: **Take** more than two years or seasons to complete their life cycle. Include: Sedges, Lantana, kikuyu grass, Wandering jew, couch grass, Sodom apple. Etc.

Plant Morphology

a) Narrow Leaved weeds: Are grass weeds e.g. Couch, Spear, Setaria, eleusine etc. Grass weeds may be perennial or annual.
b) **Broad Leaved weeds**: E.g. Black Jack, Oxalis, Lantana, Pig weeds, Devil's horse whip etc. May be annual or perennial.

Competitive Ability of Weeds

Factors Contributing to competitive ability of weeds:

a) Produce large quantities of seeds.
b) Remain viable in the soil for a long time awaiting conducive germination conditions.
c) Some weed seeds are easily and successfully dispersed e.g. Fleabane (conyza spp) has developed structures used in wind dispersal.
d) Ability to propagate vegetatively e.g. Couch grass and Wandering Jew.
e) Elaborate and extensive rooting system.
f) Ability to survive where there is limited nutrient supply.
g) Short life cycle i.e. can complete their life cycle with restricted rain regime.

Harmful Effects of weeds

a) Compete with crops for nutrients, space, light, soil moisture therefore reduce crop yields.
b) Parasitic to cultivated crops e.g. witch weed (striga).
c) Lower the quality of agricultural produce e.g. Mexican marigold—gives an undesirable flavor to milk when dairy cows feed on it. Devil's horse whip, black Jack, Forget-me –not, bristly fox toilet get attached to sheep wool thus lowering its quality.
d) Some weeds are poisonous to man and livestock. E.g. Thorn apple ,Sodom apple (when unripe)

e) Some act as alternate hosts for insect pests and others for diseases e.g. Black jack for Aphids, Subukia weed, Mallow, flower of the hour etc hosts cotton strainers. Oxalis, wild oats alternate rusts disease.
f) Allelopathic: Produce poisonous substances that suppress the growth or germination of cultivated plants they contact e.g. Couch grass is allelopathic to Maize.
g) Block irrigation channels i.e. make it difficult for water to flow freely in irrigated land.
h) Affect fishing e.g. Salvinia and water hyacinth by blocking navigation and depriving fish and aquatic animals of oxygen dissolved in water.
i) Lower quality of pastures e.g. tick berry suppress pasture undergrowth. Nut grass and Manyata grass reduce palatability of herbage and carrying capacity of pasture fields.
j) Irritate workers thus reducing their efficiency e.g. Double thorn, stinging nettle, devil's horse whip etc.

Benefits of weeds to farmers

a) Edible to both man and livestock e.g. pig weed, wandering Jew, grass weeds etc.
b) Medicinal effects e.g. Sodom apple, stinging nettle, sow thistle.etc.
c) Act as soil cover, preventing soil capping due to impact of rain drops.(development of an impervious layer on the soil surface)
d) Add organic matter to the soil on decomposition.
e) Leguminous weeds add nitrogen in the soil.

Weed Control Methods

Dictated by –weather condition, type of weed, capital available and effects on the environment.

Include;

a) Mechanical weed control.
b) Cultural weed control.
c) Biological weed control.
d) Legislative weed control.
e) Chemical weed control.

1. Mechanical weed control

Involves:

i)Tillage(cultivation)

- Desiccate the weeds by exposing the roots to the air.
- Buries weeds thus killing them.
- Hand tools or tractor implements are used.
- Done during dry season to ensure better drying of weeds.
- Weeds are destroyed before they produce seeds to break their life cycle.

Advantages of tillage in weed control

- Cheap and therefore good for small scale farmers.
- Allow infiltration of water thus minimize soil erosion.
- Earthing up is done during tillage which encourages root growth.
- Crop residue is incorporated in the soil during tillage.

Disadvantages

- Pulverizes the soil thus destroying soil structure.
- Creates suitable conditions for weeds to germinate.
- Laborious and expensive in large scale.
- Leads to water loss, soil erosion and damage to crop roots.
- Does not effectively control perennial weeds.

ii) Slashing (mowing): Is the mechanical removal of shoots from weeds especially annual weeds when done repeatedly.

iii) Uprooting: Done where weeds are scattered or where crops are too close to allow mechanical cultivation.

2. Cultural weed control

Are crop husbandry practices carried out on the farm without use of chemicals.

Include:

i)**Mulching:** smothers weeds thus preventing weed growth.

ii) **Cover cropping**; Smother the weeds.

iii) **Crop rotation**: Weeds associated with certain crops will not germinate or grow when rotated e.g. striga in cereal crops and sugar cane.

iv) **Use of clean planting materials**: Prevent introduction of weeds into the farm.

v) **Proper spacing**: Creates little space for weed growth or form a canopy which suppresses weeds.

vi) C**lean seed bed:** Starts off crops on clean bed to effectively compete with weeds.

vii) **Flooding:** Discourages growth of all non aquatic weeds.

3. **Biological weed control:**

Is the use of living organisms to control weeds.

Include:

i)Use of livestock: e.g. goats in coconut and cashew nut plantations.

ii) Use of certain weed eating fish to control aquatic weeds.

iii) Use of Moths to control cacti.

iv) Beetles to control water hyacinth.

Advantages

- Cheap.
- Not poisonous or pollute the environment.
- Less laborious.
- Does not kill soil micro-organisms.
- Does not destroy soil structure.

4. **Legislative weed control:**

-Involves government laws and acts which prevent the introduction of noxious weeds in a country or the spreading of certain weeds from one part of the country to another.

Imported materials such as seeds, food and clothes are tested to certify they are weed free.

Limitations:

- Enforcement of laws is difficult.
- Only sample of materials are checked while the bulk of the material may have some weeds.

Noxious weed law; requires noxious weeds to be destroyed or not cultivated e.g. bhang (cannabis sativa).

5. **Chemical weed control:**

Herbicides are the chemicals used to control weeds.

Ways in which herbicides work to kill the weeds.

a) **Inhibition of nitrogen metabolism:** some interfere with nucleic acids (D.N.A, R.N.A) e.g. Atrazines which increase or reduce nitrogen metabolism. Glyphosate interfere with enzyme functions.

b) **Kill the cell:** The herbicides penetrate the cell wall, destroy it and enter cell cytoplasm, killing the cell e.g. Diquate, dinosel and oils. These are contact herbicides.

c) **Causing abnormal tissue development:** Include twisting, gall formation. Some herbicides interfere with plant growth e.g. phenoxy acetic acids, benzoic acids, 2, 4-D and M.C.P.A.

d) **Inhibiting photosynthesis:** Some herbicides interfere with chlorophyll formation e.g. Atrzines, Simazines, Duron, Linuron, and Uracils.

e) **Inhibiting Respiration:** some herbicides block movement of materials from the site of manufacture to other areas. They therefore cause acute poisoning e.g. Dinozebs.

Classification of herbicides

Include:

- **Formulation**
- **Time of application.**
- **Mode of action**
- **Environmental factors.**
- **Selectivity.**

i) Formulation

Is the physical form of herbicides e.g.

- Liquids: are soluble in water or oils. Are highly concentrated or toxic e.g. dalapon, paraquat.
- Wettable powders: Finely ground particles. Form suspensions with water before application. A spreader is applied in the suspension to prevent flocculation. Constant agitation of the particles also avoids clustering. Include: atrazines, simazines and duron.
- Granules: Granule form. Control water weeds e.g. duron.

ii) **Time of application: w**hen applied at different stages of weed growth, herbicides are effective. Include:

- **Pre-emergence herbicides**: Are applied soon after crop seeds have been sown but before they emerge. Kill the germinated weeds such that

crops germinate in a weed-free environment. Include: atrazines and simazines.

- **Post-emergence Herbicides: Are** applied after crop germination or transplantation or at different stages of crop growth. Include; 2,4-D, M.C.P.A, paraquat, Glyphosate etc.

iii) Mode of Action:

Include:

- **Contact Herbicides: Ki**ll only the parts of the plant with which it comes into contact.
- **Translocated Herbicides/Systemic: K**ill the whole plant even if it comes into contact with only a small part of it i.e. they are absorbed into the plant and translocated to all parts of the plant.

iv) Environmental factors: Affect effectiveness of herbicides.

Include:

- **Wind:** blow away splash wash to unintended places while decreasing chemical concentration to the intended places.
- **Rain:** Dilute or wash away the chemical to non-toxic levels. Leaches and reach herbicides to roots of deep rooted plants thus killing them.
- **Soil:** some absorb and retain more herbicides than others and therefore require more doses to be effective.
- **Light:** Increase in light intensity increases the rate of light of light absorption and photosynthesis by plants hence increasing absorption and translocation of herbicides and therefore causing faster killing of plants. Some herbicides are decomposed by high light intensity hence become less effective.
- **Temperature**: increase translocation hence absorption of more herbicides and therefore death of plants.

v) Selectivity

Include:

- **Selective.**
- **Non-selective herbicides.**

Selective herbicide: Injures one plant and allows the other to escape injury. Selectivity of herbicides depend on susceptibility and tolerance of each plant species.

Non-selective herbicide: Injures all kinds of plants because it interferes with photosynthesis.

Factors Affecting Selectivity and Effectiveness of Herbicides

a) **Stage of growth of the plant:** young plants are more susceptible to herbicides action because of their high growth activity.
b) **Physiological/metabolic factors:** beans have a poor rate of translocation of 2,4-D. maize is able to neutralize the toxic levels of 2,4-D to less toxic 2,4-B.
c) **Herbicides characteristics:** Herbicides which interfere with photosynthesis are non- selective.
d) **Concentration:** Under high concentration herbicides kill all kinds of plants.
e) **Formulation:** Oil formulations are more toxic to plants.
f) **Method of application;** High selectivity is attained by placing the herbicide where the weed is and away from the crop.
g) **Plant morphology and Anatomy:**

Morphological and anatomical characteristics of weeds that affect selectivity:

1. **Leaf angle:** Leaf angles which are inclined e.g. grasses are less susceptible as compared to horizontal angles such as dicots.
2. **Nature of leaf surface**: Plants with thick and waxy cuticles and surfaces retain less herbicides e.g. cactus, wandering jew.
3. **Differential heights of the plants:** Shorter weeds than crops or shorter crops than weeds, selectivity are attained e.g. spraying weeds under coffee bushes.
4. **Location of growing points**: Dicots are more susceptible to herbicides because their growing points and terminal buds are more exposed than in grasses.
5. **Difference in rooting system:** Shallow rooted plants are more susceptible to herbicides than deep rooted which require herbicides with long residue effect.
6. **Specialized structures:** Plants with underground structures such as rhizomes and bulbs e.g. sedges and oxalis are not easily killed by herbicides.

Safety Precautions in Use of Chemicals

a) Read manufacturer's instructions.
b) Wear protective clothing e.g. overall, breathing masks, gloves, and boots.
c) Avoid inhaling herbicide i.e. not spray against wind, not smoke and wear a breathing mask.
d) Bath thoroughly after handling the chemical and not eat before bathing.
e) Do not unblock blocked nozzles by blowing with the mouth.
f) Avoid spraying against the wind/not spray on windy days.
g) Avoid spilling herbicides on pastures and fodder crops.
h) Dispose of empty containers and left overs e.g. by burying them.
i) Do not wash spraying equipment in water sources used by livestock and humans.
j) Store chemicals out of reach of children and away from food.
k) Wash equipment thoroughly.

Advantages of using Herbicides

1. Require less labour than mechanical cultivation.
2. Adapted to control of bothersome weeds e.g. Couch grass and sedges.
3. Does not disturb crop roots and underground structures.
4. Makes control of weeds in certain crops easier e.g. wheat, burley, carrots.
5. Efficient in both wet and dry soil conditions as compared to mechanical cultivation.
6. Maintains soil structure.,
7. Convenient to use in certain crops e.g. sisal and sugarcane and weeds such as double thorn and stinging nettle which injure farmers.
8. Cheaper than manual or mechanical cultivation (on large scale farming).

Disadvantages

- Require skilled labour in mixing and application.
- Poisonous to environment and the user.
- Some herbicides have long residue effects (pollutes environment).
- Expensive—Uneconomical in small scale.

Revision questions

1. What is a weed?
2. Name two poisonous weeds.
3. State 5 harmful effects of weeds to farm crops.
4. State 5 methods of controlling weeds.
5. Give 5 factors that affect selectivity and effectiveness of herbicides.
6. State 4 problems encountered when using herbicides in the farm.
7. How does crop rotation control weeds?
8. State three beneficial effects of weeds.
9. Classify herbicides.
10. State 5 ways in which herbicides work to kill weeds.
11. State 3 factors that determine the rate of herbicide application.
12. a) What name is given to the chemicals used to control weeds?
    b) Explain the correct procedure for mixing gramoxone in a sprayer for weed control.
13. Explain any 4 factors contributing to the competitive ability of weeds.
14. State 3 characteristics of annual weeds.
15. State 4 effects of water hyacinth attack.
16. State 3 limitations of mechanical weed control method.
17. Explain any 4 cultural methods of weed control in a field of maize.
18. Describe the classification of herbicides on the basis of formulation.
19. a) Name 4 biological agents used in weed control.
    b) State 2 advantages of biological wed control.
20. State 3 factors which make herbicides cause crop injury or poor weed control.
21. State 4 factors to consider when choosing a method of weed control.

GRAZING SYSTEMS

There are three main grazing systems

- Rotational grazing
- Continuous grazing
- Zero grazing

1) Rotational Grazing

This refers to practice of allowing livestock to feed on a part of pasture for a period down to certain level before they are moved to the next. This gives time for pasture to properly regenerate.

Advantages of Rotational Grazing

a) Livestock make maximum use of pasture
b) Reduces the build up of parasites and diseases.
c) Animal waste is distributed evenly in all fields/paddocks.
d) Pasture area is given time to re-grow before its grazed on again.
e) Excess pasture can be harvested for conservation
f) Its possible to apply fertilizers in parts of the pastures are not in use
g) It facilitates reseeding and weeding.
h) The methods of rotational grazing include paddocking, strip grazing and tethering.

a) Paddocking

- A paddock is a fenced portion of a pasture in which animals are restricted for grazing.
- Paddocking means grazing livestock in one paddock for a short period and then moving to another.
- The size of the paddocks depends on the carrying capacity of the pasture.
- There should be a watering point at each paddock.
- A water trough is placed between two paddocks so that animals can drink water from either paddock.
- Paddocking saves herding labour. However, it is very expensive to construct.

b) Strip Grazing

- Done by allowing livestock to graze on restricted portion of the pasture at a time then moving them to the next.
- It's done on very high quality pastures. Electric fences can be used to enclose animals in a given strip of pasture. Where animals are not many herding may be done to restrict them to stay within the strips. Temporary fences may also be used instead of the electric fences.
- However, the system is quite expensive.

c) Tethering

-This involves tying the animal to a post with a rope such that it feeds within a restricted area.

-The rope may also have a metal ring that slides along a strong wire supported by strong poles.

2) Continuous Grazing (Herding)

In this type of grazing, the pasture is not allowed any resting period. This method can easily result in overgrazing if the stocking rate is not controlled. It's common in the semi-arid areas.

3) Zero Grazing (Stall Feeding)

-This is the practice of rearing animals in a permanent feeding enclosure known as the stall. Feed is cut and taken to the animals in the stalls.

-They are also provided with plenty of clean water and mineral licks.

Advantages

i) There is quick accumulation of manure
ii) Animals make use of the feeds without wastage
iii) Animals produce high yields due to less wastage of energy.
iv)It's easy to control diseases and parasites
v) It requires little land
vi)It allows higher stocking rate

Disadvantages

i) High initial capital is required
ii) High management skills are needed
iii) Need a lot of labour
iv)Diseases can easily spread.

REVISION QUIZ

i.) *Use of lethal temperature*.
ii.) *Suffocation*. This is used in the Cyprus bins where CO2 is introduced to suffocate pests.
iii.) *Flooding.* This can be used c to control pests such as armyworms and cutworms. Moles can also be killed through flooding.
iv.) *Proper drying of the produce.* This makes grains hard for pests to penetrate and discourages the3 growth of moulds. Grains should be dried up to a moisture content of 12%
v.) *Physical destruction of pests.* Hand picking and trapping can be used to control pests.
vi.) *Use of scarecrows.* They scare large animals and birds out of the farm.
vii.) *Use of physical barriers.* They include use of fences to control large animals and rat proofing in stores.

viii.) *Use of electromagnetic radiation.* Some wavelengths of electromagnetic radiations can be used to deactivate enzymes in some insect pests. Some pests are attracted by certain wavelengths such as moths are attracted by ultra-violet rays and aphids by yellow light. *Once attracted, heat or chemicals can then be used to destroy them.*

X-rays can also be used to control some storage pests.

3. Cultural Methods.

- This is the use of all the good farming practices to minimise and discourage pests from attacking the crops. Cultural practices do not eradicate or kill pets but alter the environment for pest's survival and discourage pest attack. These practices include the following.

i.) *Tillage.* This exposes soil borne pests to their natural enemies or exposes them to the hot sun, which kills them.

ii.) *Weed control.* Some weeds act as alternative hosts to crop pests. Removal of such weeds reduces pest infestation.

iii.) *Early planting.* This enables crops to establish earlier before pests multiply to large numbers.

iv.) *Burning of crop residue.* This destroys pests and their eggs reducing further attack on the next crop.

v.) *Crop rotation.* This interferes with the life cycle of pests reducing their population

vi.) *Use of clean planting materials.* This ensures that no pests or their eggs are introduced into the field.

vii.) *Planting resistant crop varieties.* E.g. goose necked sorghum reduces attack by birds.

viii.) *Closed season.* This is where a particular crop is not grown for a season to control a particular pest such a not growing maize to control maize stalk bores.

ix.) *Crop nutrition/application of fertilizer.* This encourages vigorous and healthy growth of crops, which can tolerate and escape pest attack.

x.) *Pruning.* This discourages conditions, which may favour the breeding grounds of pests in crops.

xi.) *Timely harvesting.* Crops can be harvested at the right time to avoid pest attack e.g. overripe fruits encourage attack by fruit flies.
xii.) *Proper spacing.* This discourages quick spread of pests.
xiii.) *Growing of trap crop.* This is the growing of a crop to trap certain crop pests either before or at the same time with the main crop.
xiv.) *Irrigation.* Overhead irrigation controls aphids in cabbages.

4. Chemical Control.

This involves the use of pesticides to control pests. Pesticides influence the pets in three ways.

- By direct poisoning.
- By inhaling.
- By ingesting.

The pesticide used should be

- Efficient
- Selective
- Cheap
- Persistent
- Safe to the user and the environment.

Classification of Pesticides

i.) *Formulation.* E.g. soluble powders, wettable powders, fumigants, dust, liquids, granules, emulsions etc.
ii.) *Target pest.*
- Insescticides
- Nematocides
- Rodenticides.
- Fungicides.

iii.) *Mode of action.* They may be classified according to the way they function into the following.

- *Stomach poisons.* These only kill those pests, which consume the sprayed crop with the chemical, hence are selective.
- *Systemic poisons.* They are circulated to all parts of the pest once it has eaten the sprayed part of a plant.

- *Contact poisons.* They kill the pests when they are absorbed in the body through the skin or cuticle. They are not selective and may kill many beneficial organisms such as predators, pollinators, decomposers, birds etc.
- *Suffocants.* They kill by interfering with the breathing system after being inhaled.
- *Anti-feedants.* They inhibit feeding on insects and other pests thus starving them to death.
- *Repellants.* They keep the pest away from the plant.

Factors affecting the Efficiency of Pesticides

i.) *Concentration.* Correct concentration should be used when diluting the pesticide, as it is the most effective.

ii.) *Timing of Application.* They should be applied at the stage of development when the pest is most susceptible to the pesticide.

iii.) *Weather conditions at the Time of application.* If the rain falls immediately after application of a pesticide, it may wash off or dilute the pesticide thereby reducing its effectiveness.

iv.) *Persistence.* If a pesticide can remain effective for long, then the better. This ensures that more pests can be controlled.

Advantages of Chemical Control

i.) Method is faster compared to other methods such as crop rotation, field hygiene etc.

ii.) Most pesticides have rapid knock-down effect hence the method is more reliable and predictable.

Disadvantages

- Expensive.
- Most are not environmental friendly since they are toxic to man and livestock
- They require care and skill when handling and applying them.
- Most are non-selective and therefore they kill useful insects such as pollinators and predators.
- Pests establish resistance to pesticides if they are used continuously against them. E.g. DDT.

5. Biological Pest Control

This involves the use of a living organism, which is a natural enemy of the pest.

Predator	*Aphids*
Ladybirds	*Aphids*
Wasps.	*Coffee mealy bugs*
Majimoto ants	*White scales*
Chicken	*Cotton stainers.*
Cats	*Moles, rats and mice*
Chameleons.	*Most insects*
Praying mantis.	*Giant loopers*

The method is environmental friendly but it can be very slow.

Crop Diseases And Their Control

Disease

- It is a condition that interferes, impairs or disturbs the normal performance of an organism.
- A disease is a deviation from good health.

Harmful Effects of Crop Diseases

i.) Lowers crop yield.
ii.) Poor quality products hence reduced market value.
iii.) They cause food poisoning by producing toxic substances such as *Aspergillus flavus* in maize produces *Afflatoxin*; *Ergot* in wheat and barley causes nerve endings.
iv.) Increase the cost of production.

Classification of Plant Diseases

- Fungal diseases
- Viral diseases
- Bacterial diseases
- Nutritional diseases (deficiency)
- Other causes.

1. Fungal Diseases

They are either parasitic or saprophytic. This gives rise to the following categories.

Obligate parasitic fungi. They completely depend on other living organisms for food. They are found in plant parts such as leaves, roots, stems, fruits etc.

Facultative parasitic fungi. They can live on both the living and dead tissues.

Saprophytic fungi. They live as decomposers on dead decaying plant and animal remains. They are beneficial in nutrient recycling.

Parasitic fungi are grouped into three:

- Those with all the mycelia (vegetative part) and the fruiting bodies on the surface of the host such as *Erysiphe spp*, which causes mildews.
- Those with the mycelia inside the plant tissues but the fruiting bodies on the surface of the host such as

Phytophthora infestans. ***Late blight in tomatoes and potatoes***

Puccinia spp. Rusts.

Ustillago spp. Headsmut.

- Those having the mycelia and fruiting bodies all inside the host. E.g. *Fusarium spp* causing Fusarium wilts.

Examples of Fungal

1.Late Blight

- Caused by *Phytophthora infestans* .the disease affects most members of the *solanaceae* family such as Irish potatoes and tomatoes.
- The fungi are parasitic and feeds by sending short *hyphae* called *haustoria* into the cells of the host.
- Haustoria absorb plant nutrients (manufactured food) from the plant cells resulting in the death of the cell.
- The fungi reproduce by spore formation, which are dispersed by wind and raindrops.
- It spreads very quickly during warm moist conditions.

Symptoms

- Rapid drying of the leaves forming dry patches (necrotic lesions) on leaves and fruits.
- Affected fruits appear rotten and fall off prematurely.

Control

- Spraying with Bordeaux mixture and other copper based fungicides.

2. Rusts

- Cause – Puccinia spp.
- They attack the leaves and stems of most cereal crops.
    - P. Sorghi - sorghum
    - P. graminis. Maize

Symptoms

- Infected leaves have red to brown pustules hence reduced photosynthetic are and low yields.
- Crops appear rusty.

Control

Spraying with Bordeaux mixture and other copper based fungicides

3. Smuts

- Cause – Ustillago spp.
    - U. scitiminea – sugar cane
    - U. nuda - wheat
    - U. maidis - Maize.
- This produces large number of black spores, which forms black masses on maize tassels and maize cob.

Control

- Hot water treatment of the seeds.
- Use of certified seeds
- Crop rotation.
- Field hygiene e.g. rogueing and proper disposal of previous crop residue.

4. Coffee Berry Disease (CBD)

- Cause – *Colletotricum coffeanum*.
- It attacks the flowers, leaves and berries.
- Flowers and leaves have dark brown spots.

- Spots on leaves develop along the margin and later spread to the rest of the leaf causing defoliation.
- The disease attacks both green and ripe berries.
- Attacked green berries fail to form beans and are hollow.
- Attacked ripe berries have sunken wounds and are difficult to pulp/process.

Control

- Spraying with appropriate copper based fungicides.
- Open pruning.
- Resistant varieties e.g. Ruiru 11.

Other Fungal Diseases

- Damping off. *Pythium spp.*
- Powdery mildew.
- Root rots – *Armillaria spp*.
- Downey mildew – *Peranospara spp*.
- Early blight – *Alternaria spp*.
- Anthracnose – ***Colletotricum lindemuthianum***

2. Viral Diseases

- All viruses are parasitic and very small.
- They are only able to reproduce and multiply in living tissues.
- When outside living tissues, they form spores in cysts, which remain inactive until they get into a living tissue.
- They are therefore obligate parasites. Viral infections interfere with important life processes of plant such as photosynthesis, respiration, transpiration, and nitrogen utilisation.

Symptoms of Viral infections

i.) Leaf chlorosis – loss of chlorophyll.
ii.) Leaf curling.
iii.) Mosaics – production of light green patches on leaves.
iv.) Malformations (distortions) of plant parts e.g. galls (swellings), small leaves etc.
v.) Rosetting –production of abnormally short nodes hence stunting.

NB/Insect vectors such as aphids and mealy bug transmit viral diseases. Infected vegetative parts such as sugar cane cuttings also transmit viral diseases.

Examples of Viral diseases

- Maize streak. – Formation of white/yellow stripes on leaves parallel to midrib.
- Greening disease – attacks leaves of citrus.
- Tristeza – attacks citrus trees. The leaves fall off and there is dying of twigs.
- Cassava mosaic -
- Brown streak of cassava
- Potato leaf roll
- Tobacco
- Groundnut rosette.

Viral diseases are controlled by controlling the vectors.

C. Bacterial Diseases

- Bacteria are facultative parasites. They are single celled and microscopic. Not all bacteria are harmful.
- Some are beneficial to man e.g. *Rhizobium spp* which is a nitrogen fixing bacteria.
- They may be transmitted through insects, wind, raindrop splashes, manures, seeds, irrigation water, cultivation implements and pruning knives.
- They enter plants through openings such as stomata, lenticels and wounds.

Symptoms of Bacterial Diseases

- Wilting even when water is in adequate amount due to blockage of xylems.
- Cankers – results into the death of plant tissues.
- Gall formation in the infected tissues.

i) Bacterial Blight of Coffee (BBC)

Cause – *Pseudomonas syringe.*

Bacteria enter plant through wounds and natural openings. It's common in areas experiencing hailstorms.

Symptoms

- Dark necrotic lesions with water soaked margins on affected parts.
- Shoot die back.
- Cankers on mature bark and wood killing the whole plant.

Control

- Spraying chemical eg. Supanil, before, during and after the flowering periods especially during the wet weather.

ii) Bacterial wilt (*Pseudomonas solanacearum*)

- Attack potatoes, tomatoes and other *solanaceae* plants
- Affected plants wilt even when the soil is moist.
- Leaves droop and plants eventually die
- High temperature accompanied by wet conditions favour the disease.

iii) Black arm of cotton

iv) Black rot of cabbage

v) Halo blight of beans

D. Nutritional disorders

When crops do not get enough nutrients, deficiency symptoms appear eg

- Yellowing of leaves
- Drying of leaves
- Falling of leaves, flowers and fruits
- Stunted growth
- Death.

E OTHER CAUSES

I. Flooding.
   - During flooding ammonia may be formed.
   - Since ammonia is toxic, it has burning effect to plants.

II. Chemical
   - Toxic chemical compounds in the soil may be absorbed by the plants leading to death of the plant eg. Cyanides.

III. Poor weather.
   - Extreme day and night temperature may be injurious to the crop. Eg very cold temperature causes frost injury in tea.

IV. Stress

- Stressful conditions on the plant such as irregular watering may causes physiological disorders such as blossom end rot in tomatoes.

Control of crop diseases

a) Cultural methods

- This involves the use of crop husbandry practices that discourages the outbreak of diseases without the use of chemicals. They include;

i.) Planting resistant crop varieties that can withstand the effect of certain diseases without lowering the yields eg Ruiru II is a coffee variety resistant to CBD.

ii.) Practicing proper spacing of crop. Overcrowding results to quick spread of diseases.

iii.) Use of health planting materials. Some diseases are seed borne and can effectively be controlled by use of artificial seeds for planting.

iv.) Practicing field hygiene eg burning of crop residue destroying infected plants etc.

v.) Drying of cereals and pulses to a moisture content of 12 – 13% before storage. This discourages attack by moulds (fungi)

vi.) Heat treatments of some planting materials eg treating sugar cane cutting with water at 50^0c for 30 minutes control ratoon stunting disease effectively.

vii.) Proper pruning of crop destroys the micro- climate that may have encouraged build up of diseases causing organisms.

b) Chemical control

- Chemical control should be practised only when all other methods have proved to be ineffective and when it's economical.
- Chemical control measures include:

i.)Seed dressing

This is the application of fungicides before planting seeds.

The fungicides prevent attack on the planted seeds.

ii.)Spraying

This is the application of chemical such as fungicides using a sprayer.

iii.)Soil fumigation.

This is the application of chemical (fumigants) in the soil. The chemical are usually in dust or granule form and are mixed with the soil to kill soil borne diseases causing organisms in the soil eg in the control of Bacterial wilt in potatoes.

Advantage of chemicals

- Chemical act faster in controlling diseases.(effective)
- Chemical requires less labour in application.

Disadvantages of chemicals

- Expensive
- Requires skills in application
- Toxic to humans and livestock
- Pollutes environment
- Some do not break down easily

c). Legislative method

This involves imposing of regulations and laws in cases of diseases outbreaks to prevent the introduction and spreading of diseases.

REVISION QUESTIONS

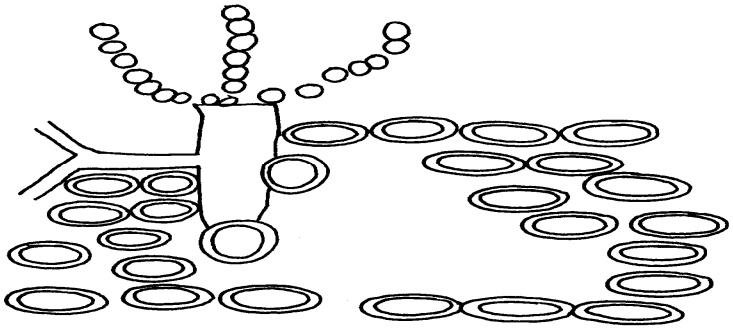
1 Below is a diagram of a bird which is a crop pest.

(i) Identify the bird_____ (½mk)

(ii) **State two** ways by which the bird causes loss in crops. (1mk)

(iii) **State four** methods which are used to control the pest. (2mks)

2. Study the diagram below and answer the questions that follow.



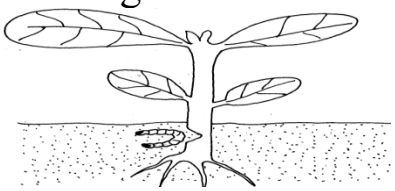
(a) Identify the fungal disease indicated above (½)

(b) State the causal organism of the disease identified above (1mk)

(c) State two symptoms of the disease above (lmk)

(d) State one control measure for the disease in the control field (lmk)

3. The diagram below shows a kale seedling attacked by a pest.



a) Identify the pest. (1mk)

b) What damage does the pest cause to the crop? (1mk)

c) State one method of controlling the pest. (1mk)

d) Name two other insect pests other than the one identified in (a) above that attack kale in the field. (2mks)

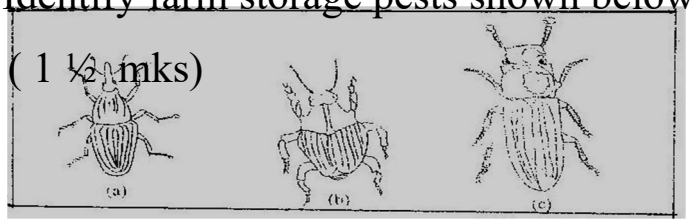
4. Describe the physical and cultural measures employed in the control of pests in crop production.(20 marks)

5. Given the pest shown in the diagram below

i) Name the barrier you would put on a grain store to control the pest

ii) Apart from the use of barriers list four other physical methods of pest control in and out store. (2mks)

6 (a) Identify farm storage pests shown below (1 ½ mks)



(b) Name crop products attacked by each of the above pests (1 ½ mks)

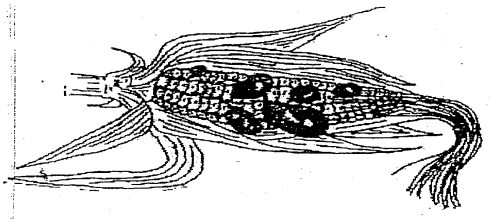
(c) Name one chemical control of the above pests (½ mk)

7. Define the following terms as used in crop pests and diseases; (2mks)

a) Economic Injury Level. (EIL)

b) Integrated Pest Management (IPM)

8. Below is an illustration of a maize cob attacked by smut disease. Study: it carefully and answer the questions that follow:



a) Beside w`hat is visible on the maize cob. State **two** other symptoms of the disease. (2mks)

b) State **three** control measures of the above disease. (3mks)

9. Study the crop pest illustrated below.

(a) Identify the crop pest. (1mk)

(b) State **two** effects of the above pest. (1mk)

(c) State **three** methods of controlling the pests. (3mks)

10) Describe the methods of disease control in crops under the following headings.

Cultural methods (14 Marks)

Chemical methods (6 Marks)

11) The diagram below represents crop pests

(a) Ide 

…… ……..…… (½ mk)

(b) Name **Two** crops that are attacked by the above pests (1mk)

(c) Give **three** control measures (1 ½ mks)

ANSWERS

1. I) Identify-A-Weaver bird (1x ½ = ½ mk

ii) 2 ways – bird causes damage

i) Eats grass

2) Causes the grains to fall off

3) Exposes maize cobs to rain leading to rotting

4) Strips the leaves (2x ½ 1mk)

2. (a) Blight (1x ½ = ½mk)

(b) phytophthora infestans(1x1=1 mk)

(ç) - fruits rot and fall prematurely

- Brown lesions on stems, leaves and fruits (2x ½ =1 mk

(d) Spraying using fungicides/Bordeaux mixture (lx1 mk)

3. a) - Cut – worm . ***(1 x 1 = 1mk)***

b) Cuts the stem of seedlings ***(1 x 1 = 1mk)***

c) - Application of appropriate pesticide / dust soil with aldrin and rake into soil. ***(1 x 1 = 1mk)***

d) i) Aphids

ii) Sawfly. ***(2 x 1 = 2mks)***

4. **Physical and cultural measures employed in control of pests in crop production**

Physical methods

i) Physical destruction of pests which involve hand picking or trapping and killing them eg moles in the garden
ii) Flooding-some pests like cut worms and army worms will be drawn if flooded. Flooding may be used to kill underground pests like moles
iii) Proper drying of the produce-drying of grains make them hard for pests to break and penetrate hence discouraging the growth of mould. Grains should be dried to moisture content of about 11-13% moisture content
iv) Use of electromagnetic radiation-certain wavelength of electromagnetic radiation like radioactive. Radiation may be used to deactivate enzymes in some insects and pests
v) Use of lethal temperature-this involves the use of extreme temperatures either too cold or too hot conditions to control pests by inhibiting their survival i.e. use of hot water to control pink ball worm
vi) Use of physical barriers-this include use of materials that prevent pests from getting to the crop i.e. rat guard/metal plates on posts of raised granaries. Construction of fences around the field and trenches to control large animals
vii) Suffocation-has been used in Hermetic Cyprus bins where build up of carbon (iv) oxide is used to suffocate pests
viii) Use of scarecrows-are used in scaring large animals and birds out of the farm

Cultural method

i) Closed season-the period in which a susceptible crop is not grown in order to control a certain pest or group of pests. During this period crop residues are collected and disposed off to ensure destruction of the pest.
ii) Timely planting-early planting of crops are more likely to escape pest attack than late planted ones eg maize stalk borers

iii) Timely harvesting- some storage pests like grain weevils attack the crop while in the field therefore early harvesting will enable the crop escape the attack
iv) Proper tillage- field cultivation will expose the pests which are soil borne like white grubs. The pest is exposed and scorched by the sun or eaten by birds and other predators
v) Planting resistant crop varieties-plant breeders have developed plants which have natural protective mechanisms against pest attack i.e Goose necked sorghum against birds
vi) Field hygiene- this means keeping the field free from any plant materials harbouring pests i.e. Rogueing and removal of crop residues from the field
vii) Alteration of environmental conditions-creations of certain micro-climate that is not conducive to some insects i.e. open pruning in coffee to discourage antestia bugs, mulching reduces thrips
viii) Trap cropping-a crop which is planted before or together with the main crop purposely for attracting away from the main crops. The pest is then killed by either spraying with chemicals, ploughing the crop or rogueing.
ix) Crop rotation-crops which are more preferred by a particular pest are rotated with those that are not or less preferred i.e. groundnuts and potatoes that control nematodes. This starves the pest to death.
x) Destruction of alternative hosts-some weeds act as alternative host to crop pests. The removal of such weeds reduces pest infestation
xi) Crop nutrition- application of fertilizers and manure makes the crops to grow strong and be able to resist and escape attack.
xii) Use of clean planting materials- this prevent introduction and spreading of crop pests. Seeds, suckers and crowns should be free from pests
xiii) Proper spacing- proper spacing makes it difficult for pests to move from plants to plant while close spacing in groundnuts discourage Aphids

xiv) Use of organic manure-FYM, compost manure has been found to discourage various pests ie eel worms

xv) Irrigation-overhead irrigation is able to control Aphids in cabbages

20x1=20 marks

6. (a) Identify farm storage pests shown below.

(a) Maize weevil

(b) Bean weevil / bean bruchid

© Flour weevil.

(b) Name crop products attacked by each of the above pests.

(a) Maize /wheat /barley/sorghum grains;

(b) Bean /bonavist bean /butter bean seeds;

© Maize /wheat/barley/sorghum/millet flour

(c) Name one chemical control of the above pests.

- Use of actellic powder on dry grains and seeds of maize and beans
- Respectively/primiphos-methy/organophosphate. (1/2 mark)

7 – it is the level at which the tolerance of a plant has been exceeded. (1mk)

- It is the combination of many methods to effectively control pests. (1mk)

8(a) -Severe dwarfness
-Increased tillering

(b) -Planting resistant varieties
-Use of certified seeds
-Field hygiene
-Crop rotation

9(a) -Maize weevil

(b) -Makes tunnels beneath the seed coat
-Make circular holes on the surface of the grain

(c) -Dusting maize cob with malaltion
-Fumigate maize with methyl bromide
-Proper storage hygiene
-Ensure grains are stored at correct moisture content

10 **a) Cultural methods of crop disease control.**

- Using healthy planting materials to prevent the crops from being infected by seed borne diseases.
- Practicing field hygiene such as a burning crop residue using clean implements, clean weeding to destroy micro-habitat for diseases.

- Proper seedbed preparation e.g. Control of root rot disease.
- Proper spacing to control dumping off diseases especially in nursery bed.
- Heat treatment to control ratoon stunting disease in sugar cane.
- Proper drying of cereals and pulses for proper storage.
- Use of disease resistant varieties e.g. Ruiru II, Resistant to CBD

Any 7, 1 for mentioning and 1 for explaining 7 x 2 = 14 marks

b) Chemical disease control in crops

- Through seed dressing application of fungicides on seeds before planting.
- Sol fumigation – application of fumigants in soil to control soil borne diseases.
- Spraying – application of fungicides / insecticides.

Any three 1 for mentioning and 1 for explaining 3 x 2 = 6 marks