SENIOR TWO AGRICULTURE

THEME: CROP PRODUCTION

TOPIC 2.1: CEREAL GROWING

Competency: The learner should be able to understand the basic parts of a plant and their functions, and should appreciate the growth requirements of crop plants and be able to grow cereals successfully

LEARNING OUTCOMES

The learner should be able to:

a) explain the ways in which crops are important to humans
b) understand the structures and functions of the basic parts of a plant
c) understand the structures and functions of the parts of the reproductive system of a plant
d) understand the factors that influence plant growth and crop production
e) show skills in classifying crops as annual, biennial and perennial
f) understand the value of cereals both in nutritional terms and as a commodity
g) understand how to select appropriate planting material for the cereal chosen for growing
h) show skills in growing cereals

ANNUAL CROPS PRODUCTION

Annual crops are those crops whose life span is one year or less. When planted, they grow up and reach maturity within one season. They include vegetables, cereals, legumes, field crops and root crops. Vegetables were covered in Topic 9 and in this Topic we shall deal with the other annuals crops.

CEREAL CROPS

These are also referred to as **grain crops** because they are mainly grown for grain production. They belong to the family of grasses called **Gramineae**. Their grain is biologically classified as a special kind of fruit called **caryopsis**. This grain is rich in carbohydrates, particularly starch. They also contain some protein, minerals like calcium and iron and vitamins. Worldwide, they are the major source of food for both humans and livestock. Table below gives the examples of grain crops grown in Uganda.

Table: Examples of grain crops grown in Uganda

English name	Scientific (Botanical) name
Maize	**Zea mays**
Finger millet	Eleusine corocana
Sorghum	Sorghum bicolor
Rice	Oryza sativa
Buirush millet	Pennisetum typhoides
Bread wheat	Triticum aestivum

Grain crops are grown almost in all the major climatic regions of the world because of the following reasons:

They can grow well in a wide range of soils

Several cereals are able to grow in each kind of climatic regions of the world as shown in Table below.

Climatic region	Cereals grown
Tropical	Maize, finger millet, sorghum and rice.
Sub-tropical	Maize, rice and wheat.
Warm Temperate	Barley and barley.
Cold temperate	Oats and rye.

Because of their high carbohydrate content, they serve as the major source of energy for humans and livestock.

Compared with other crops, they give high yields of dry matter (grain and straw) per unit area of land used.

The practices carried during production can be mechanized, for example, planting, weeding, harvesting, threshing and winnowing.

Compared with other crops, their production is less labour intensive.

MAIZE PRODUCTION

Maize originated from South America and was introduced in East Africa by the Portuguese. Currently, maize is one of the most important cereals grown in Uganda and East Africa as a whole.

Importance of maize

Maize is eaten in various forms. It can be eaten when roasted or boiled, as maize meal (posho) after grinding; it can be used to make porridge or local brew (kwete).

Maize can serve as feed for livestock in many forms. It can be fed to livestock in grain form, or the flour can be mixed with other ingredients to produce a concentrate feed. Also, the outer coat can be removed from the grains before grinding and fed to livestock as maize bran. Maize plants can be cut after flowering and turned into silage.

Maize is used in the manufacture of many industrial products which include starch, glucose, syrup, cooking oil and explosives.

Popularity of maize

Maize is very popular in Uganda because of the following reasons.

- It is more palatable as compared to other cereals.
- It generates a lot of income to the farmer.
- Where soils and climatic conditions can permit, it is the highest yielder per unit of land used.
- It requires less labour to produce compared to other cereals.
- It has a variety of uses, e.g., food, source of oil, animal feed, etc.
- Compared to other cereals, it is rarely destroyed by pests especially birds.

Varieties of maize

Maize varieties currently grown in Uganda are synthetic and hybrid varieties.

Synthetic varieties are obtained as a result of letting many inbred (pure) lines to cross-pollinate themselves. Synthetic varieties are capable of remaining stable especially with the changing environmental conditions and they are easy to produce. In addition, it is possible for the farmers to select seeds from their previous crop and use it again as seed for planting. Synthetic varieties were developed in Uganda at Namulonge research station. They include Longe 1 which was released in 1991. It is a quick maturing variety and it takes only 110 – 115 days. It is moderately resistant to major pests and diseases. Under good management, it can yield 2 – 4 tons per hectare of grain.

Hybrids varieties are obtained by crossing two or more inbred (pure) lines together under controlled pollination. Examples of hybrid varieties of maize which have been produced at Namulonge in Uganda are Longe 2H, Longe3H, Longe 4, Longe 5 (Nalongo) and PAN 67. Longe 2H and 3H can yield as much as 7 tons of grain per hectare. Longe 5 has high quality

protein as compared to other varieties of maize. Longe 4 is early maturing and resistant to drought. Other hybrid varieties are UH981and UH982. Under good and good management they can yield about 5-7 tons of grain per hectare. They take about 125 days to mature. They are resistant to major pests and diseases. However, the hybrids do not breed true to type. The second generation is very variable and gives poor yields. For this reason, the seeds for planting have to be purchased from farm shops every planting season. The farmer cannot use seed from his harvested crop for planting. Normally, hybrid varieties give higher yields than synthetic varieties. But hybrids require higher management standards in order to produce high yields.

Composite varieties are obtained after letting two or more open pollinated varieties to cross-pollinate. Improvement can be possible through recurrent selection. Farmers are able to retain seed from their own crop and use it for planting in the next season. Composite varieties used to be grown in the 1970s and were developed at Kawanda research station, hence the name Kawanda composites. An example is Kawanda Composite A (KWCA), which takes too long to mature (135 – 140 days).

Plant characteristics

Maize is an annual plant with a non-branching erect stem which can grow up to 4.0 – 4.3 m high depending on the variety of maize and the environmental conditions. The plant has a fibrous root system. It also has prop roots that grow from the nodes close to the ground and they provide support to the plant. The whole stem is divided into internodes of varying lengths by nodes. At the top of the plant there is the male inflorescence (tassel) which produces pollen. In the middle of the stem in the female inflorescence (cob or ear) which bears the female flowers. The leaves of the plant are parallel veined and are attached on to the stem by sheaths.

Growth requirements

Rainfall. Young maize is moderately drought resistant but requires a good soil air/moisture balance during the first 4-5 weeks after planting. Too much water (rainfall) just before germination prevents optimum growth. Optimum rainfall during the first five weeks after planting is 200 mm. From five weeks onwards, maize requires well distributed rainfall up to silking stage. Dry conditions are required when the crop is mature in order to reduce the moisture content of the grain.

Temperature and altitude. Different varieties of maize are suited for different temperatures. Suitable temperatures range from 20 – 30 ^{0}C. Too low and too high temperatures usually lead to rotting and late maturing, respectively. Maize grows well at altitudes from sea level up to

2400 m.

Soils. Maize grows well in deep, well drained, fertile soils and does not tolerate water logging. Maize grows well in a variety of fertile soils from sandy to clay, loam or silty loam soils with enough moisture and a pH 6 – 7.

Field operations

Seed bed preparation

The land should be prepared early enough for timely planting and proper decomposition of the vegetation. A rough seedbed is recommended because it does not encourage soil erosion and maize seeds can germinate properly in a rough seedbed. Also, a rough seedbed is cheaper to prepare. Land that had a crop in the previous season can be ploughed and hallowed once. Virgin land can be ploughed once and harrowed twice.

Planting

The seeds for planting should be of the variety recommended for that particular area or locality. It is important to use certified seeds. Use viable seeds of high germination percentage. Maize can be sown manually mechanically using a maize planter. Planting should be done at the correct time. In high potential areas, planting should be one week after the onset of rains. In medium potential areas, planting should be done at the onset of rains. In the areas with low potential, planting should be done before the onset of rains. Late planting should be avoided as this can result to low yield.

Advantages of planting maize early

- Plants benefit from nitrogen which is released by the dry soil when wetted.
- Plants benefit from moisture especially during the critical stages of growth, i.e., during tasseling and silking.
- The plants suppress weeds.
- They suffer less from fungal diseases.

Spacing

A spacing of 90 cm between rows and 30 cm between plants is recommended. If a maize planter is used to plant maize, the spacing should be 60 cm between rows and 40 cm between plants. Two to three seeds should be sown in each hole and then later thinned to only 1-2 plants per hole. This is done to avoid overcrowding. Crowded plants grow tall and thin and do not yield well because of competition for light, space, soil moisture and nutrients.

Spacing of maize during planting depends:

- The variety selected for planting
- Whether there is intercropping with other crops or not
- The climatic conditions such as rainfall and temperature
- Whether planting is done manually or, is mechanized.

Weeding

Maize should be weeded in the early stages of crop growth because it is easily out-competed by weeds. Weeds can be controlled manually using hand hoes on small scale farms or using herbicides such as Atrazine, 2, 4-D and Simazine on large scale farms. Two rounds of weeding always give good results or yields.

Fertilizer application

Maize plants respond to nitrogen and phosphorous. A nitrogen fertilizer such as sulphate of ammonia can be applied at a rate of 125 – 250 kgs/ha and a phosphate fertilizer such as single super phosphate can be applied at the rate of 125 kg/ha. Maize should be top dressed with a nitrogen fertilizer when the plants are 30 – 45 cm high (knee height).

Harvesting: Maize matures within 4 – 6 months depending on the variety. It can be harvested when the moisture in the grain is still high and dried in the sun, or in the crib. This allows the field to be prepared early for the next crop.

Pests of maize

Field pests

Maize stalk borer (Busseola fusca)

This pest bores and makes holes in the young leaves and stems of maize plants. The damage caused reduces the rate of water movement up to plant leaves. In severe cases, the plants wilt and die.

Control measures

Maize stalk borers can be controlled by:

- Use of chemicals such as Maladrex, Malathion and Endosulfan
- Burning plant residues
- Practicing early or timely planting and
- Practicing crop rotation as well

Army worms (Spodoptera exempta)

These are usually found in clusters mostly under the leaves. They appear greyish –green in color when still young. They suck sap from the leaves of plants causing them to turn yellowish.

Control measures

The Army worms can be controlled by:

- Spraying with pesticides such as Malathion and Endosulfan
- Early or timely panting
- Crop rotation
- Burning the crop residues
- Having a closed season.

Spotted stalk borer (Chillo partellus)

This pest damages the leaves and then also bores into the stem. It usually affects maize that is planted out of season.

Control measures

- Timely planting
- Crop rotation
- Applying chemicals, e.g., Endosulfan
- Burning the crop residues

American bollworm (Helicoverpa armigera)

This pest causes considerable damage to maize plants by boring into the cobs and feeding on the developing grain.

Control measures

Using chemical sprays such as Dimecron.

Avoid intercropping maize with crops that are attacked by this pest, e.g., cotton

Termites (Pseudocanthoterms militaris)

They feed on stems of maize at ground level. The damage is severe at the onset of the dry season.

Control measures

- Apply pesticides such as Aldrin and Dieldrin.
- Destroy anthills within and near the fields

Leaf hoppers (Cicaducina inbila)

These suck sap from the leaves of plants. As they do so they transmit maize streak virus from plant to plant.

Control measures

Early planting

Use of closed season

Storage pests of maize

Maize weevil (Sitopholus zea mais)

This pest attacks both shelled grain and that on cob. The weevil bores into the grain and feeds on the endosperm.

Control measures

Applying pesticides in powder or dust form, e.g., Lindane dust and Malathion dust.

Drying the grain on cob properly before storage.

Avoid storing maize in same store with other crop products that are attacked this weevil, e.g., rice, cassava and cow peas.

Angoumois grain most (Sitotroga cerealella)

Infestation starts in the field and continues in the store. It also attacks wheat and sorghum.

Control measures

Ensure thorough drying before shelling.

Apply Lindane dust.

Red flour beetle (Tribolium castaneum)

This pest feeds and lays its eggs in the maize flour.

Control measures

Apply Lindane dust on to the grain

Rodents

Rats and mice can cause considerable damage by feeding on the stored grain. They also contaminate stored grain with their droppings.

Control measures

Using rat poison such as Zinc phosphide, Diphacinone and Warfarin

Using rat traps

Making the store rat proof by constructing the store above ground on supports and fixing rat guards on to the supports to prevent rodents from climbing into the store.

Diseases of maize

Leaf blight

It is caused by fungus called Helmithosporium turcicum, which is soil-borne disease. The affected plants show greyish-green lesions on the leaves. The leaves eventually dry up. In severe cases, the plants die or become stunted and do not produce cobs.

Control measures

Crop rotation with crops that do not belong to the maize family

Growing resistant varieties.

Maize streak virus disease

This disease is caused by virus (viral disease). Affected plants show yellowish or white stripes or lines on the leaves running parallel to the leaf veins. The plants become stunted and they never produce cobs.

Control measures

- Uprooting and burning the affected plants. They can also be fed to livestock.
- Practicing crop rotation
- Practicing closed season so as to control the leaf hoppers
- Applying chemicals to kill leaf hoppers
- Growing resistant varieties.

Gray leaf spot

It is caused by fungus called Cercospora zeae maydis. Affected leaves show brown, long narrow and rectangular lesions. In severe attack, the entire leaf may become affected and this leads to premature death of the affected plants.

Control measures

Carrying crop rotation

Burning crop residues

Rust

It is caused by fungi called Puccinia sorghi and Puccinia polysora. The leaves of the affected plants show dark brown spots on the lower sides.

Control measures

Growing resistant varieties.

Maize breeding

Definitions of common terms:

Inbred line. This is a pure line developed by allowing the plant to pollinate itself and selection is done by the breeder for up to seven generations until homozygous plants are obtained.

Homozygous plants. They are plants obtained after several generations of self-pollination (inbreeding).

Hybrids. These are plants obtained after crossing two or more different inbred lines under controlled pollination.

Composites. These are varieties obtained after letting two or more open pollinated crop varieties to pollinate themselves randomly.

Synthetics. These are varieties obtained by letting inbred lines to pollinate themselves randomly.

Heterosis. This is a genetic variation where the progeny are more superior to than the parents.

Objectives of maize breeding

To develop varieties that are:

- Resistant to adverse environmental conditions such as diseases, drought and pests.
- Able to mature uniformly.
- Early or quick maturing.
- Resistant of lodging.
- Of high quality e.g., high protein content.
- Well covered by husks so as to protect the grain from birds and attack by fungi.
- High yielding.

Selection (breeding) methods

For maize breeding to be effective there must be sound selections.

They include the following.

Mass selection. This is referred to as random selection where ears are selected randomly from planted plots. They are shelled and mixed together in one container (bulked). The seeds are then planted in rows in the following season. The ears (cobs) from the best rows are selected randomly shelled and the gain bulked. The process continues until plants that are uniform in characteristics such as height, colour and shape of grain, time to maturity, resistance to certain diseases, etc. are obtained.

Ear–to–row selection. In this method, the selection is done as follows:

- About 250 ears are selected and shelled.
- Seeds from each ear are kept separately.
- Seeds from each ear are planted in a row.

- The best 10–20 rows are selected and their seeds planted another year or season. The process is continued until the plants with the desired characteristic are obtained.

Recurrent selection. This method involves:

- Isolation of the first generation (F1) lines from the desired source to be improved.
- Developing the lines in the top cross.
- Inter crossing of a group of lines selected from the above.
- Synthesis of the population for the next cycle.

Types of maize hybrid crosses

Single cross. This is a hybrid progeny obtained from crossing two inbred lines. (inbred line **A x** inbred line **B**).

Double cross. This is a hybrid progeny obtained from crossing two single crosses together. e.g. (single cross **A x B**) **x** (single cross **C x D**).

Top cross. This is a cross between an inbred line and an open pollinated variety e.g. synthetic varieties.

Three way cross. This is a cross between an inbred line and a single cross e.g. (single cross **A x B**) x inbred line **D**.

SORGHUM PRODUCTION

Sorghum is a cereal crop grown mainly for its grain. It is drought resistant and it is mainly grown in areas receiving scanty rainfall. In Uganda it is mainly grown in the drier and hot lowland areas of the eastern and northern (Lango, Teso, Karamoja) where it is a staple food, and south-western regions (Kabale, Kisoro, Rukungiri). It is believed to have originated from Eastern Africa (Ethiopia and Sudan).

Importance of sorghum

Sorghum grain may be prepared and consumed in many ways by man. For example, it can be ground and used to make porridge (obushera) and local brew (omuramba, marwa, ajon), it is mixed with banana juice to make beer (mwenge), it can be mixed with millet and/or cassava and mingled to make a paste (ugali). It is used by brewing industries to make beer. The stems and leaves can be used as feed for livestock.

Plant characteristics

Sorghum has an extensive root system, which enables it to be drought resistant. Some sorghum varieties produce tillers (side shoots) but most have a single stem. The stem is erect and is

divided into sections called internodes by nodes. On each node there develops a leaf attached on to the stem by a sheath. Stem height depends on the variety and ranges between 1.0 and 3.6 m tall. The heads also vary according to variety; the panicle may be loose or compact. It may be erect or bent like the neck of a goose (Figures (i), (ii) and (iii). Colour of grain varies from pale yellow to red and the grains are covered by husks (glumes). The plants can be ratooned.

Improves varieties of sorghum

Serena and **Dobbs.** Both varieties are light brown seeded and mature in about 100 days (3 months). They are short cultivars (1.5 m tall). Serena yields about 3–4 tons of grain per hectare, while Dobbs yields about 2–3 tons of grain per hectare.

Seredo and **Sekedo.** Both varieties are high yielding (3–5 tons of grain per hectare) and their grains are light brown in colour. They are suitable for lowland areas below 1530 m above sea level. Sekedo is moderately tolerant to stem borers and shootfly.

Epuripur. It produces white grain and of high quality though the yield is low (2.5–3 tons of grain per hectare). It is also suited to low land areas. It matures in about 110 days ($3^1/_2$ months). It is susceptible to damage by birds. It is moderately tolerant to stem borers and shootfly.

Hijack, Himidi and **Hibred hybrids.** These varieties are high yielding (up to 6 tons of grain per hectare). They are susceptible to the shootfly, and they reach the height of about 1.55 m tall.

Growth requirements

Rainfall. Sorghum does well in areas with well-distributed rainfall of about up to 425–625 mm during its growing period.

Temperature and altitude. It is grown in altitudes of 900–1500 m above sea level. It requires warm conditions with a mean temperature of 30 ^{0}C.

Soils. Sorghum grows well in a variety of soils from sandy to clayey, but should be well drained and fertile. Compared to maize, it is resistant to water logging and yields well on less fertile soils.

Reasons to why Sorghum performs well in dry areas

- Sorghum has an extensive root system that is able to absorb water from a large volume of soil.
- Sorghum plants contain silica that prevents them from collapsing during droughts
- The process of photosynthesis is more efficient in sorghum
- Sorghum leaves usually role inwards and the stomata close, so as to reduce the rate of evaporation (water loss from plants).

Field operations:

Seed bed preparation and planting

The seedbed should be prepared properly (fine seeds) as the sorghum seeds are small. Germination in a rough seedbed is not uniform and this leads to uneven maturity of the plants. It can be done by ox-plough, hand or tractor.

Planting

Planting should be done at the on set of rains. Methods that can be used row planting and broadcasting. Row planting is highly recommended as compared to broadcasting. Four to five seeds are planted in each hole and then later thinned to one plant per hole.

Spacing

Depends on the moisture content in the soil, soil fertility, altitude and cultivar. Because of being tall, local varieties should be planted at a wide spacing (i.e., 90 cm between rows and 30 cm between plants). Improved varieties should be planted at a close spacing (i.e., 60 cm between rows and 20 cm between plants).

Weeding

This should be done at early stages of the crop growth. Where broadcasting has been used, weeds are uprooted by hand. Where row planting was used, weeds can be removed by hoeing. Two rounds of weeding are recommended if high yields are to be realized. Selective herbicides, such as Atrazine and 2,4-D can be used.

Thinning

This is done to remove unhealthy, poor quality and excess sorghum seedlings. This should be done at early weeding (two weeks after planting) in row planted sorghum. It is done when sorghum is 15 cm tall.

Fertilizer application

Sorghum responds to phosphorus and nitrogen. A phosphate fertilizer can be applied when sowing at the rate of 100–200 kgs/ha. Where necessary, top dressing with a nitrogen fertilizer can be done at the rate of 100 kg/ha.

Harvesting and processing

Sorghum is ready for harvesting in 3–9 months depending on the cultivar. Harvesting is done by cutting the heads (panicles) from the stalks. After drying, threshing is done to remove grains from the husks.

Drying and storage

The grain should be dried to moisture content of 10–11percent and treated with an insecticide before storage. Sorghum can be stored while still on the head. But when stored in this way, sorghum becomes susceptible to the grain moth.

Pests of sorghum

Birds

Birds, particularly Sudan Dioch (Quelea quelea aethiopica) feed on ripening grains and cause serious yield reduction. Birds are the most damaging vertebrate field pests of sorghum.

Control measures

- Use of traps
- Scaring birds with scare crows
- Growing goose necked cultivars
- Growing cultivars with grains having husks.
- Growing bitter sorghum varieties

Sorghum shootfly (Atherigona soccata)

It attacks sorghum 5–25 days after seedling emergence. The larvae enters the plant through the funnel made by young leaves. Their feeding destroys the growing points of the seedlings. When attacked very early, the plants produce tillers and produce more heads. But the tillers and unattacked plants mature at different times leading to irregular harvests and yields are low. Leaves turn, purple, white.

Control measures

- Destroying volunteer host plants in around the sorghum field
- Timely planting
- Use of insecticides such as Carbofuran, Disulfoton. Aldicab, Dimethoate, Endosulfan, Carbaryl and Cytrolane.
- Destroying crop residues after harvesting
- Crop rotation
- Mixed cropping with non-host crops
- Planting resistant cultivars.

Stalk or stem borers

These are occasional field pests of the aerial pasts of sorghum. They cause damage by feeding on the young leaves and later tunneling into the stems, which leads to poor plant growth and

reduced yields. They include Maize stalk borer (Busseola fusca), Spotted stalk borer (Chilo partellus), Pink stalk borer (Sesamia calamistis).

Control measures

- Applying chemicals such as Endosulfan, Carbaryl, Malathion, Sevin and Carbofuran
- Timely planting
- Use of resistant or tolerant cultivars
- Growing varieties with uniform maturity period
- Destroying crop residues after harvesting
- Destroying volunteer host plants in around the sorghum field
- Removal of affected plants before the larvae hatch
- Crop rotation
- Mixed cropping with non-host crops
- Timely application of insecticides e.g. DDT & Endosulfan.

Sorghum midge (Contarinia sorghicola)

The adults are minute reddish flies that are difficult to detect. They lay eggs inside the glumes with the help of a long ovipositor. The eggs hatch in 2-3 days and the larvae suck sap from developing grains, which prevents grain development. Attacked grains become shriveled. With heavy infestation, the whole panicle produces no grain.

Control measures

Applying chemicals such as Dimethoate, Phosalone, Diazinon, Endosulfan, Carbaryl and Malathion.

Early and uniform planting

Growing quick maturing varieties

Burn or bury crop residues, especially old heads and trash during the dry season

Destroy self-sown or ratoon plants that come into flower early in the season

Growing resistant varieties

Storage pests of sorghum:

These include the rice weevil (Sitophilus oryzae) and Angoumois grain moth (Sitotroga cereallela). They are dangerous pests of stored sorghum grain in Uganda. The attack occurs in the field and they are later carried into the stores.

Control measures

Use of chemicals such as Malathion, Actellic and Carbofuran

Proper drying of the grain before storage.

Diseases of sorghum

Smut (Covered kernel smut)

It is caused by a fungus called Sporiosorium sorghi. Attacked grains become filled with a sooty mass of spores. The fungus of disease is seed borne.

Control measures.

- Growing resistant cultivars,
- Field sanitation, e.g., destroying infected plants and crop residues
- Seed dressing
- Growing resistant varieties
- Planting and use of certified seeds.

Leaf blight

This is caused by Exserohilum turcicum fungus. The disease attacked sorghum plants when intercropped with maize. Affected plant leaves turn whitish and dry up. The whole plant might be affected in severe cases.

Control measures

Growing resistant cultivars like Dobbs and Serena.

Anthracnose.

It is caused by a fungus called Cilletotrichum graminicola. Long elliptical lesions appear on the lower leaves of affected plants and progress upwards. Leaves turn reddish to purple.

Control measures

- Planting resistant cultivars.
- Destroying crop residues after harvesting
- Destroying volunteer host plants in around the sorghum field
- Crop rotation

Objections of improving sorghum

- To develop palatable cultivars, e.g., cultivars with low hydrochloric and prussic acids
- To develop disease and pest resistant cultivars
- To obtain cultivars that mature uniformly

- To develop cultivars that are resistant to lodging
- To develop cultivars that are early maturing
- To obtain cultivars that are resistant to Stringa weed, e.g., Serena is fairly resistant.
- To develop high yielding cultivars

FINGER MILLET (Eleusine carocana)

Finger millet is the second most important cereal crop in Uganda after maize. It is mainly grown in the eastern, northern and western areas of the country where it is a staple food. It can be stored for a long time without using insecticides. Its seeds are small such that they dry out quickly and insects cannot live inside them. It can be used to combat famine or serve as a food security crop in drought prone areas, since it can be stored long without getting spoilt.

Importance of millet

- Finger millet is ground to make flour that is mingled and eaten as millet bread (ugali).
- It can be used to make drinks such as porridge (obushera) and local brew (malwa, ajon).
- It can be used as poultry feed.

Varieties of millet

Most of the varieties grown are local, and can be identified at maturity by characters such as plant height, maturity period, shape and size of panicle and grain colour. Improved varieties that have been released include PESE 1, PESE 2, Serere 1, Gulu E and Egenyi. All of them take 90–100 days to mature. PESE 1 and PESE 2 are high yielding (2.0–3.5 tons of grain per hectare) than the rest which yield only about 2 tons of grain per hectare.

Plant characteristics

Finger millet plant has a dense, shallow fibrous root system. The stem is erect and grows up to 1.25 m. At the tip of the stem is an inflorescence consisting of four to nine spikes. It has narrow grass-like leaves, each attached on to a node by a leaf sheath.

Growth requirements

Rainfall. It requires moderate, well distributed rainfall of about 1000 mm during the growing season. It is very sensitive to dry spells due to being shallow rooted.

Temperature and altitude. Finger millet grows well in the temperature range of 18–27 ^{0}C

Soils. Finger millet needs well-drained fertile soils. It grows best on free-draining sandy loam

soils.

Field operations:

Seedbed preparation

A fine seedbed is needed for finger millet since the seeds are very small. Two to three tillage operations are required. A clean seedbed is required to reduce weed competition, and the crop is very difficult to weed.

Planting

Traditionally, finger millet is sown by broadcasting the seed using hands, followed by covering with a thin layer of soil. The recommended method is to plant millet in rows spaced at 30 cm. A planter or an ox-drawn seeder can be used in planting. Being small, the seeds should be placed not more than 5 mm depth. Row planting makes weeding and harvesting easier.

Weeding and thinning

Weeding is done manually using hands. It is very slow and requires a lot of labour. When it is sown in rows, ox-drawn weeder can be used to weed. Finger millet must be weeded early, when it is about 7.5 cm tall. Thinning is done simultaneously with weeding, to a spacing of 3–5 cm between plants. Transplanting can also be done to fill up the gaps. Second round of weeding should be done four weeks after the first one.

Fertilizer application

The majority of farmers do not apply fertilizers. But with a decline in soil fertility caused by continuous cropping, it has become necessary to apply fertilizers. Finger millet responds to nitrogen and phosphorus. The recommended fertilizers are Single super phosphate (SSP) at the rate of 125 kgs/ha applied after seedbed preparation and Sulphate of ammonia at the rate of 125 – 250 kgs/ha applied as a top dressing four weeks after germination.

Harvesting and drying

Local varieties reach maturity in 120-130 days, while improved varieties take about 110 days. Harvesting should be done immediately after ripening to avoid shattering and damage by birds. Harvesting is labour demanding and is usually done communally. A small hand knife is usually used to cut the heads from stalks. The heads are then dried in the sun. After thorough drying, the crop is stored in the granary without threshing.

Pests of finger millet

Finger millet has no major storage pest problems. Apart from birds that may be a problem when the grains are still in the soft stage of growth, finger millet is free from pests.

Control measures

Scaring off the birds

Diseases of finger millet

Blast

Finger millet is mostly affected by blast disease, which is caused by a fungus called Pyricularia grisea. It attacks different plant parts, i.e., leaves (leaf blast), nodes (node blast), neck of inflorescence (neck blast) and the head (head blast). Plants attacked by leaf blast show linear lesions on the young leaves and small circular spots with greyish brown centres and reddish margins on the older leaves. Affected leaves die prematurely. Plants attacked by head blast show black lesions on the inflorescences or heads and nodes.

Control measures

Application of chemicals, e.g., Benlate.

TOPIC 2.2A: ROOT AND STEM TUBER GROWING

Competency: The learner should be able to grow and process root and stem tubers for the market

LEARNING OUTCOMES

The learner should be able to:

a) understand the meanings and the value of roots and stem tubers, both in terms of nutrition and as a commodity
b) understand how to select appropriate planting material for the crop chosen for growing
c) show skills in growing roots/stem tubers
d) show skill in handling roots/stem tubers during and after harvest
e) show skill in processing and solar drying of roots/stem tubers

INTRODUCTION TO ROOT CROPS

These include cassava (Manhot esculenta), sweet potatoes (Ipomoea batatas) and yams (Dioscorea spp). They produce swollen roots, which serve as food storage organs. These roots store large quantities of starch, and thus can be eaten as sources of carbohydrates.

CASSAVA PRODUCTION

Cassava belongs to the family Euphorbiaceae. It is believed to have originated from South and Central America. It is one of the most important roots crop grown in Uganda. Cassava roots contain cyanogenic glucoside, which changes to hydrocyanic acid (HCN) when the roots are damaged. Sweet varieties contain lower amounts of HCN than the bitter ones. The content of HCN in cassava depends on genetic and environmental factors, such as soil fertility and length of drought. Bitterness can be removed from cassava by eliminating HCN through processing. Cassava is popular because it is:

- Drought tolerant
- Able to perform relatively well on less fertile soils
- Resistant to pests

- Able to stay long in the soil without getting spoilt, thus can serve as a famine crop
- Less labour demanding to grow and process it.

Importance of cassava

- Fresh tubers can be boiled or heated in oil and eaten.
- Dried tubers can be ground into flour and mixed with finger millet, sorghum, or maize flour and mingled into bread (ugali, kalo, atapa).
- Starch can be extracted from the roots and then used the textile industry
- Cassava leaves can be eaten as green vegetables.
- Cassava is used to make local drinks such as kwete, malwa.

Varieties of cassava

Cassava varieties are classified according to the levels of HCN in the roots and leaves.

Cassava with high HCN contents. These include local varieties such as Ntogolo (found in West Nile) and Kikapa (found in Kamuli district).

Cassava with low HCN contents. These include Bukalasa 8, Bukalasa 11, Nase 1 and SS 4.

Intermediate types. These include Nase 2, Ebwanatereka and Nase 3 (Migyera).

High yielding, cassava mosaic disease resistant varieties that have been developed and released to the farmers include Nase 1, Nase 2 and Migyera. Nase 1 yields about 25 tons/ha, while Nase 2 and Migyera yield about 40 and 45 tons/ha, respectively. Nase 1 takes 12–14 months to mature, while Nase 2 and Migyera take 12–15 and 10–12 months, respectively.

Plant characteristics

Cassava is a biennial shrub that grows up to a height of 1–4.5 m. It is propagated mainly by stem cuttings or stakes. Adventitious roots develop on the cuttings, and subsequently develop into fibrous roots. After 1–2 months from planting, the fibrous roots begin to swell and form tubers. The shoot system develops from axillary buds located on the nodes on the cuttings. After growing to a certain height, the stems produce 2–3 branches at the apex. This is repeated after the branches have grown up to a certain length. The leaves are attached on to the stem by long petioles. The lamina is simple with a smooth margin but palmately lobed. The plants produce flowers that are cross-pollinated and give rise to seeds.

Growth requirements

Rainfall. Cassava is a fairly drought resistant crop and can be grown in areas receiving 500–750 mm annually. But it requires 1000–2000 mm of rainfall annually for optimal growth.

Temperature and altitude. Cassava grows well under warm climate, and thus cannot grow at altitudes greater than 1500 m. Optimum temperature range is 24–30 ^{0}C.

Soils. It can grow best in well drained, deep, fertile soils. But it can grow and yield fairly even in areas with less fertile soils. Shallow and stony soils discourage tuber growth. Yields are low on very fertile soils because they encourage vegetative growth instead of tuber development.

Field operations

Seedbed preparation

A rough seedbed is recommended. The seedbed may be ridged or flat-tilled. Sometimes planting is done on flat seedbeds and then the soil is drawn around the plants during weeding to form ridges.

Planting

Good quality, disease free stakes are should be planted if high yields are to be realised. Planting should be done in such a way to ensure at least two months of rainfall for proper crop establishment. The stakes can be placed in the planting holes vertically, inclined at angle or holizontally, depending on soil type and occurrence of soil pests like termites. When placed vertically, at least two-thirds of the stake should be buried under the soil. When placed horizontally, the whole stake should be buried to a depth of 10 cm.

Spacing

This depends on variety planted, soil fertility level, amount of rainfall, cultural practice (mono or intercropping), and end-use of the tubers. In pure stands, the spacing should be 1.5 x 0.9 m or 1.2 x 1.2 m for short-term varieties, and 1.8 x 1.8 m for long-term varieties.

Weeding

Cassava should be kept weed-free within the first 3–4 months after planting to allow for proper establishment and tuber formation (tuberization). Weeds can be controlled by hand hoeing or using chemicals such as Glyphosate and Gramaxone. A cover crop such as beans and groundnuts can be grown to provide a ground cover.

Harvesting

The time of harvesting depends on the variety plants and varies between 6 and 36 months. Cassava should be harvested before the roots harden or become fibrous. Harvesting can be done using hands in light soils and where the crop was planted on ridges. A few tubers can be harvested when needed for consumption. The whole crop may be harvested and sold while still

fresh, or sliced and dried. Once the tubers are harvested, they should be consumed as soon as possible before they get spoilt.

Pests of cassava

Cassava mealybug (Phenococcus manihoti)

This pest was introduced in eastern and western Uganda in 1992 from Kenya and Democratic Republic of Congo (DRC). It causes serious damage in areas that experience prolonged droughts and those that receive scanty rainfall. The mealybugs suck sap from the shoots and also inject toxic saliva into the shoots which causes defoliation and death of stems.

Control measures

- Early planting in areas with heavy and long rains
- Planting resistant varieties such as Nase 1 and Migyera
- Biological control using a wasp called Apoanygyrus lopezi from South America has been able to reduce the populations of the mealybug significantly.
- Integrated control measures involving the use of crop resistance, early planting, disinfecting planting materials, weed control and biological control.

Green cassava mite (Mononychellus tanajoa)

This is the most serious pest of cassava plants. Serious damage occurs during the dry season and to cassava plants grown in infertile soils. The adult mites attack the growing points and suck the plant sap. Affected plants show poorly developed tubers, stunted growth, leaves become mottled and yellow, and there is complete defoliation (leaf shading) under severe infestation.

Control measures

- Integrated control measures involving the use of crop resistance, early planting, weed control and biological control.
- Planting clean cuttings
- Uprooting and burning affected plants
- Applying chemical such as Rogor
- Not planting cassava in the same field for some time

Termites (Pseudocanthoterms militaris)

These feed on stakes before they sprout. The damage is more serious when stakes are planted during drought in sandy soils.

Control measures

- Planting at the onset of the rainy season.
- Destroying anthills within and near cassava fields.
- Applying Diedrin into the anthills.

Cassava scale

This is a small, white, pear shaped insect which sucks sap from stems and branches. Heavily infested plants become defoliated and wilt, leading to reduced yields.

Control measures

- Uprooting and burning affected plants
- Using clean planting materials.

Elephant grasshopper (Zonocerus variegatus)

This attacks cassava during the dry season and at the onset of the rainy season. It feeds on the leaves causing total defoliation of the crop.

Control measures

- Spraying the plant with Dieldrin and Fenitrothion.
- Early planting

Whiteflies (Bemisia tabaci)

These are white, sap sucking insects. As they feed they transmit cassava mosaic virus that causes cassava mosaic disease.

Control measures

- Early planting

Diseases of cassava

Cassava mosaic disease

This is a viral disease. Currently, it is the most serious disease of cassava. It is spread by planting infected cuttings and by the white flies. Infected plants become stunted, the leaves are mottled yellow and poorly developed, the tubers are poorly formed, all of which leads to reduced yields.

Control measures

- Uprooting and burning infected plants.

- Planting varieties of cassava that are mosaic resistant, e.g., Nase 1 and Migyera.
- Planting disease free stakes.
- Applying chemicals to destroy the whiteflies that spread the virus.

Brown streak disease

It is also caused by a virus. It is spread by the whiteflies and infected cuttings. Affected plants show dark brown strips on the stems, mottled leaves that later turn yellow and black necrotic lesions the roots.

Control measures

- Planting clean cuttings.
- Uprooting and burning infected plants

Leaf spot

It is caused by fungus called Cercospora henningsii. Affected plants have angular or rounded spots on the leaves that are brown on the upper side and greyish on lower sides.

Control measures

By disease free stakes.

SWEET POTATO PRODUCTION

Sweet potato belongs to the family Convolvulaceae. It is a herbaceous, perennial plant although it is cultivated as an annual crop. It is the third most important starchy staple food crops of Uganda after cassava and banana. It is grown as a subsistence crop in small plots.

Importance of sweet potato

It is an important food security crop for both rural and urban households. The root is boiled or fried and then eaten.

Varieties of sweet potato

A very large number of local varieties are grown in various parts of Uganda. Improved varieties that have been released to farmers are Tanzania (TZ), Tororo 3, New Kawogo, No. 29 (Bwanjule), No. 39 (Wagabolige) and No, 389A (Sowola). These varieties are high yielding, resistant to sweet potato virus disease and are highly accepted by consumers.

Plant characteristics

Sweet potato is vegetatively propagated using stem cuttings. Adventitious roots develop on the

nodes of cuttings that are buried in the soil. Some of the roots become gradually swollen and serve as food storage organs. Each plant produces many trailing stems, and roots develop on the nodes that touch the ground. The shapes of leaves and tubers and tuber colour vary from variety to variety. Some varieties have deeply lobed leaves, while others have leaves with entire lamina. The plant produces flowers that give rise to capsules containing 1 – 4 seeds.

Growth requirements

Rainfall. Sweet potatoes are drought resistant, and grow very well in areas with scanty rainfall (i.e., 750 mm annually).

Temperature and altitude. Sweet potatoes perform well in warm and cool areas. They can be grown at altitudes ranging from sea level up to 2000 m.

Soils. Potatoes grow in a variety of soils, but they give good yields when planted in fertile soils.

Field operations

Seed bed preparation

Sweet potatoes are mostly grown on mounds, which vary in height depending on the type of soil. Small mounds are used in soils containing a lot of clay. In Uganda, ridges are used in hilly areas like Kabale and West Nile so as to control soil erosion, and in swampy (lowland) areas where drainage is poor. Intercropping sweet potatoes with other crops, such as beans is possible where ridges are used.

Planting

Planting can be done at anytime as long as there is sufficient moisture in the soil. Vegetative propagation is most widely practiced, and pieces of vines (cuttings) are used as planting materials. Some farmers allow them to wilt, or even sprout before they are planted. The number of cuttings planted on each mound depends on the size of the mound. The number recommended is three cuttings per mound. The cuttings are planted by burying the cut end in the soil.

Spacing

When grown on ridges sweet potatoes, the ridges are space 0.9 – 1.5 m apart, and the cuttings are spaced at 0.3 – 0.6 m along the ridge.

Weeding

Weeding sweet potatoes is necessary within the first 1–2 months after planting, and it is done by hand or using hand hoes. When fully established, sweet potato vines cover the ground and suppress the weeds.

Fertilizer and manure application

This in not necessary because, nitrogen fertilizers encourage vegetative growth at the expense of tuber development; and phosphate and potassium fertilizers do not increase the yield significantly.

Harvesting

Depending on the variety and environmental conditions, sweet potatoes take 4–8 months to reach maturity. This can be done using sharpened stick instead of hand hoes so as to avoid damaging the tubers. Few tubers can be harvested at a time, or the whole crop can be harvested at once and sold.

Pests of sweet potatoes

Sweet potato butterfly (Acraea acerate)

The larvae of this pest feed on the leaves causing defoliation and consequent yield loss. The attack is more serious during the drought.

Control measures

- Early planting to escape damage during drought
- Applying chemicals such as Carbaryl, Ambush, etc.
- Collecting and destroying nests of young caterpillars

Whiteflies (Bemisia tabaci)

These are small flies that suck sap from young leaves and shoots of potato vines. They transmit the sweet potato chlorotic stunt virus from one plant to another.

Control measures

- Growing more resistant varieties.
- It is not economical to use chemicals to control the whiteflies.

Clearwing moth (Synenthodon spp)

The larvae of this pest bore into and feed on the vines destroying transport tissues of the plants. The larvae can also migrate or tunnel through the vines and into the tubers. This pest can also

bore directly into the tubers when in storage.

Control measures

- Treating vines with chemicals, e.g., Aldrin dust before planting.
- Planting vines that are free from the pest
- Timely planting and harvesting
- Crop rotation
- Burning infested plant materials and alternate host plants

Sweet potato weevils (Cyclas brunneus and Cyclas puncticollis).

The larvae make tunnels into and feed on the vines and tubers. As they feed, they destroy transport tissues in the plants and also spoil the tubers making them bitter and discoloured. Severe attack occurs during the dry season. These weevils can also survive on weeds belonging to the same family as the potato.

Control measures

Same as for clearwing moth.

Sweet potato aphid

These suck sap from young leaves and stems causing wrinkling and curling of leaves. They transmit a number of viral diseases from one plant to another, e.g., the sweet potato feathery mottle viruses.

Control measures

- Usually, it is not necessary since the natural enemies such as lady bird beetles, spiders and wasps are effective
- By spraying with chemicals like Dimethoate, Carbaryl, Malathion and Diazinon.
- Early planting

Diseases of sweet potatoes

Alternaria blight

This is caused by a fungus. The disease causes irregular brown lesions on older leaves, leaf petioles and stems. The tubers become decoloured and sometimes may rot.

Control measures

- Destroy crop residues and volunteer plants
- Use clean planting materials

- Planting resistant varieties.

Fusarium wilt

It is caused by a soil-borne fungus called Fusarium oxysporium sp. batatas. The disease causes yellowing of leaves and wilting and death of vines.

Control measures

- By growing resistant varieties
- Use of clean planting materials
- Destroying crop residues

Foot rot

It is caused by a fungus called Plenodomus destruens. Attacked plants show dark spots at the bases of stems at soil level. The spots form lesions that encircle the stems causing them to darken and finally dry up. Harvested tubers can also rot in storage.

Control measures

- Use clean planting materials
- Destroying crop residues

Sweet potato viral diseases

Sweet potatoes are attacked by many viral diseases and they include the following:

Sweet potato feathery mottle potyvirus disease. This is transmitted or spread by aphids. Symptoms are chlorotic spots on older leaves, cracking of tubers, leaves become stunted and distorted.

Sweet potato chlorotic tunt cloresterovirus or stunting disease. Infected plants become stunted with small distorted leaves, narrow and crinkled, with a chlorotic mosaic or vein clearing.

Control measures for viral diseases

- Planting resistant varieties
- Uprooting and burning infected plants

TOPIC 2.2B: LEGUME AND OIL SEED

Competency: The learner is able to grow and store legumes and oil seeds for the market

LEARNING OUTCOMES

The learner should be able to:

a) know the structure of a seed and understand the functions of each part
b) show skills in breaking seed dormancy in crops and optimising germination (s, u)
c) understand the value of legumes and oil seeds in both nutritional and financial terms
d) understand how to select appropriate seeds for growing a chosen crop
e) show skills in growing legumes and oil seeds
f) show skill in handling legumes and oil seeds during and after harvest
g) know, understand and apply the skills involved in the various methods of storing legumes and oil seeds

They all belong to the family called Leguminosae, and they fix atmospheric nitrogen into the soil. They are quite rich in proteins and some of them such as groundnuts and soybean are rich in oil. For most of them, seeds are eaten except for the French beans of which pods are eaten.

Examples of legumes grown in Uganda

English name	Scientific/botanical name
Beans	Phaseolus vulgaris
Garden and field peas	Pisum sativum
Chick pea	Cicer arietinum
Pigeon peas	Cajanus cajan
Soybean	Glycine max
Groundnuts	Arachis hypogea
Cowpeas	Vigna unguiculata
Sunflower	genus Helianthus

PRODUCTION OF BEANS

Beans also known as common bean are low growing annual plants. They have a wide range of distribution throughout E. Africa. They are only absent where temperatures are too high or too low to allow proper fruit setting.

Importance of beans

- The seeds are boiled and then eaten as source of protein. Young leaves can also be boiled and eaten.
- The residues can serve as feed for livestock
- They can be intercropped with other crops such as maize so as to provide a cover to the soil, hence prevent soil erosion.

Varieties of beans

A number of improves varieties of beans have been developed and released in Uganda. They include K20, K131, K132, OBA1, MCM1015 and MCM2001. Varieties K20, K132 and OBA1 are determinate in growth habit or bush type and they take 80 days to mature. Varieties K131, MCM1015 and MCM2001 are of indeterminate growth habit and they take 88- 90 days to mature.

Plant characteristics

Beans are annual leguminous plants with a well-developed tap root system. There may be nodules on the roots, and some bean varieties do not nodulate at all. The leaves are trifoliate and the fruit is a pod containing seeds. The growth habit of beans varies greatly; some are determinate with bush type growth habit while others are either indeterminate climbing, or non-climbing types. Flower colour also varies a great deal, and they are mostly white. Seeds are of very many shapes, sizes and colours.

Growth requirements

Rainfall. Beans require a well distributed rainfall throughout the growing season. Less rainfall is required towards harvesting to avoid discolouration of seeds due to attack by pests and diseases.

Temperature and altitude. Beans grow well at altitudes between 900–2100 m above sea level. High temperatures cause poor pod formation.

Soils. They perform best in fertile soil, well drained soils.

Field operations

Seed bed preparation

Beans have large seeds and therefore they do not require a fine seedbed. The seedbed can be harrowed once after primary cultivation. It should be prepared at least 11/2 months before the date of planting to allow complete decomposition of the vegetation and weeds.

Planting

Planting should be done at the onset of the main rains, and 2 – 3 seeds should be places in each hole. Planting of beans intended for the seed industry and for canning should be done at a time which will allow maturity to coincide with dry weather.

Spacing

The spacing used depends on the growth habit of the variety planted and the method of planting. Bush (determinate) types are usually closely spaced than indeterminate types. Recommended spacing for bush types is 60 cm x 15 cm for hand planting and 66 cm x 7.5 cm for machine planting.

Weeding

This is done by using a hand hoe or hands if the soil is wet. One round of weeding carried out three week after planting can effectively control the weeds.

Fertilizer application

Beans respond to nitrogen and phosphorus. But because of being a low yielding crop, it is not economical to apply fertilizers.

Harvesting

Beans are usually left to dry up in the field, especially those for the seed industry. Harvesting is done by uprooting whole plants and transporting them to the drying ground. When all the pods are dry, they are threshed, winnowed and spread again under the sun to dry up thoroughly before storage.

Pests of beans

American bollworm (Helicoverpa armigera)

The damaging stage of this pest is the larva (caterpillar) whose colour varies from yellowish-green to brown with dark and light stripes. The larvae make circular holes in the sides of the pods, enter and feed on the developing seeds. Attacked pods may wilt and die. This pest attacks many other crops such as maize, cotton, tobacco and tomato.

Control measures

Applying chemicals such as Dimecron, Endosulfan, Thiodan.

Bean fly (Ophiomyia spp)

The eggs are laid on the leaves of seedlings. After hatching, the larva migrates through the leaf petiole to the base of the stem at ground level, feeds on it and later pupates. The attacked plant turns yellow, the base of stem swells and cracks, and eventually the plant dies or becomes stunted.

Control measures

- Seed dressing with chemicals such as Endosulfan, Dieldrin.
- Early planting.
- Crop rotation.

Spotted (cowpea) pod borer (Maruca testulais)

The larvae are cream or olive green in colour, with rows of black spots on the dorsal and lateral surfaces and a black head. They feed on flowers and then later bore into the pods and feed on developing seeds.

Control measure

Applying chemicals such as Dimecron, Endosulfan.

Bean aphid (Aphis fabae)

They are black in colour. They cluster on to the growing points, leaves and pods. In severe cases affected plants wilt and die. It occurs when it is slightly only. They suck sap from plants causing stunted growth. Also, this aphid transmits bean common mosaic virus from one plant to another.

Control measures

- Controlling the aphid with chemicals such as Pirimicarb, Ambush, Dimethoate, Thiodan and Diazinon.
- Early planting

Bean flower thrips (Taenothrips sjostedti)

The adults are tiny, shiny-black insects which are found concealed in the leaf buds and flowers. The adults and nymphs feed at the bases of petals and stigma. Flowers of affected plants become damaged and discoloured, and they drop prematurely. The damage is severe during

drought.

Control measures

- Applying insecticides such as Cypermethrin
- Intercropping beans with cereals such as maize
- Mulching the garden.

Bean bruchid (Acanthoscelides obtectus)

This is the most important pest of beans in storage. It attacks beans while still in the field. The larvae bore through the pods and into the seeds where they feed making tunnels within the seeds. After pupation, the adult beetles emerge by breaking the seed coats at the ends of tunnels leaving circular holes on bean seeds. Emerging adults can lay eggs, which eventually hatch into larvae that attack more bean seeds.

Control measures

- Thorough drying of beans before storage
- Dusting the beans in storage with Gamma-BHC dust or Lindane dust

Diseases of beans

Bean anthracnose

This is caused by fungus called Colletothricum lindemuthianum. It is normally favoured by cool temperatures and humid conditions. The fungus is spread by insects, rain splash, wind and infected seeds. Attacked plants have brown or black lesions on the undersides of the leaves, leaf petioles, branches, stems and pods. Infection on pods appear as pink to black spots which develop into sunken cankers containing pinkish masses of spores. Seeds within diseased pods become infected.

Control measures

- Growing resistant varieties.
- Crop rotation.
- Destruction of crop residues.
- Use of clean/certified seeds.
- Applying chemicals such as Dithiocarbamate, Dithane M45 and Benomyl.

Bean rust

This disease is caused by fungus called Uromyces appendiculatus and Uromyces phaseoli.

White spots appear on the leaves and they develop into reddish-brown pustules on the lower and upper leaf surfaces. Severe infection leads to leaf deformation and premature defoliation. Rust is favoured by moderate temperatures and prolonged wet conditions and is spread by air borne spores and by rain splash.

Control measures

- Growing resistant varieties
- Spray using Dithiocarbamate.
- Intercropping with cereals like maize

Bean common mosaic disease (BCMD)

This is caused by bean common mosaic virus (BCMV), which is transmitted by aphids and infected seeds. Affected plants become stunted, leaves become mottled and brittle, and leaf margins curl downwards.

Control measures

- Growing resistant varieties
- Uprooting and burning infected plants

Halo blight

It is caused by bacteria called Pseudomonas psyringae. It is favourable by coal humid conditions and it can be spread by rain splash, insects and infested seeds. It is characterized by water-soaked spots on the lower leaf surface and on pods accompanied by a halo of greenish-yellow tissue around the water soaked areas.

Control measures

- Growing resistant varieties
- Planting healthy seeds.
- Rogue and burn infested plants.
- Crop rotation, at least a two-year rotation.

Angular leaf spot

It is a fungal disease caused by Phaeoisariopsis griseola. The fungus is seed borne. Affected leaves show grey spots on the lower leaf surface which later turn brown and then to black colour and hairy. The lesions are angular because of delimitation by the veins. Pod and stem

lesions are reddish brown and often surrounded by a dark coloured border. It is spread by infected seed and trash, by wind and rain splash.

Control measures

- Growing resistant varieties, e.g., K131, K132, OBA1, MCM1015, MCM2001 and K20.
- Crop rotation.
- Use of clean/healthy seeds.
- Intercropping with cereals
- Destruction of crop residues in the field

PRODUCTION OF GROUND NUTS

They are also called peanuts and they originated from South America.

Importance of groundnuts

- Groundnuts can be crushed and used to make soup which accompanies the main dish, or can be eaten when fried. Groundnuts are rich in protein, minerals, vitamins and oil.
- Oil can be extracted from groundnuts and used for cooking and making margarine.
- The residue that remains after extracting oil is used as livestock feed.

Varieties of groundnuts

Varieties of groundnuts are grouped into two main types basing on the growth habit.

Erect bunchy types. These have an upright central stem and vertical branches. Examples are Red Beauty and Bukene.

Spreading types. These have a short upright central stem with laterals growing horizontally along the ground. An example is Igola-1.

Erect types are less yielding than the spreading types when grown under similar conditions. Currently there are three commercial varieties grown in Uganda. These are Roxo 531, Red Beauty and Igola-1. Roxo matures in 100–110 days with an average seed yield of 1260 kg/ha, while Red Beauty takes 90–100 days and yields about 1100 kg/ha. Igola-1 matures in 120–130 days and is higher yielding (2.5–3.3 tons/ha), resistant to rosette virus disease and is tolerant to drought.

Plant characteristics

The groundnut plant is an annual herbaceous legume. It has a tap root system and the roots bear

nodules. Depending on the growth habit, the stem is either of the erect or spreading type and the leaves are pinnate. Each inflorescence bears yellow flowers which are self-pollinated. After pollination, the stalk on to which the ovary is attached grows into a peg. The peg bearing the ovary at its tip grows downwards and enters the ground. While underground, the ovary develops into a pod with 1–6 seeds.

Growth requirements

Rainfall. Groundnuts require 1000–1300 mm of annual rainfall that is well distributed throughout the growing period. A three-month wet season is needed for proper growth of groundnuts. Dry weather can cause poor vegetative growth, poor peg penetration into the soil and the development of small shriveled nuts. Dry conditions are needed for harvesting and drying of groundnuts.

Temperature and altitude. Groundnuts require a warm climate. They grow best at altitudes ranging from sea level up to 1500 m.

Soils. Light, sandy, fertile, calcium-containing soils are the best. Calcium deficiency causes poor seed formation.

Field operations

Seed bed preparation

The seedbed for groundnuts does not need to be made fine, since they have large seeds.

Planting

It is advisable to carry out sowing early in the rains so as to ensure rapid and uniform germination. Late-planted groundnuts are seriously attacked by rosette virus disease and leaf spot disease. Chop and plant method is commonly used when planting but row planting is the best. Depth of planting is between 5 and 7.5 cm.

Spacing

Close spacing is necessary so as to obtain a complete soil cover which reduces the population of aphids in the crop. Rosette virus disease which transmitted by aphids is consequently reduced. The recommended spacing for erect bunchy varieties is 45 cm x 10 cm and 45 cm x 15 cm for spreading types.

Weeding

Groundnuts should be weeded in the early stages of growth, as weeding after flowering

interferes with the formation of pods.

Fertilizer application

Application of SSP fertilizer at the rate of 125 - 250 kg/ha just before planting has been recommended.

Harvesting

Maturity in groundnuts is indicated by the darkening of the veins on the inner surface of the pods or shells. Groundnuts are ready for harvesting when most of the leaves are shed and when pods turn dark brown inside. Harvesting is done by uprooting the plants manually using hands. The pods are then plucked off the plants and dried in the sun. Alternatively, the plants are turned upside down after lifting and left to dry in the field. The pods are then removed by hand. Delayed harvesting and drying encourages chances of attack by soil-borne fungi.

Pests of groundnuts

Aphids (Aphis crassivora)

These suck sap from young leaves, shoots and flowers causing abnormal growth. During feeding they transmit the groundnut rosette virus from plant to plant.

Control measures

- Early planting
- Close spacing
- Applying insecticides such as Menazon, Dimethoate, Phpsphamidon, etc.

Diseases of groundnuts

Cercospora leaf spot

This is caused by a fungus called Cercospora personata. Affected plants have dark brown to black spots are seen on the upper and lower surfaces of the leaves. The disease is spread by wind and is severe under humid conditions.

Control measures

- Early planting
- Seed dressing with fungicides like Thiram
- Crop rotation

- Destruction of the infected and volunteer plants
- Destroying crop residues

Groundnut blight

It is caused by a fungus called Sclerotium rolfsii which is soil borne. The attack is severe during wet weather. Attacked plants wilt and die in patches in the field. When closely observed, the lower parts of affected plants are covered with white fungal mycelium and there are sunken brown lesions on stems near ground level.

Control measures

- Early weeding
- Uprooting and destroying affected plants

Groundnut rosette virus disease

This is caused by virus that is transmitted by the aphid called aphis craccivora. The leaves of affected plants become mottled and curl. The internodes become shorter leading to stunting of plants.

Control measures

- Close spacing to discourage the attack of plants by aphids
- Planting as early as possible
- Applying insecticides like Menazon, Endosulfan and Dimethoate.

SUNFLOWER PRODUCTION

Sunflower belongs to the family Compositae. It is an oil crop and contains 25–50 percent oil depending on the variety. It is mainly grown in the northern and eastern parts of Uganda.

Importance of sunflower

Sunflower is the second leading oil crop in the world. Provides high quality edible oil. After extracting oil from seeds the residue is used to make livestock feed.

Varieties of sunflower

Sunfola with black seeds is currently the only recommended variety. It is early maturing; its oil content is 40 percent and yields about 1.8 tons of seed per hectare.

Plant characteristics

Sunflower is an annual plant with an erect stem whose height ranges between 0.6 and 4.5 m depending on the variety. The plant has a tap root system with dense surface feeder roots. The leaves are large and ovate. The inflorescence forms at the stem apex and is circular.

Growth requirements

Rainfall. It is suited to drier areas and can withstand drought conditions better than other crops. It grows well in areas receiving 750 mm rainfall annually.

Temperature and altitude. It can be grown from sea level up to 2600m.

Soils. It grows well on a wide range of free draining soils, ranging from sandy to clayey soils.

Field operations

Seedbed preparation

Land preparation should be done early enough so that planting can be done on time. The tilth should be fairly fine. On large scale farms, weeds can be killed using pre-emergency herbicides.

Planting

Up to five seeds should be sown in each hole because some do not germinate. Planting should be done early so that flowering can coincide with maximum rain, and the harvesting with dry season.

Spacing

This varies with the area and variety planted. It can be spaced at 90 x 30 cm or 75 cm x 50 cm with 1–2 plants in each hole, or 75 cm x 25 cm leaving one plant per hole after thinning.

Weed control

Should be kept free from weeds within the first month. Manual weeding can be done in small scale farms.

Fertilizer application

Sunflower does not require high application if the soil is naturally fertile. NPK or CAN may be applied at the rate of 40 – 80 kgN/ha.

Harvesting

Harvesting should be done when the heads turn brown. A lot of shattering occurs if the heads dry up before harvesting is done.

Pests of sunflower

Birds

These are the most important pests of sunflower, and they can cause total loss if not controlled.

Control measures

- Scaring them off

American bollworm

This pest bores into the stems of plants and make tunnels that later cause wilting of plants.

Control measures

Applying chemicals such as Sevin, Malathion, and Endosulfan.

Other pests include rodents and termites. The damage they cause is minor.

Diseases of sunflower

These include rust, bacterial stem canker, virus leaf mottle, stem or stalk rot, head rot and leaf spot. These diseases are of minor importance since they do not cause significant crop damage.

THEME: ANIMAL PRODUCTION

TOPIC 2.3: DOMESTIC ANIMAL REARING

Competency: The learner should be able to rear and market a domestic animal profitably.

LEARNING OUTCOMES
The learner should be able to:

a) identify different types of farm/farmed animals and their purpose
b) understand the value of rearing domestic animals both in terms of their contribution to the human diet and as a commodity through which farmers make a living
c) understand how to select an animal to rear
d) understand the basics of caring for domestic animals, including the nutrient and feed requirements and provision of water
e) show skills needed to keep farm animals in healthy state
f) understand the types of housing for different animals and the reasons for the designs, and show skills in constructing an animal house
g) understand the digestive and reproductive system of ruminants and non-ruminant animals
h) understand the significance of animal feeding programs
i) know how to conserve and use feeding resources
j) understand how to prepare fodder grass and crops for feeding animals
k) understand the importance of planned animal breeding and selection

Livestock farming is simply the management and breeding of domestic, livestock or farm animals for the purpose of obtaining their meat and products (milk, eggs, leather, etc.). It can also be described as the economic activity that involves raising domestic animals for human consumption and obtaining meat, milk, wool, fur, honey, among others.

Importance of livestock production or domestic animal rearing

- Livestock production is important to people in many different ways:
- It is a source of food in form of milk, eggs and meat. Therefore it is the source of is the useful form of dietary protein and energy.
- Livestock products like milk, eggs and meat skins, hides and horns are sold to earn income
- Livestock act as assets that can be converted into cash whenever the family needs it
- It is a security asset influencing access to informal credits and loans and being also a source of collateral for loans.
- Livestock is used in the payment of dowry in most cultures in Uganda
- Livestock is a source of animal manure which is used in crop production.

- Livestock is also used to transport agricultural inputs and outputs and people. Animals such as horses, donkey and yaks can be used as means of transport
- Livestock is also used in traditional rituals, ceremonies and festivities and is given as a gift in worships (e.g. installation of ancestral spirits, ritual slaughter, bride wealth).
- The grazing of livestock is sometimes used as a way to control weeds and undergrowth. For example, in areas prone to wild fires, goats and sheep are set to graze on dry shrub which reduces the risk of fires.
- Livestock produce a range of fibre/textiles. For example, sheep and goats produce wool and deer and sheep can make leather.
- Livestock is a source of farm labour for example ox-ploughing

Factors affecting livestock production

A number of physical, biological and socio-economic factors interact to influence the nature and extent of animal agriculture practiced in any region.

Here are some of the factors:

- Climatic factors like temperature, rainfall, and humidity also affect livestock production
- The type of soils; fertile soils promote livestock production in may ways such as growing of fodder crops for animal feeds
- The type of vegetation also affects livestock production for example cattle, goats and sheep require grass
- Availability of suppliers (vets, equipment, feed companies). These are important in providing health services to livestock
- Availability of land: keeping livestock requires land. However, the size of land will depend on the type and number of livestock kept
- Water availability and quality influence the livestock sector, which uses water for animal drinking, feed crops, and product processes
- Diseases and parasites affect the health of livestock and thus their production
- Location of processing plants encourages farmers to keep animals
- Availability of capital is important in managing livestock farms

Care and protection of domestic and pet animals:

Like human beings and plants, it is also important to take protection and care of animals. Some

of the ways through which we can care for domestic animals include:

We should provide them with comfortable and safe dwelling place. Sheds for domestic animals should be made airy and lighted. These animals should be protected from sun-stroke in summer and cold-wind in winter.

Domestic animals should be kept clean and their wastes, i.e. dung etc. should be promptly removed from the shed and be properly disposed of. The wastes should be utilized for making manure or bio-gas or dung cakes.

Domestic animals should be given nutritive food or fodder. Green fodder is a prime necessity for domestic animals. They should also be given clean water to drink. Dirty or polluted water may cause damage to their health. There should be arrangement of water for their wash or bath also.

Sick animals should be treated properly with medicines according to the advice from a veterinary doctor.

Skills needed to keep domestic animals in a healthy state

Responsible livestock owners must learn to recognize and care for illness among animals.

Good animal husbandry starts with proper **health care and management**. Livestock production is greatly affected by diseases. Knowing these diseases is important in planning and organizing effective animal healthcare programs. So, every livestock farmer should note the following precautions to maintain the good health of their animals.

How to Keep Animals Healthy

- Prevent contact with infected livestock
- Avoid overcrowding in the house
- Keep the young animals separate from the adults
- Isolate sick animals
- Avoid equipment for sick animals being brought into the house
- Prevent unhygienic people from entering the pens
- Get accurate and early disease diagnosis by a qualified veterinarian
- Avoid unnecessary medication
- Eliminate ticks, lice, mites and control predatory animals.
- Consider droppings as a potential source of diseases
- Keep the pen clean and dry
- Keep the feed and water uncontaminated
- Feed must meet all the **nutritional requirements** of the animals

- Ensure periodic vaccination
- Maintain a record of the incidence of diseases and treatment administered

How to Prevent and Control Diseases in Farm Animals

Since it has been known that diseases are one of the major factors that negatively influence the performance of farm animals, the following measures must be put in place to control diseases in farm animals:

- Quarantine (separate) new stock of animals coming into the farm for some days before adding them to the old stock
- Cull (remove) chronically infected animals
- Isolate animals that are sick from the main flock
- Dispose of pen litter material properly
- Maintain personnel hygiene and sanitation
- Use of footbath
- Practice approved method of sanitation
- Change animal pastures periodically
- Vaccination of healthy animals (don't ever vaccinate sick animals)
- Disinfect shed where sick animals were kept
- Use anti-serum in affected animals
- Slaughter, burn or bury 6ft deep with lime underground animals affected by a severe disease
- Treat timely animal stock and regularly check them for signs of diseases
- Give an immediate report of disease outbreak to the necessary Diseases Control authorities

Farmers have to take the health of their animals very importantly. These animals need to have good health for them to be productive and profitable in the farm.

Types of housing for animals

Proper housing and management of animal facilities are essential to animal well-being

Primary Enclosures

The primary enclosure (usually **a cage, pen, or stall**) provides the limits of an animal's immediate environment.

Sheltered or Outdoor Housing

Sheltered or outdoor housing such as **barns**, **corrals, pastures**, and **islands** is a common primary housing method for some species and is acceptable for many situations.

In most cases, outdoor housing entails maintaining animals in groups

There are several factors to consider when planning adequate livestock shelter in cold weather:

Air quality: Animal shelters should be open, providing natural ventilation, or enclosed, using fans and proper air inlets around the ceiling perimeter to provide good air circulation. Tight buildings result in a buildup of respiration gases, and animal odors, which can irritate the animal's lungs and cause pneumonia. Dangerous ammonia levels1 can also build up and lead to suffocation death of animals and their caretakers.

Drafts: Animals can stand cold temperatures, but you should protect them from drafts. Constructing panels in front of an open building can reduce drafts. Consider drafts at animal height, not person height. When animals are allowed to run loose in a pen instead of being hitched, they will search for the most comfortable spots as needed.

Dry bedding area: Animals will be far more comfortable in the cold if they have clean, dry bedding. A thick, dry bed provides insulation from the cold ground and decreases the amount of energy the animal has to expend to keep warm. Shelter from the snow and rain allows an animal's coat to remain dry, which provides maximum insulating value.

Digestive system ruminants and Non-ruminant Animals

Ruminant and non-ruminant animals are two types of animals with different digestive purposes. Apart from that, the general anatomy of both digestive system is similar.

What are Ruminant Animals?

Ruminant animals are herbivores with a complex stomach called a rumen. Some examples of ruminant animals are cattle, **sheep, goats, buffalo, deer, elk, giraffes and camels**. One of the most significant features of the **ruminant digestive system** is the presence of a complex stomach with four compartments. They are rumen, reticulum, omasum, and abomasum.

The first three compartments, the rumen, reticulum, and omasum break down plant fibers by fermentation with the help of microflora. This fermentation results in volatile fatty acids such as acetate, butyrate, and propionate. Hence, this process is called the foregut fermentation. The forth compartment secretes digestive enzymes.

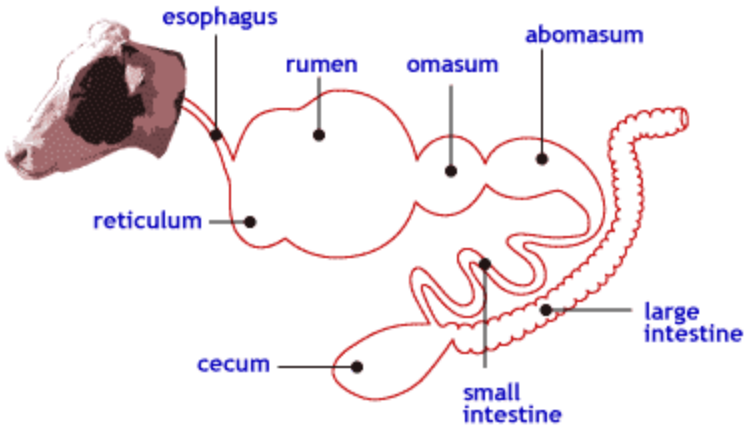

Figure 1: Ruminant stomach

Also, these animals ruminate or completely digest the food by chewing the cud. The four processes of rumination are;

1. **Regurgitation:** Vomiting the cud from the stomach to the mouth
2. **Re-mastication:** Biting and grinding food inside the mouth
3. **Re-salivation:** Secretion and mixing of saliva with the food
4. **Re-swallow:** Taking back the food to the stomach

What are Non Ruminant Animals

Non-ruminant animals are omnivores or carnivores with a single stomach compartment within the digestive system. Examples of non-ruminant animals include poultry, horse, swine, fowl, dog, and rabbit. The digestive system of the non-ruminant animals is called **monogastirc**. Some examples of non-ruminant animals are human, horse, swine, fowl, dog, and rabbit. The components of the non-ruminant digestive system are mouth, esophagus, stomach, small intestine, large intestine, and rectum.

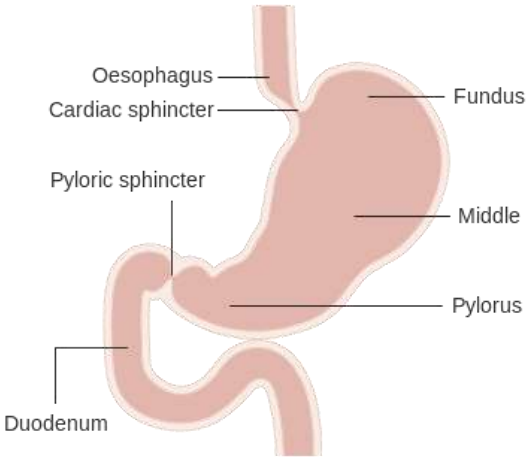

Figure 2: Non Ruminant Stomach

Non-ruminant animals do not chew the cud. Also, they do not digest the plant materials such

as cellulose through fermentation.

Similarities between Ruminant and Non Ruminant Animals

- Ruminant and non-ruminant animals have a complete digestive system.
- The digestive system of both consists of a mouth, esophagus, stomach, small intestine, large intestine, and a rectum.
- Both eat throughout the day and constantly lose energy.

Difference Between Ruminant and Non Ruminant Animals

Aspect	Ruminant animals	Non-ruminant animals
Definition	Ruminant animals refer to animals that chew and regurgitate their food more than once, and digest it multiple times in different stomachs	Non-ruminant animals refer to the animals that digest food in one stomach.
Type of Diet	Ruminant animals are herbivores, which consume plant material as food	Non-ruminant animals are either omnivores or carnivores, thus consuming both plant and animal materials.
Stomach	Ruminant animals have a complex stomach with four compartments	Non-ruminant animals have a simple stomach with a single compartment.
Length	Ruminant digestive system is long	Non-ruminant digestive system is short.
Enzymes to Digest Proteins	Ruminant animals do not produce enzymes for protein digestion	Non-ruminant animals have such enzymes.
Canines	Ruminant animals have two blunt canines	Non-ruminant animals have four sharp canines.
Premolars and Molars	The premolars and molars of the ruminant animals move in the lateral direction	while they move in the vertical direction in non-ruminant animals.
Saliva	Ruminant animals produce more saliva with no carbohydrate digestive enzymes	Non-ruminant animals produce less saliva with carbohydrate digestive enzymes.
Regurgitation	Ruminant animals undergo regurgitation	Non-ruminant animals do not undergo regurgitation.
Liver	The liver of the ruminant animals is large	while the liver of the non-ruminant animals is comparatively small.
Time Taken to Digest Food	Ruminant animals take a longer time to digest plant material	Non-ruminant animals take comparatively less time for their digestion.

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TOPIC 2.3.1: POULTRY REARING

LEARNING OUTCOMES
The learner should be able to:

a) understand and identify the important breeds of poultry reared in Uganda and their place in supplying the market
b) understand how eggs are hatched and ways of raising chickens
c) know how to care for the health of poultry and understand the role of veterinary services
d) demonstrate knowledge of diseases and pests affecting poultry
e) demonstrate the use of tools and equipment for controlling diseases and pests in poultry
f) show skill in handling poultry and its products
g) understand how to market animal products
h) understand the importance of and demonstrate entrepreneurial skills in marketing poultry
i) apply knowledge and skills related to the marketing of animals and products

POULTRY FARMING; Poultry farming means 'raising various types of domestic birds commercially for the purpose of meat, eggs and feather production'. The most common and widely raised poultry birds are chicken.

About 5k million chickens are being raised every year as a source of food (both meat and eggs of chicken). The chickens which are raised for eggs are called layer chicken, and the chickens which are raised for their meat production are called broiler chickens. The UK and USA consume more meat and eggs of chicken than other Countries of the world. On an average the UK alone consumes more than 29 million chicken eggs every day. However, in a word commercial poultry farming is very necessary to meet up the demand of animal nutrition (eggs and meat). Commercial poultry farming is also very profitable. And commercial poultry farming business is one of the traditional business ventures. Here we are describing more about the advantages of poultry farming business and the steps for running this business.

Benefits of Poultry Farming

Poultry farming business has numerous benefits. As a result many farmers prefer to invest in this business. People generally establish poultry farm for the purpose of producing eggs, meat and generating high revenue from these products. Billions of chickens are being raised throughout the world as a good source of food from their eggs and meat. However, here I am shortly describing the main benefits of poultry farming.

The main benefit of poultry farming is, it doesn't require high capital for starting. You need just basic capital to start raising poultry. And most of the poultry birds are not costly enough to start rising.

Poultry farming doesn't require a big space unless you are going to start commercially. You can easily raise some birds on your own backyard with one or numerous coops or cages. So, if you are interested in poultry farming, then you can easily do it on your own backyard with several birds.

Commercial poultry farming business also ensure high return of investment within a very short period. Some poultry birds like broiler chickens take shorter duration of time to mature and generating profit.

Poultry farm structures do not require high maintenance. You can minimize diseases and illness in poultry by following proper hygiene and care. Diseases are less in some poultry birds like quails, turkeys etc.

In most cases, you don't need any licensed. Because almost all types of poultry birds are domestic. Although, if you need licensed from the relevant authority it is also easy for poultry.

Poultry provides fresh and nutritious food and has a huge global demand. Global consumers of poultry products prefer them due to their nutrients and freshness. Poultry products are not much expensive and most of the people can afford those.

Marketing poultry products is very easy. There is an established market for poultry products in almost all places of the world. So, you don't have to think about marketing your products. You can easily sell the products in your nearest local market.

Poultry farming creates income and employment opportunities for the people. Unemployed educated youth can easily create a great income and employment opportunity for them by raising poultry commercially. Women and students can also do this business along with their daily activities.

Almost all banks approve loans for these types of business venture. So, if you want to start this business commercially, then you can apply for loans to your local banks.

There are many more benefits of poultry farming along with the above mentioned benefits. Start raising and you will gradually learn everything.

Various Methods of Poultry Farming

World watch institute described that, about 74% of total poultry meat and 68% of total poultry eggs produced from intensive poultry farming method. Free range farming is the other

alternative method of intensive poultry farming. Free range farming method is used for large number of poultry birds with high stocking density. There are some basic differences between intensive and free range poultry farming. Intensive poultry farming method is a highly efficient system which saves, land, feed, labor and other resources and increases production. In this system the poultry farming environment is fully controlled by the farmer. So, it ensures continuous production throughout the year in any environment and seasons. Intensive poultry farming has some disadvantages too.

Some people say intensive system creates health risks, abuse the animals and harmful for environment. On the other hand free range poultry farming method requires a large place for raising the birds and the production is about the same as intensive method. However, in the case of both intensive and free range poultry farming method the producers must have to use nationally approved medications like antibiotics regularly to keep the poultry birds free from diseases.

POULTRY BREEDS (EXOTIC BREEDS)

These are breeds which are brought from other country.

These are two main groups of exotic chicken breeds

Pure breeds.

These are pure for one bread and are further divided into

Heavy Breeds: These are chicken breeds which have heavy body weight they include:- Rhode /island red-Origin American

Characteristic: Brownish used feathers

Some have black wing and tail

Females are good/layer

Black Australop – Origin Australia

Characteristics male birds have bright red feathers around the neck, on the tail and wings.

Females are fairly good layers

Orpington –Origin from England

Characteristics

Birds have black feather with white bars

They are quite heavy in weight.

Some of the distinguished varieties are black variety.

Barred Plymouth Rock:

Origin America

Characteristics:

Birds have black feather with white bars
Birds have got long bodies and are hardy.
Females do not easily stop lying.

Light breeds: These are chicken breeds with an average light body weight.

Majority are suitable for egg foundation. They include:-

Leghorns: Origin Mediterranean countries. Some distinguished varieties of these breeds are

HYBRIDS.

These are types of bread which result from crossing two or more breeds of poultry

Some are suitable for egg production and other are suitable for meet i.e. Broilers
Broilers grow and increase in weight very fast while Hybrid layer produce more eggs than their crossed parents.

Examples of Hybrids are

- Shavers
- Hornber

- Haco
- Sterlin

POULTRY MANAGEMENT

This involves the following operation:-

- Egg incubation
- Rearing of chicks
- Feeding of CHICKS
- Administration of drugs
- Prevention of vices
- Disease and parasite control.

INCUBATION OF EGGS

Meaning: This is the treatment of fertile eggs in order they develop into chick:-

This is achieved only when they are subjected to environment with suitable temperature, humidity and ventilation.

- Temperature – 300c – 350
- Humidity 60%-70%

NB: The time taken from fertilization and full maturity of an egg to produce a chick i.e. known as **incubation period.**

Incubation periods for different birds are:-

- Chicken 21 days
- Ducks 28 days
- Turkeys 28 days
- Goose 30 days

Incubation process can be achieved by two methods

- Natural process (Natural incubation)
- Artificial process(artificial incubation)

NATURAL INCUBATION

Terminologies:

Brooding: Is a process of supplying heat either naturally or artificial to an egg (fertilized) to facilitate hatching.
Broody hen: A hen that site on fertilizer eggs so as to supply heat.

Natural incubation is done by allowing a broody hen to sit on the egg until they hatch.

Usually a hen site for 21 days until they hatch.
This is very common to love breed whereby they make nests and lay eggs. After laying a number of eggs, the hen site on the eggs, whereby its body provides heat and humidity to the egg; until they hatch.
The hen usually turns the eggs over to allow the developing embryo not to settle to one side.
The hen should be supplied with water, feed and a good shelter.
The capacity of the brooding hen is 10-15eggs.

Best way:

- Prepare the broody hen by dusting i.e. with insecticide powder e.g. Gamatox to full lice and other external parasite in its feathers.
- Prepare the nesting place; preferably a box measuring 40cm x 35cm x 35cm is sufficient; as well a basket of reasonable size.
- Part soft material or clean dry sand on the floor of the box on top of which maize husk, paddy husks or wood shavings can be put.
- Put 10-15 eggs in the box and allow the hen to site on the egg noting down the dates.
- Put drinking water and feed containers.
- After 21 days check for hatched eggs.

ARTIFICIAL INCUBATION.

This is achieved by placing eggs in special equipment called an INCUBATOR.

Types of incubators

- small incubators
- flat type
- still air
- table incubators
- Large incubators
- cabinet incubators
- walk in incubators

NB:

Small incubator holds 50-300 eggs at a time.

Large incubator holds thousands of egg at a tome which large ones are heated by electricity.

Procedure.

- Collect fertilizer eggs of medium size 56gm 63gm with thick shells.
- Conduct egg testing to check for cracker or only in the yolk. This is done by candling method clean and disinfects the incubator 7 days before starting incubation.
- Switch on the source of heat 3 days before.
- Put water into the water pan as well as egg in the egg tray (each egg should be placed in such a way the large end facing upwards), and place the tray in the incubator.
- Keep the temperature in the incubator at 370c 390c and humidity at 60%.
- Turn egg 3-5 a day in the first 18 days to facilitate equal distribution of heat wound the

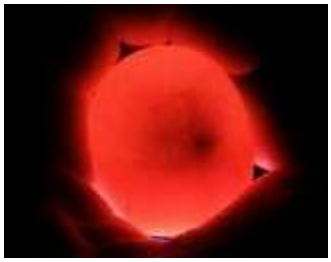
egg so that the embryo may not stick to the shell.

- After 4-7 days repeat egg candling and also on the 14th days do the same.
- On the 15th day shift the eggs to the hatching compartment in the incubator; and raise humidity 70% and lower temperature 5th 360c – 370c.

Precaution

- The incubator should be well ventilated and place in a well ventilated place.
- Avoid direct sunlight falling on to the incubator through windows
- Clean and disinfect incubator after ever hatch.
- Operate the incubator 3 days before setting in the eggs so as to be sure if it is working
- When the eggs hatch do not remove the chicks from the incubator on the first day
- The hatchery room and incubator must be cleaned regularly
- Wear protective clothing and wash them regularly
- Always place a foot bath with disinfectant at the entrance to avoid risk of disease transmission.

Egg testing process by candling.



- Candling is done by using a small box or container with a hole on top; with an electric lamp or hurricane lamp on it.
- The egg is put in the hole and the light is switched on; and egg observation is done.
- A fertile egg has a round small disc inside the yolk; and the yolk is dark in colour.
- If it is fertile, a dark spot will be seen inside the egg near the middle of the egg.

Importance

Is to identify defected eggs which have to be removed from the incubator. They include:-

- Thin shelled eggs
- Cracked shelled eggs

- Defects in the yolk.

FORMS OF POULTRY PRODUCTION IN UGANDA

There are 3 forms of keeping poultry in Uganda.

- Multipurpose poultry production.
- Commercial meat production.
- Commercial egg production.

Multipurpose poultry production.

This taken account of keeping local poultry breeds usually in small scale production. The main products from this form are egg and meat.

Commercial meat production.

Broilers are chicken which are kept for meat production. Their feature include

- To obtain high mature weight
- Good ability convert feed into meat (High feed conversion efficiency) e.g. Heavy breed; Red island red.

Commercial egg production.

Pullets which are kept for egg production are celled layers.
The quality of a good layers include:-

- Should have an ability to lay much egg up to 200 eggs during the whole laying period.
- Have the ability to convert feeds into eggs efficiently e.g. all types of light breeds.

SYSTEMS OF POULTRY REARING

Poultry rearing: This refers to the rearing or locking after poultry birds.
These are 3 main system of rearing poultry mainly:-

- Free range
- semi – intensive
- intensive

Capital: Intensive system required high investment than the other system hence if you have less capital use semi intensive or free rang

Purpose of keeping poultry:

- The suitable system also depends on whether you are keeping layers, broilers or dual purpose birds.
- Most of the layers and broilers are kept by intensive system, which dual purpose poultry are kept under free range system.

Numbers of birds to be kept.

- Few birds can be raises using free range system while many birds prefer intensive system. Space available.
- If space is not available and you have capital use intensive systems.
- If there is plenty of space you use semi intensive or free range stem.

Environmental factors.

- This needs consideration on weather factors
- Presence of predators
- Presence of thieves
- If the place has thieves, predators and too cold the birds need protection hence use intensive system.

FREE RANGE SYSTEM (EXTENSIVE SYSTEM)

This is a system whereby poultry birds are locked in the house during the night and allowed to go out to find their own feed and water during the daytime. Sometime it is called (EXENSIVE SYSTEM)

It is particularly suitable for local/ indigenous breeds which are hardy and can without adverse weather e.g. cold, rainfall e.t.c. and able to find their own food.

Advantages:

- These are no feed cost as the births find their own food and no supplementary food is given to them.
- The birds get balanced diet as they eat a variety of foods e.g. grass, insect, grain ex.
- Initial cost is very low as a small cheap house is all that is needed.
- Very low cases of vice e.g. egg eating, cannibalism father packing etc.

- Eggs and meat produce under this system are palatable and nutrition.
- Birds get a lot of exercise due to free movement.

Disadvantages:

- The system requires alot of space.
- The birds may destroy people's properties e.g. crop while looking for food.
- Low security to the birds as they may be eaten by predators or stolen by thieves or killed by vehicles.
- It is difficult to collect eggs as they may lay eggs in awkward places and hence difficult to keep records.
- The system is not suitable for keeping hybrid broiler and layers.
- Birds are subjected to advance weather e.g. rain cold.
- Disease infection and spreading is high and difficult to control.

Semi – Intensive System

This is a system where by birds are provided with a form of a housing, surrounded by an area which is enclosed in a fence whereby in the night the birds sleep in the house; while during the day the birds walk within the area

House and run system

In this system birds are provided with small houses surrounded by an area called a Run; whereby drinking water (waters) and feeds (feeders) are provide.
Resting places (perches) and laying boxes are also kept
During the day the birds are allowed to well freely and enclosed them inside the house during the night.

Fold unit system.

The system is similar to the house and run system as it consist of a house and run but the housing unit is mobile called folds/arks with a sold roof covered by wire netting.

A fold unit of 7mx3mx3m is enough for 20-30 birds.

Advantages of semi intensive system.

- The movement of fold unit and the alternating use of run is easen the control of parasites and disease
- Simple and cheap poultry houses can be used.
- Spread of manure in the runs is made possible as the birds drop their feaces in the runs.
- Easy to called egg if layer are kept under their system.
- Easy to observe an attend birds in case of infection.

Disadvantages of semi intensive system.

- Fold units can easily get broken if material used is not durable.
- It is not easy to keep many birds under this system thus not suitable for commercial production of chicken.
- Somehow expensive and capital is needed in purchasing fences, food drugs etc.

INTENSIVE SYSTEM

This is a system where by many birds are confirmed in a small place/building where feeding and during water is supplied.

Types:

Deep litter system-This is a system whereby birds are kept in a house or pen in which litter is spread on the floor of the rouse or pen.

The litter could be either of:

- Timber shavings
- Sawdust
- Paddy husk
- Maize grain husks filed to a uniform depth of 10-15cm

The litter shout be changed every time when a new flock is put.

NB: Avoid making the litter damp (by spilling water) as may cause disease and parasites of infection.

Repair roots to avoid leakage during rain seen.

NB:

The bottom 60cm of each wall should be solid made of cement; the rest should be wire netting.
In case of wind cover the wire netting with sacks on the side which wind blows
Do not keep many birds in one house. Allow 2-3 birds/m2 of floor space.
Provide birds with:

- Water through
- Feed through
- Laying boxes for layers
- perches (Roosters)

Advantages of deep litter system

- Suitable for commercial production as many birds can be kept in a small area
- Birds are protected from basic weather, predators and thieves.
- Egg collection in easier if layer are kept
- Keeping of record is made possible,
- Litter from the house is a good source of manure.

Disadvantages of deep litter system

Encourages vices e.g. cannibalism and eating habit

If litter becomes damp; spread of coccidiosis disease can be high.

Sometimes birds become broody

High initial cost of building poultry house

High feed cost

High labour requirement

Battery Cages-This is a system where by bird are kept in cages of 1-2 birds where food and water through are within in the front point of the cage.

The floor of cages is made up of wire netting

When the eggs are laid they slide to the front of the cage and can be collection

Suitable for eggs production birds but not broilers.

NB

Clean the metal sheet under the cage where feaces are collected. One row of a cage in known as a tier.

Advantage of Battery cage systemic

- Large number of birds can be kept in small area
- Egg recording is made possible
- Food and water cannot be made dirty
- Egg eating and breaking is not possible
- Clean eggs are collected
- Vices are minimize e.g. cannibalism
- Easy to identify disease birds.

- Hen cannot be broody if the floor is cold.
- Birds cannot be infected by intestinal worm and disease.
- Easy provision of water and feeds.

Disadvantage of Battery cage systemic

- Highly expensive so as to buy cages.
- High skill is required to operate the system.
- Is feed for layers only.

CHICK REARING BROODING

Definition: This is a period of growth during which supplementary heat is provided for the young chicks. Young chick must be provided with heat, light, fresh air good food and water.

Methods:

Natural: By using a Brooding hen which looks after its own chicks.

It provides the chicks with warmth by sheltering them from cold and wetness. It also scares enemies to protect the chicks.

Types of Brooders

Hover brooder

Battery brooder

Homemade brooder

Heated Tin brooder

Kerosene lantern brooder

Fireless brooder

Preparation of Brooder House and Brooding area

- Before buying chicks the brooder house should be prepared
- Clean the Brooder house wall floors and disinfect it thorough and leave it to dry
- Prepared the enclosure and floor of the brooder house by using cardboard's' with a height of 45-60cm.

- Spread litter on the floor uniformly in the enclosure.
- Install the source of heat e.g. bulb or hurricane lamp 40cm above the floor.
- Light the source of heat 12hrs before the arrival of the chicks and ensure a temperature of 32- 350c always.
- Put fresh water for drinking in shallow containers.
- Provide enough chick mash (contain 20-22% protein.

NB: The brooding house should be well ventilated.

SEXING CHICKS.

The action of identifying the sex of each chick which facilitate the separation of male chicks from female chicks.

This is usually done by expects using special instrument.

Sometimes the experts rood may make mistake therefore it is advisable that this operation be done when chicks reach the age of 8 weeks. At this age the cockerels (male birds) must be separated from the pullets (female birds). Usually cockerels have larger combs and wattles than pullets.

REARING OF DAY OLD CHICKS UP TO 8th WEEK.

1st WEEK:

1st DAY:

Once you bring the chicks remove them from the boxes and put them in the brooder.

Let them drink a lot of water and food; and change to fresh feed several times a day. Feed them into CHICK MASH

Maintain temperature in the brooder between 320c – 350c 2nd Day -3rd Day.

Replace feed and water at least twice per day.

Check temperatures in the brooders

Overcrowding – low temperature

Away from heat source high temperature

Evenly distributed throughout the floor –right temperature.

Stir up the litter on the floor once per day.

Replace any damp litter with a fresh one 4th -7th day

Expand the brooder by making the area enclosed by the cardboard wall much large by joining

another piece of cardboard into the wall.

Observe temperatures; supply feed and drinking water.

Remove any dead chick.

Stir up the litter regularly and put fresh if it is damp.

2nd WEEK ONWARDS

Reduce temperature in the brooder as the chicks will be bigger and bearing more and more feathers.

This is by lifting the heat source much higher from the surface of the floor or turn down the wick of the hurricane lamp

Re move heat source when chick are at 4-5wk stage.

Provide light during the night so that the chick can eat and drinking to facilitate fast growth

Make sure the litter is dry all the time as well as fresh feed and clean fresh water.

Add more water and feed troughs as the chicks grow bigger.

Provide adequate floor space and adequate space on feed troughs in the brooder and be well distributed (i.e. 1000cm2/bird as floor space)

NB: at weeks old they are called growers of which they are cared differently.

Broiler growers may be shifted or reared in the same house.

Layer growers are normally shifted from the brooder to another house.

Common Poultry Diseases

Respiratory Diseases

There are many common and important diseases which can affect the respiratory system (air passages, lungs, air sacs) of poultry. Poultry refers to birds that people keep for their use and generally includes the chicken, turkey, duck, goose, quail, pheasant, pigeon, guinea fowl, pea fowl, ostrich, emus, and rhea. Due to modern systems of management, usually with high poultry densities, these diseases are able to readily spread.

Fowl Pox

Synonyms: chicken pox (not to be confused with chicken pox in humans; the human disease does not affect poultry and vice versa), sore head, avian diphtheria, bird pox

Species affected: Most poultry—chickens; turkeys, pheasants, quail, ducks, psittacosis, and ratites—of all ages are susceptible.

Clinical signs: There are two forms of fowl pox. The dry form is characterized by raised, wart -like lesions on unfeathered areas (head, legs, vent, etc.). The lesions heal in about 2 weeks. If the scab is removed before healing is complete, the surface beneath is raw and bleeding. Unthriftiness and retarded growth are typical symptoms of fowl pox. In laying hens, infection results in a transient decline in egg production.

Transmission: Fowl pox is transmitted by direct contact between infected and susceptible birds or by mosquito. Virus-containing scabs also can be sloughed from affected birds and serve as a source of infection. The virus can enter the blood stream through the eye, skin wounds, or respiratory tract. Mosquito become infected from feeding on birds with fowl pox in their blood stream. There is some evidence that the mosquito remains infective for life. Mosquito are the primary reservoir and spreaders of fowl pox on poultry ranges. Several species of mosquito can transmit fowl pox. Often mosquito winter-over in poultry houses so, outbreaks can occur during winter and early spring.

Treatment: No treatment is available. However, fowl pox is relatively slow-spreading. Thus, it is possible to vaccinate to stop an outbreak. The wing-web vaccination method is used for chickens and the thigh-stick method for turkeys older than 8 weeks.

Prevention: Fowl pox outbreaks in poultry confined to houses can be controlled by spraying to kill mosquito. However, if fowl pox is endemic in the area, vaccination is recommended. Do not vaccinate unless the disease becomes a problem on a farm or in the area. Refer to the publication PS-36 (Vaccination of Small Poultry Flocks) for more information on fowl pox vaccinations.

Newcastle Disease

Synonyms: pneumoencephalitis

The highly contagious and lethal form of Newcastle disease is known as viscerotropic (attacks the internal organs) velogenic Newcastle disease, VVND, exotic Newcastle disease, or Asiatic Newcastle disease. VVND is not present in the United States poultry industry at this time.

Species affected: Newcastle disease affects all birds of all ages. Humans and other mammals

are also susceptible to Newcastle. In such species, it causes a mild conjunctivitis.

Clinical signs: There are three forms of Newcastle disease mildly pathogenic (lentogenic), moderately pathogenic (mesogenic) and highly pathogenic (velogenic). Newcastle disease is characterized by a sudden onset of clinical signs which include hoarse chirps (in chicks), watery discharge from nostrils, labored breathing (gasping), facial swelling, and paralysis, trembling, and twisting of the neck (sign of central nervous system involvement). Mortality ranges from 10 to 80 percent depending on the pathogenicity. In adult laying birds, symptoms can include decreased feed and water consumption and a dramatic drop in egg production.

Transmission: The Newcastle virus can be transmitted short distances by the airborne route or introduced on contaminated shoes, caretakers, feed deliverers, visitors, tires, dirty equipment, feed sacks, crates, and wild birds. Newcastle virus can be passed in the egg, but Newcastle-infected embryos die before hatching. In live birds, the virus is shed in body fluids, secretions, excreta, and breath.

Treatment: There is no specific treatment for Newcastle disease. Antibiotics can be given for 3–5 days to prevent secondary bacterial infections (particularly E. COLI). For chicks, increasing the brooding temperature 5°F may help reduce losses.

Prevention: Prevention programs should include vaccination (see publication PS-36, Vaccination of Small

Poultry Flocks), good sanitation, and implementation of a comprehensive biosecurity program.

Infectious Bronchitis

Synonyms: IB, bronchitis, cold

Species affected: Infectious bronchitis is a disease of chickens only. A similar disease occurs in bobwhite quail (quail bronchitis), but it is caused by a different virus.

Clinical signs: The severity of infectious bronchitis infection is influenced by the age and immune status of the flock, by environmental conditions, and by the presence of other diseases. Feed and water consumption declines. Affected chickens will be chirping, with a watery discharge from the eyes and nostrils, and labored breathing with some gasping in young chickens. Breathing noises are more noticeable at night while the birds rest. Egg production drops dramatically. Production will recover in 5 or 6 weeks, but at a lower rate. The infectious bronchitis virus infects many tissues of the body, including the reproductive tract. Eggshells become rough and the egg white becomes watery.

Transmission: Infectious bronchitis is a very contagious poultry disease. It is spread by air, feed bags, infected dead birds, infected houses, and rodents. The virus can be egg-transmitted, however, affected embryos usually will not hatch.

Treatment: There is no specific treatment for infectious bronchitis. Antibiotics for 3–5 days may aid in combating secondary bacterial infections. Raise the room temperature 5°F for brooding-age chickens until symptoms subside. Baby chicks can be encouraged to eat by using a warm, moist mash.

Prevention: Establish and enforce a biosecurity program. Vaccinations are available.

Avian Influenza

Synonyms: AI, flu, influenza, fowl plague

Species affected: Avian influenza can occur in most, if not all, species of birds.

Clinical signs: Avian influenza is categorized as mild or highly pathogenic. The mild form

produces listlessness, loss of appetite, respiratory distress, diarrhea, transient drops in egg production, and low mortality. The highly pathogenic form produces facial swelling, blue comb and wattles, and dehydration with respiratory distress. Dark red/white spots develop in the legs and combs of chickens. There can be blood-tinged discharge from the nostrils. Mortality can range from low to near 100 percent. Sudden exertion adds to the total mortality. Egg production and hatchability decreases. There can be an increase in production of soft-shelled and shell-less eggs.

Transmission: The avian influenza virus can remain viable for long periods of time at moderate temperatures and can live indefinitely in frozen material. As a result, the disease can be spread through improper disposal of infected carcasses and manure. Avian influenza can be spread by contaminated shoes, clothing, crates, and other equipment. Insects and rodents may mechanically carry the virus from infected to susceptible poultry.

Treatment: There is no effective treatment for avian influenza. With the mild form of the disease, good husbandry, proper nutrition, and broad spectrum antibiotics may reduce losses from secondary infections. Recovered flocks continue to shed the virus. Vaccines may only be used with special permit.

Prevention: A vaccination program used in conjunction with a strict quarantine has been used to control mild forms of the disease. With the more lethal forms, strict quarantine and rapid destruction of all infected flocks remains the only effective method of stopping an avian influenza outbreak. If you suspect you may have Avian Influenza in your flock, even the mild form, you must report it to the state veterinarian's office. A proper diagnosis of avian influenza is essential. Aggressive action is recommended even for milder infections as this virus has the ability to readily mutate to a more pathogenic form.

For more information on avian influenza, refer to publication PS-38 (Avian Influenza in Poultry Species).

Infectious Coryza

Synonyms: roup, cold, coryza

Species affected: chickens, pheasants, and guinea fowl. Common in game chicken flocks.

Clinical signs: Swelling around the face, foul smelling, thick, sticky discharge from the nostrils and eyes, labored breathing, and rales (rattles an abnormal breathing sound) are common clinical signs. The eyelids are irritated and may stick together. The birds may have diarrhea and growing birds may become stunted.

Mortality from coryza is usually low, but infections can decrease egg production and increase the incidence and/or severity of other diseases. Mortality can be as high as 50 percent, but is usually no more than 20 percent. The clinical disease can last from a few days to 2–3 months, depending on the virulence of the pathogen and the existence of other infections such as mycoplasmosis.

Transmission: Coryza is primarily transmitted by direct bird-to-bird contact. This can be from infected birds brought into the flock as well as from birds which recover from the disease which remain carriers of the organism and may shed intermittently throughout their lives. Birds risk exposure at poultry shows, bird swaps, and live-bird sales. In apparent infected adult birds added into a flock are a common source for outbreaks. Within a flock, inhalation of airborne respiratory droplets, and contamination of feed and/or water are common modes of spread.

Treatment: Water soluble antibiotics or antibacterials can be used. Sulfadimethoxine (Albon), Di- Methox™) is the preferred treatment. If it is not available, or not effective, sulfamethazine

(Sulfa-Max), SulfaSure), erythromycin (gallimycin, or tetracycline (Aureomycin) can be used as alternative treatments.

Sulfa drugs are not FDA approved for pullets older than 14 weeks of age or for commercial layer hens. While antibiotics can be effective in reducing clinical disease, they do not eliminate carrier birds.

Prevention: Good management and sanitation are the best ways to avoid infectious coryza. Most outbreaks occur as a result of mixing flocks. All replacement birds on "coryza-endemic" farms should be vaccinated. The vaccine (Coryza-Vac) is administered subcutaneously (under the skin) on the back of the neck. Each chicken should be vaccinated four times, starting at 5 weeks of age with at least 4 weeks between injections. Vaccinate again at 10 months of age and twice yearly thereafter.

Swollen Head Syndrome

Synonyms: Facial cellulitis, thick head, Dikkop, SHS

Species affected: Chickens and turkeys are the known natural hosts. Experimentally, guinea fowl and pheasants are susceptible but pigeons, ducks, and geese are resistant to the infection. SHS does not presently occur in the United States, but is present in most countries of the world.

Clinical signs: In chicks and poultry, there is initial sneezing, followed by reddening and swelling of the tear ducts and eye tissue. Facial swelling will extend over the head and down the jaw and wattles. Adult chickens have mild respiratory disease followed by a few birds having swollen heads. Other signs include disorientation, twisting of the neck, and a significant drop in egg production.

Transmission: The infection spreads by direct contact with infected birds or indirectly by exposure to infectious material.

Treatment: There is no proven medication for swollen head syndrome. The disease is caused by a virus classified as a pneumovirus. A disease closely mimicking SHS is caused by a mixed infection of respiratory viruses and specific bacteria. Antibiotic therapy may be helpful against the bacterial component.

Prevention: A commercial vaccine is available. Swollen head syndrome is considered an exotic disease and a live vaccine is not approved for use in the United States.

Mycoplasma synoviae

Synonyms: MS, infectious synovitis, synovitis, silent air sac

Species affected: chickens and turkeys.

Clinical signs: Birds infected with the synovitis form show lameness, followed by lethargy, reluctance to move, swollen joints, stilted gait, loss of weight, and formation of breast blisters. Birds infected with the respiratory form exhibit respiratory distress. Greenish diarrhea is common in dying birds (see Table Clinically, the disease in indistinguishable from MG.

Transmission: MS is transmitted from infected breeder to progeny via the egg. Within a flock, MS is spread by direct contact with infected birds as well as through airborne particles over short distances.

Treatment: Recovery is slow for both respiratory and synovitis forms. Several antibiotics are variably effective. The most effective are tylosin, erthromycin, spectinomycin, lincomycin, and chlorotectracycline. These antibiotics can be given by injection while some can be administered in the feed or drinking water. These treatments are most effective when the antibiotics are injected.

Prevention: Eradication is the best and only sure control. Do not use breeder replacements from flocks that have had MS. The National Poultry Improvement Plan monitors for MS.

Mycoplasma meleagridis

Synonyms: MM, N strain, H strain

Species affected: MM affects turkeys of all ages, although poults are affected more severely than mature turkeys. Recently, MM has been shown to infect pigeon, quail and peafowl.

Clinical signs: A drop-off in production and hatchability can be expected in breeder flocks. There can be very high mortality in young poults. Unthriftiness, respiratory distress, stunting, crooked neck with deformity of cervical vertebrae, and leg deformation are common in young birds (see Table 1).

Transmission: Egg transmission is low in the early breeding period, but rises as the the age of the flock increases. Infections can be introduced into a flock by contaminated equipment, shoes, and clothing of workers and visitors.

Treatment: Several antibiotics have been effective including tylosin, erythromycin, spectinomycin, and linco-spectinomycin.

Prevention: The best preventive measure is to keep MM-free breeders. The MM-free status of breeders can be confirmed by periodic blood tests through the National Poultry Improvement Plan.

Aspergillosis

Synonyms: brooder pneumonia, mycotic pneumonia, fungal pneumonia, ASPERGILLUS. When the source of the disease is the hatchery, the disease is called brooder pneumonia. In older birds, the disease is called aspergillosis.

Species affected: All birds (domestic poultry, pigeons, and canary and zoo bird species), animals, humans, and plants are susceptible.

Clinical signs: Aspergillosis occurs as an acute disease of young birds and a chronic disease in mature birds. Young birds have trouble breathing and gasp for air. Characteristically, there are no rales or respiratory sounds associated with aspergillosis. Feed consumption decreases. Occasionally there is paralysis or convulsions caused by the fungal toxin. Mortality in young birds averages 5–20 percent, but may be as high as 50 percent. Mature birds also have respiratory distress, reduced feed consumption, and may have a bluish and dark color of the skin (cyanosis). Nervous disorders, such as twisted necks, may occur in a few birds. Mortality in mature birds is usually less than 5 percent.

Transmission: Aspergillosis is caused by a fungus. The fungus grows well at room temperature and higher. All litter and nest materials (peat moss, peanut hulls, sawdust, peat, and bark, straw) have been known to have been contaminated with aspergillus. Feed and water should be suspect when attempting to identify the source of contamination.

Treatment: There is no cure for infected birds. The spread can be controlled by improving ventilation, eliminating the source of the infection, and adding a fungistat (mycostatin, mold curb, sodium or calcium propionate, or gentian violet) to the feed and/or copper sulfate or acidified copper in the drinking water for 3 days. The litter can be sprayed lightly with an oil-base germicide to control dust and air movement of fungal spores.

Prevention: It is important to thoroughly clean and disinfect the brooding area between broods. Use only clean litter, preferably soft wood shavings. Do not use sawdust, litter high in bark content, or shavings that have been wet.

Viral Diseases (nonrespiratory) Marek's Disease

Synonyms: acute leukosis, neural leukosis, range paralysis, gray eye (when eye affected)

Species affected: Chickens between 12 to 25 weeks of age are most commonly clinically affected. Occasionally pheasants, quail, game fowl and turkeys can be infected.

Clinical signs: Marek's disease is a type of avian cancer. Tumors in nerves cause lameness and paralysis. Tumors can occur in the eyes and cause irregularly shaped pupils and blindness. Tumors of the liver, kidney, spleen, gonads, pancreas, proventriculus, lungs, muscles, and skin can cause in coordination, unthriftiness, paleness, weak labored breathing, and enlarged feather follicles. In terminal stages, the birds are emaciated with pale, scaly combs and greenish diarrhea (see Table 2).

Marek's disease is very similar to Lymphoid Leukosis, but Marek's usually occurs in chickens 12 to 25 weeks of age and Lymphoid Leukosis usually starts at 16 weeks of age.

Transmission: The Marek's virus is transmitted by air within the poultry house. It is in the feather dander, chicken house dust, feces and saliva. Infected birds carry the virus in their blood for life and are a source of infection for susceptible birds.

Treatment: none

Prevention: Chicks can be vaccinated at the hatchery. While the vaccination prevents tumor formation, it does not prevent infection by the virus.

Lymphoid Leukosis

Synonyms: visceral leukosis, leukosis, big liver, LL

Species affected: Although primarily a disease of chickens, lymphoid leukosis can infect turkeys, guinea fowl, pheasants, and doves, but not on a large scale.

Clinical signs: The virus involved has a long incubation period (4 months or longer). As a result, clinical signs are not noticeable until the birds are 16 weeks or older. Affected birds become progressively weaker and emaciated. There is regression of the comb. The abdomen becomes enlarged. Greenish diarrhea develops in terminal stages.

Transmission: The virus is transmitted through the egg to offspring. Within a flock, it is spread by bird-to- bird contact and by contact with contaminated environments. The virus is not spread by air. Infected chicken are carriers for life.

Treatment: none

Prevention: The virus is present in the yolk and egg white of eggs from infected hens. Most national and international layer breeders have eradicated lymphoid leukosis from their flocks. Most commercial chicks are lymphoid-leukosis negative because they are hatched from LL-free breeders. The disease is still common in broiler breeder flocks.

Infectious Bursal Disease

Synonyms: Gumboro, IBD, infectious bursitis, infectious avian nephrosis

Species affected: chickens

Clinical signs: In affected chickens greater than 3 weeks of age, there is usually a rapid onset of the disease with a sudden drop in feed and water consumption, watery droppings leading to soiling of feathers around the vent, and vent pecking. Feathers appear ruffled. Chicks are listless and sit in a hunched position. Chickens infected when less than 3 weeks of age do not develop clinical disease, but become severely and permanently immunosuppressed.

Transmission: The virus is spread by bird-to-bird contact, as well as by contact with contaminated people and equipment. The virus is shed in the bird droppings and can be spread by air on dust particles. Dead birds are a source of the virus and should be incinerated.

Treatment: There is no specific treatment. Antibiotics, sulfonamides, and nitrofurans have little or no effect. Vitamin-electrolyte therapy is helpful. High levels of tetracyclines are contraindicated because they tie up calcium, thereby producing rickets. Surviving chicks remain unthrifty and more susceptible to secondary infections because of immunosuppression.

Prevention: A vaccine is commercially available.

Equine Encephalitis

Synonyms: EE, EEE, WEE

Note: This disease should not be confused with St. Louis Encephalits (SLE). Chickens are used

as sentinels (test animals) in SLE suspect areas, such as southern Florida. While SLE is also carried by mosquitos, that is where the similarities between the two encephalitis diseases end. Chickens do not get SLE. Refer to

Factsheet VM71 (St. Louis Encephalitis - The Role of Chickens) for more information on SLE.

Species affected: Equine encephalitis is a contagious disease of birds (especially pheasants), mammals (especially horses), and people. Birds are the major source of the virus.

Clinical signs: Two forms affect birds: eastern equine encephalitis (EEE) and western equine encephalitis (WEE). The clinical signs are identical and include reduced feed consumption, staggering, and paralysis. Surviving birds may be blind, have muscle paralysis, and have difficulty holding their head up. Damage to the bird's nervous system varies with species. In pheasants, there is pronounced leg paralysis, twisting of the neck, and tremors. Mortality is high. Chukar partridges and turkeys show drowsiness, paralysis, weakness, and death.

Transmission: Infected mosquitoes are the primary source of the virus. The CULISETA MELANURIA mosquito is the primary transmitter of the virus to poultry. Other mosquito species transmit the disease too, but feed mostly on other animals. Cannibalism of sick or dead birds by penmates is a major source of transmission within pens.

Treatment: none

Prevention: Remove the source of infection by establishing mosquito control: keep weeds mowed in a 50- foot strip around bird pens. This removes cover and resting areas for mosquitos. Eliminate mosquito breeding areas. Fog areas with Malathion.

It is possible to immunize birds, especially pheasants, with the vaccine prepared for horses. The recommended dose is one-tenth of a horse dose per bird.

Egg Drop Syndrome

Synonyms: egg drop, egg drop syndrome 76, EDS-76

Species affected: The natural hosts for EDS virus are ducks and geese, but EDS has become a major cause of reduced egg production in chickens in many parts of the world. No illness has been observed in ducks or geese. Chickens of all ages and breeds are susceptible. The disease

is most severe in broiler-breeders and brown-egg layer strains.

Clinical signs: There are no reliable signs other than the effects on egg production and egg quality. Healthy- appearing hens start laying thin-shelled and shell-less eggs. Once established, the condition results in a failure to achieve egg production targets. Transient diarrhea and dullness occur prior to egg shell changes. Fertility and hatchability are not affected (see Table 2).

Transmission: It is believed that the syndrome was first introduced into chickens from contaminated vaccine. Vertical transmission occurs from infected breeders to chicks. Newly hatched chicks excrete the virus in the feces.

Treatment: There is no successful treatment. Induced molting will restore egg production.

Prevention: Prevention involves a good biosecurity program.

Infectious Tenosynovitis

Synonyms: viral arthritis, tenosynovitis, teno, reovirus enteritis, reovirus septicemia, malabsorption syndrome, helicopter disease

Species affected: turkeys and chickens

Clinical signs: Several serotypes of the reovirus have been identified. Some localize in the joints (tenosynovitis) while others target respiratory or intestinal tissues (septicemic form).

The principal sign of tenosynovitis is lameness with swelling of the tendon sheaths of the shank and area extending above the hock (see Table 2). Affected birds are lame, sit on their hocks, and are reluctant to move. Rupture of the tendon can occur in older roaster birds, resulting in permanent lameness of the affected leg. If more than two joints are affected, the entire carcass will be condemned.

Infection can also play a part in broiler stunting, the result of malabsorption syndrome. In chicks, malabsorption due to viral enteritis is called "helicopter disease" because feathering is affected. Wing feathers protrude at various angles. A reovirus is believed to play only a secondary role in this syndrome.

In commercial layer flocks, increased mortality may be the first sign of the septicemia form. Egg production will decrease by about two to three times the mortality rate. For example, a mortality rate of 5 percent will be accompanied by a 10–15 percent drop in egg production. In the septicemic form, joint involvement is present but less pronounced. Affected birds beco me cyanotic (blue) and dehydrated. The tips of the comb turn purplish. The entire comb darkens as the disease progresses.

Transmission: The infection spreads rapidly through broiler flocks, but less rapidly in caged layers. Spread is by respiratory and digestive tract routes. The virus is shed in the feces.

Treatment: There is no satisfactory treatment available. With hens, tetracycline, molasses, and oyster shell therapy is helpful.

Prevention: A vaccine is available for use in endemic areas or on endemic farms.

Non-respiratory Bacterial Diseases

Fowl Cholera

Synonyms: avian pasteurellosis, cholera, avian hemorrhagic septicemia

Species affected: Domestic fowl of all species (primarily turkeys and chickens), game birds (especially pheasants and ducks), cage birds, wild birds, and birds in zoological collections and aviaries are susceptible.

Clinical signs: Fowl cholera usually strikes birds older than 6 weeks of age. In acute outbreaks, dead birds may be the first sign. Fever, reduced feed consumption, mucoid discharge from the mouth, ruffled feathers, diarrhea, and labored breathing may be seen. As the disease progresses birds lose weight, become lame from joint infections, and develop rattling noises from exudate in air passages. As fowl cholera becomes chronic, chickens develop abscessed wattles and swollen joints and foot pads. Caseous exudate may form in the sinuses around the eyes. Turkeys may have twisted necks.

Transmission: Multiple means of transmission have been demonstrated. Flock additions, free-flying birds, infected premises, predators, and rodents are all possibilities.

Treatment: A flock can be medicated with a sulfa drug (sulfonamides, especially

sulfadimethoxine, sulfaquinonxalene, sulfamethazine, and sulfaquinoxalene) or vaccinated, or both, to stop mortality associated with an outbreak. It must be noted, however, that sulfa drugs are not FDA approved for use in pullets older than 14 weeks or for commercial laying hens. Sulfa drugs leave residues in meat and eggs. Antibiotics can be used, but require higher levels and long term medication to stop the outbreak.

Prevention: On fowl cholera endemic farms, vaccination is advisable. Do not vaccinate for fowl cholera unless you have a problem on the farm. Rodent control is essential to prevent future outbreaks.

Pullorum

Synonyms: bacillary white diarrhea, BWD

Species affected: Chickens and turkeys are most susceptible, although other species of birds can become infected. Pullorum has never been a problem in commercially grown game birds such as pheasant, chukar partridge, and quail. Infection in mammals is rare.

Clinical signs: Death of infected chicks or poultry begins at 5–7 days of age and peaks in another 4–5 days. Clinical signs including huddling, droopiness, diarrhea, weakness, pasted vent, gasping, and chalk-white feces, sometimes stained with green bile. Affected birds are unthrifty and stunted because they do not eat. Survivors become asymptomatic carriers with localized infection in the ovary.

Transmission: Pullorum is spread primarily through the egg, from hen to chick. It can spread further by contaminated incubators, hatchers, chick boxes, houses, equipment, poultry by-product feedstuffs, and carrier birds.

Treatment: Treatment is for flock salvage only. Several sulfonamides, antibiotics, and antibacterials are effective in reducing mortality, but none eradicates the disease from the flock. Pullorum eradication is required by law. Eradication requires destroying the entire flock.

Prevention: Pullorum outbreaks are handled, on an eradication basis, by state/federal regulatory agencies. As part of the National Poultry Improvement Program, breeder replacement flocks are tested before onset of production to assure pullorum-free status. This mandatory law includes chickens, turkeys, show birds, waterfowl, game birds, and guinea fowl. In Florida, a negative pullorum test or certification that the bird originated from a pullorum-

free flock is required for admission for exhibit at shows and fairs. Such requirements have been beneficial in locating pullorum-infected flocks of hobby chickens.

Necrotic Enteritis

Synonyms: enterotoxemia, rot gut

Species affected: Rapidly growing young birds, especially chickens and turkeys 2-12 weeks of age, are most susceptible. Necrotic enteritis is a disease associated with domestication and is unlikely to threaten wild bird populations. Necrotic enteritis is primarily a disease of broilers, roasters and turkeys. Ulcerative enteritis, on the other hand, commonly affects pullets and quail.

Clinical signs: Initially there is a reduction in feed consumption as well as dark, often blood-stained, feces. Infected chickens will have diarrhea. Chronically affected birds become emaciated. The bird, intestines, and feces emit a fetid odor

Transmission: Necrotic enteritis does not spread directly from bird to bird. Bacteria are ingested along with infected soil, feces, or other infected materials. The bacteria then grow in the intestinal tract. Infection commonly occurs in crowded flocks, immuno-suppressed flocks, and flocks maintained in poor sanitary conditions.

Treatment: The clostridia bacteria involved in necrotic enteritis is sensitive to the antibiotics bacitracin, neomycin, and tetracycline. However, antibiotics such as penicillin, streptomycin, and novobiocin are also effective. Bacitracin is the most commonly used drug for control of necrotic enteritis. As with all drugs, legality and withdrawal time requirements must be observed.

Prevention: Prevention should be directed toward sanitation, husbandry, and management.

Ulcerative Enteritis

Synonyms: quail disease

Species affected: Captive quail are extremely susceptible and must be maintained on wire-bottom pens or on preventive medications. Chickens, turkeys, partridges, grouse, and other species are occasionally clinically affected.

Clinical signs: In quail, the disease is acute with high mortality. In chickens, signs are less

dramatic. Acute signs are extreme depression and reduction in feed consumption. Affected birds sit humped with eyes closed. Other signs included emaciation, watery droppings streaked with urates, and dull ruffled feathers. Accumulated mortality will reach 50 percent if the flock is not treated.

Transmission: Birds become infected by direct contact with carrier birds, infected droppings or contaminated pens, feed and water. Bacteria are passed in the droppings of sick and carrier birds. Infection can be spread mechanically on shoes, feed bags, equipment, and from contamination by rodents and pets.

Treatment: Bacitracin and neomycin can be used singly or in combination. Other antibiotics and drugs such as tetracyclines, penicillin, Lincomycin, and Virginomycin are also effective. Consult a veterinarian for dose, route, and duration of treatment.

Prevention: Ulcerative enteritis is difficult to prevent in quail. When quail have access to their own droppings, this disease commonly occurs. To eradicate, depopulate stock, thoroughly clean and disinfect, and start over with young, clean stock.

Botulism

Synonyms: limberneck, bulbar paralysis, western duck sickness, alkali disease

Species affected: All fowl of any age, humans, and other animals are highly susceptible. The turkey vulture is the only animal host known to be resistant to the disease.

Clinical signs: Botulism is a poisoning causing by eating spoiled food containing a neurotoxin produced by the bacterium CLOSTRIDIUM BOTULINUM. Paralysis, the most common clinical sign, occurs within a few hours after poisoned food is eaten. Pheasants with botulism remain alert, but paralyzed. Legs and wings become paralyzed, and then the neck becomes limp. Neck feathers become loose in the follicle and can be pulled easily.

If the amount eaten is lethal, prostration and death follow in 12 to 24 hours. Death is a result of paralysis of respiratory muscles. Fowl affected by sublethal doses become dull and sleepy.

Transmission: Botulism is common in wild ducks and is a frequent killer of waterfowl because the organisms multiply in dead fish and decaying vegetation along shorelines.

Decaying bird carcasses on poultry ranges, wet litter or other organic matter, and fly maggots from decaying substances may harbor botulism. There is no spread from bird to bird.

Treatment: Remove spoiled feed or decaying matter. Flush the flock with Epsom salts (1lb/1000 hens) in water or in wet mash. It has been reported that potassium permanganate (1:3000) in the drinking water is helpful. Affected birds can be treated with botulism antitoxin injections.

Prevention: Incinerate or bury dead birds promptly. Do not feed spoiled canned vegetables. Control flies. Replace suspected feed.

Staphylococcus

Synonyms: staph infection, staph septicemia, staph arthritis, bumblefoot

Species affected: All fowl, especially turkeys, chickens, game birds, and waterfowl, are susceptible.

Clinical signs: Staphylococcal infections appear in three forms septicemia (acute), arthritic (chronic), and bumblefoot. The septicemia form appears similar to fowl cholera in that the birds are listless, without appetite, feverish, and show pain during movement. Black rot may show up in eggs (the organism is passed in the egg). Infected birds pass fetid watery diarrhea. Many will have swollen joints (arthritis) and production drops.

The arthritic form follows the acute form. Birds show symptoms of lameness and breast blisters, as well as painful movement. Birds are reluctant to walk, preferring to sit rather than stand.

Bumblefoot is a localized chronic staph infection of the foot, thought to be caused by puncture injuries. The bird becomes lame from swollen foot pads.

Transmission: STAPHYLOCOCCUS AUREUS is soil-borne and outbreaks in flocks often occur after storms when birds on range drink from stagnant rain pools.

Treatment: Novobiocin (350g/ton) can be given in the feed for 5–7 days. Erythromycin and penicillin can be administered in the water for 3-5 days or in the feed (200g/ton) for 5 days. Other antibiotics and drugs are only occasionally effective.

Prevention: Remove objects that cause injury. Isolate chronically affected birds. Provide nutritionally balanced feed

FEEDING THE CHICKS

First 4 weeks

During the first 4 weeks: Chicks for layers are fed on Chick mash whereby for Broilers are fed on Broiler mash

Both of them are well compounded feeds and contain a mixture of Food substances and antibiotics

Feeding Growers

When chicks reach 5 weeks old they are called growers and are fed on Growers Mash for Layers and Broiler Mash for Broilers.

Broilers:

They are fed on Broiler Mash until they are ready for slaughtering

The food should be of the right quality and quantity to make them heavy enough for slaughter during 7 – 8 weeks.

Poor quality feeds of low quantity makes the birds to take longer time to become big enough for slaughter.

Layers:

They are fed on Growers Mash until 5 months old where the feed is changed to Layers complete

Meal (Layers Meal) gradually.

Start with a mixture of Growers Mash and Layers Mash

As days pass reduce the proportion of Growers Mash and increase Layers Mash

After 1 week feed the birds with Layers Complete Meal only

Supplementary Feeds

Broilers and Layers should be provided with supplementary feeds such as:

Green Vegetables or Green leaves of Legumes e.g. beans, Lucerne etc to provide protein (legumes) and Vitamin A (green leaves)

The feeding is done by tieing the leaves with ropes and hangs them in the poultry shed

POULTRY DISEASES AND PARASITES

Ill health: Is a condition in which birds are unwell? Ill health in Poultry can be detected through visible signs such as appearance: Birds become abnormal, appetite and Feeding; A sick bird is reactant to feed and swallow with difficult.

Defecation; Diarrhea/water, blood stained faces or contaminated with worms segment indicating diseases.

Mucous discharge; Due to respiratory and digestive system problems the birds would discharge mucous through nose or mouth

DISEASES; This is a condition in which an individual's physical and psychological state shows diversion from a normal state

CAUSES OF DISEASES

Diseases may be caused through the following causes:- Nutritional causes

Excess feed to birds may cause rapture of stomach, diarrhea and constipation while under feeding in the other hand results into starvation and nutritional.

Living organisms

These are of two groups

Infectious diseases

These are caused by microorganisms e.g. bacteria, virus, fungus etc Parasitic diseases: This group include External parasites (Ectoparasites)

These live outside the body of a bird e.g. flies, lice mites etc

Internal parasites: (Endo parasites)

These are found inside the body of the bird such as alimentary canal e.g. tape worms

Miscellaneous diseases

Vices

These are undesirable habits of poultry.

Control measures

Supply feed with enough minerals and protein
Reduce light intensity in the poultry house
Provide enough waiters and feeders to reduce scrabbling and fighting.

Nutritional disorders

Vitamin A:

Deficiency causes Nutritional rupee condition in which the birds have yellow- white pustules in the mouth

Vitamin D:

Calcium (Ca) and Phosphorus deficiency causes sickest.

Parasites in poultry

Internal or ecto-parasites

External end parasites

Generally external parasites bites the chicken on the body surface and suck blood causing the birds to scratch themselves by beak and toes. Examples, lice mites fly etc.

Internal parasites suck blood in the alimentary system resulting to loss of blood, pale combs and wattles and diarrhea examples tape worm, Roundworm, caecum worm, thread worm

TOPIC 2.3.2: FISH AND AQUAPONICS FARMING

LEARNING OUTCOMES

The learner should be able to:

a) know and understand terminology relating to fish farming and aquaponics
b) understand why fish farming is important in Uganda and the value of fish, both in nutritional terms and as a commercial product
c) know how to select appropriate fish for rearing
d) understand how a fish pond is constructed and how to determine whether the soil in a given area is suitable for a pond(v)
e) to construct a fixed pond or a mobile pond/aquaponic system or an aquarium
f) understand how to, and show skills in, stocking and managing a fish pond and/ or an aquaponic system
g) recognise and understand how to deal with different diseases, parasites and predators
h) understand methods of harvesting fish and apply learning in practice

Fish farming is the practice of raising fish in man-made ponds or tanks for human consumption. This is also known as aquaculture and has become widespread over the globe in the past few decades.

We are far past the days of catching fish in ponds or streams and selling at the local market as fish farming in Uganda has advanced over time and farmers now grow the fishes in their farms or houses. This way they are able to control output and revenue.

New and existing farmers hoping to start or expand their capacity are encouraged to start fish farming, as it has proven to be very beneficial in terms of sales and overall profit.

Therefore a fish farm is where fish are raised for food. The fish are raised in **tanks** or in **ponds** and sold to people or companies.

Some fish that are raised on fish farms are:

- Tilapia
- Cod
- Catfish
- Salmon
- Carp

Fish Farming In Uganda

Fish farming has become one of the most lucrative businesses around Uganda. There are different types of fish that can be reared and they include the Nile perch, Tilapia and catfish and they this can be done either on small scale or large scale. Fish farming has also reduced illegal fishing on the lakes of Uganda and has also increased the government's revenues.

When starting up any business, there are a few things one needs to set up that specific business

and this goes for the fish farming business and some of the things needed to start fish farming are listed below.

The capital needed

The first thing to consider before starting a fish farm is the capital at hand. This automatically determines the size of fish ponds that you are to construct, the number of fish you are to start with, the food to be purchased and the labor to be used to take care of the fish. The cost of fish varies per supplier.

You need to get land

Land can be got anywhere as long as you can construct ponds on it. An acre would be good since it will harbor more than three ponds and the more the ponds the larger the number of fish you can rear. After acquiring land the next step is to construct the ponds

Construction of the fish ponds

This will need an expert when you start construction and you can either ask for help from another fish farmer about the specifications of the pond or hire an engineer and a plumber. The pond should have proper drainage or else the fish will die with a poor drainage system and you will also need a net that will cover the fish pond to prevent predators from attacking the fish and this will cost you almost 300,000 shillings only.

It should be noted that the pond will need a lot of preparation especially before placing the fish in it and the farmer can use the guidelines below to prepare the fish pond well.

1. If you are re using the same pond, then drain the water that is in it and let it dry for 14 days.
2. Make sure you apply agricultural limestone at the bottom of the fish pond.
3. Apply manure as an organic fertilizer like cattle, rabbit and poultry manure in the pond before filling it with water.

4. After applying the manure, fill the pond with fresh clean water which is not treated with chemicals.
5. Then lastly fill the pond with UREA and DAP as inorganic fertilizers in the pond after filling it with water. UREA can be filled on a weekly basis at 30 tablespoons per 1oo meters squared and DAP at 15 teaspoons per 100 square meters squared.

Get an overhead tank

The overhead tank needs to be connected through plumbing to the ponds for supply of the water. It's a reservoir of water for the ponds and the water flows into the ponds when the need arises.

Construct a borehole nearby

A borehole will be needed if you are to start fish farming. The borehole provides clean fresh water from underground which is the safest water for the fish to live in as chemically treated water from the taps is not recommended for fish farming.

You should note that if the inflow of the water though the plumbing is too low, the water will have oxygen depletion and will have a lot of toxins leading to the high mortality of the fish.

Undergo training

Before you start fish farming, you need to first undergo training to get familiar with the numerous types of fish you can rear, the trade of fish, the way you can feed and take care of them and other things you need to know about the fish farming business. Training is important because this is a risky venture and you need to avoid mistakes where necessary.

Purchase young fish for your farm

There are different farms in Uganda that specialize in supplying the young fish also known as fingerlings and it is recommended that you get yours from such places. The best fish species to get are the Tilapia and catfish since they reproduce easily and these can boost your farm in the long run.

The fish feeds

The commonly used feeds on fish farms are floating pellets, dry skin pellets, crumbles and meals. These have four fixtures that they must follow and these include

- A fixed feeding location for the fish, the fish should be fed from the same place and not everywhere around the pond.
- A fixed feeding time that is the fish should be fed between 10 am and 4 pm when the fish is most active and the oxygen levels have dissolved
- A fixed feeding quality, the quality of the feeds given to the fish should not change and it should be of high quality in order to get good quality fish.
- A fixed feeding quantity for the fish, the quantity fed to the fish should remain constant and should not change.

The types of fish that can be reared

There are different types of fish that can be reared and the most common fish include the following

The tilapia fish

The Tilapia is the most common fish on the Ugandan market and it stays in shallow clean fresh water and it is good for business since it grows fast that is attains maturity sexually at two months leading to rapid reproduction.

The Trout

The Trout grows in relatively cold areas and it can be reared in highland areas. It is not common now days on the market because of the unavailability of the good quality feeds in Uganda and the seeds but it is also good for fish farming.

The catfish

This is so easy to cultivate and that's why if you are planning to start fish farming it is the best because it is easy to cultivate since it matures at two years and it might not be the most desired on the market but the easiness of cultivation makes it desirable.

The Nile perch

A mature tilapia is of about 121 to 137 cm long and if you are to use it on your farm, then you should put it in its own pond because of its large nature and it's a predator and can feed on the other fish if placed in the same pond.

Benefits of fish farming in Uganda

- It is an income generating source for the farmer from the earnings they get from selling the fish.
- Fish is highly rich in protein and fish farming helps in matching the high demand for protein on the Ugandan market.
- It reduces the unemployment rates since labor has to be hired in order to take care of the fish in the pond.
- Fish farming does not in any way degrade the environment that is other aquatic life can live there hence preserving wetlands and preserving the environment.
- Fish faring does not require a lot resources to start and it can also be done on a small scale basis.
- Fish is eaten by almost half the population in the country as food. Fish farming has increased the number of fish sold on the market.

The risks involved in fish farming in Uganda

- The fish sold from the fish farms is too expensive due to the cost of production and it competes with that from the lakes which is cheap, this might cause a loss as Ugandans prefer the cheap fish to the expensive one.

- Fish is widely known to be very sensitive and any slight mistake made will lead to a high mortality rate of the fish. Therefor you must be very careful while rearing the fish.
- Setting up the farm and maintaining the ponds can be very expensive compared to other farms like poultry and yet the profits need patience. So if you are setting up a fish farm, you need to be patient with everything you do on a fish farm
- Compared to other farms where you can get other by products like manure, when you start fish farming be sure that the only thing you will get is fish and only if they are well taken care of.
- In conclusion, there is no business that is started that does not have risks but the best thing to do is to look at the bright side and concentrate on the benefits and you will enjoy profits in the long run from fish farming.
- Ask for advice from fellow farmers who are into fish farming and find out how they maintain their farms and also understand the trade process of how fish is transport and its market. Read through the above and you will reap big from fish farming in Uganda.

Aquaponics

On the other hand, **aquaponics** is a cooperation between plants and fish and the term originates from the two words aquaculture (the growing of fish in a closed environment) and hydroponics (the growing of plants usually in a soil-less environment).

Aquaponic systems come in various sizes from small indoor units to large commercial units.

How Does Aquaponics Work?

Fish eat the food and excrete waste, which is converted by beneficial bacteria to nutrients that the plants can use. In consuming these nutrients plants help to purify the water.

Aquaponics integrates aquaculture and hydroponics into one production system. Aquaponics relies on the food introduced for fish, which works as the system's input. As fish eat this food and process it, they transform it into urine and fecal matter, both rich in ammonia, which in sufficient quantities can be toxic to plants and fish.

Afterward, the water (now ammonia-rich) flows, together with un-eaten food and decaying plant matter, from the fish tank into a biofilter. Afterward, inside this biofilter, bacteria break everything down into organic nutrient solutions (nitrogen-rich) for growing vegetables.

Aquaponics' Benefits

One of the benefits of aquaponics is that it makes it possible to have an intensive food production system that's still sustainable;

- Aquaponics encompasses two agricultural products (fish and vegetables) being produced from one nitrogen source (fish food)
- Aquaponics is an extremely water-efficient system
- Aquaponics doesn't require soil and therefore it's not susceptible to soil-borne diseases;

- Aquaponics doesn't require using fertilizers or chemical pesticides
- Aquaponics is a synonym of higher yields and qualitative production
- Aquaponics means a higher level of biosecurity and lower risks from outer contaminants;
- Aquaponics allows a higher control (as it's easier than soil control) on production leading to lower losses
- Aquaponics can be used on non-arable lands such as deserts, degraded soil or salty, sandy islands;
- Aquaponics creates little waste, as it mimics nature's circular approach
- Aquaponics requires daily tasks, harvesting, and planting which are labour-saving and therefore can include all genders and ages
- Aquaponics can integrate livelihood strategies to secure food and small incomes for landless and poor households
- Aquaponics creates fish protein - a valuable addition to the dietary needs of many people;
- Aquaponics is a completely natural process that mimics all lakes, ponds, rivers, and waterways on Earth
- From a nutritional standpoint, aquaponics provides food in the form of both protein (from the fish) and vegetables

Aquaponics' Weaknesses:

Every coin has two sides. We can also find some weaknesses that come along with adopting an aquaponics design. The following are the weaknesses of aquaponics:

- The very high initial start-up costs (compared with both hydroponics or soil production systems) of aquaponics is one of its weaknesses
- Aquaponics requires deep expertise in the natural world. In order to be successful, farmers need to have knowledge not only on growing vegetables but also on how fish and bacteria work. And technical skills regarding plumbing or wiring are also needed
- As a follow up from the previous point, it's often hard to find a perfect match between the needs (such as pH, temperature, substrate) of fish and plants
- Aquaponics has fewer management options (an issue developed ahead) compared with stand-alone aquaculture or hydroponics
- Mistakes managing the system can quickly cause its collapse
- Daily management is needed, which means the organization is crucial

- Its energy demand, which means it has energy costs
- Fish feed needs to be purchased on a regular basis
- The products of aquaponics alone aren’t enough to ensure a balanced diet

TOPIC 2.3.3: RABBIT REARING

LEARNING OUTCOMES
The learner should be able to:

a) know the most important breeds of rabbits, their characteristics, their
b) importance in commercial farming and their value in nutritional and financial terms
c) show skills in constructing a rabbit house
d) understand the safety 'Dos and Don'ts' of rabbit-keeping
e) show skills in feeding, managing and rearing of rabbits
f) show skills in carrying out rabbit health checks
g) demonstrate skills of treating diseases and pests in rabbits
h) show skills in processing and marketing of rabbits and rabbit products
i) show entrepreneurial skills in rabbit rearing

Rabbit farming has become a popular micro-livestock farming business just like livestock farming. Though it requires hard work and sufficiency of dedication, it has the potential to generate good primary income as well as additional income streams.

It is also quite profitable both for the farmers and young entrepreneurs as they can also start this venture as an agricultural business practice to make money.

In most parts of the world, rabbits are considered a pet and may not be deemed fits for slaughtering for its meat and because of this, it is most times considered as poultry other than livestock in such areas

What is a rabbit farm?

Rabbit farming, in other words, called **cuniculture** involves the agricultural practice of raising domesticated rabbits as micro-livestock for their meat, wool and fur production.

The wood and fur production is very profitable and their meat is considered best after poultry birds as well.

An aspiring rabbit farmer should know that you need good quality breeds of this animal, house and good quality food. Following these steps will lead you to a successful rabbit farming business.

Breeds and Breeding

It is interesting to note that East Africa does not have wild rabbits. The brown creatures that are seen, mostly at night, on the plains are hares, not rabbits. The rabbits used for meat production are pure breeds of crosses of:

- **New Zealand White**: has a good growth characteristic, capable of attaining slaughter weight of 3 kg live weight within 12-14 weeks depending on feeding regime. It is one of the best commercial breeds that grows to a weight of about 5 kg and has all-white colour making its fur marketable. It is considered a dam breed because of its excellent mothering instinct.
- **Californian White:** it is bred to have broad shoulders and meaty back and hips and hence has a good meat breed with good dressing percentage. It is shorter and stockier and is white except for its ears, nose, feet and tail which are either dark grey or black. It is an ideal sire breed for interbreeding with other rabbit breeds for purposes of meat production.
- **Flemish giant**: this is one of the largest rabbit breeds, weighing up to 7 kg live weight. Though Kenyan farmers like it because of its size, this breed is not an ideal meat breed because of its high bone to meat ratio and its slow growth. Interbreeding it with other breeds may help improve its characteristics
- **French Ear-lopped** (sometimes referred to as Belgian Flop): The Lop family shares the distinction of being one of the oldest fancy breeds. The ear length, shape and size of the rabbit are a major attraction with farmers. It is favoured for meat production because of its body weight.
- **Dutch:** fairly small but compact rabbit with shorter forelegs. It often has characteristic markings.
- **Chinchilla:** The Chinchilla is kept almost exclusively as a pet or for fur, which we do not

Breeding from selection of animals, to weaning of the young rabbits

In rabbits, males are referred to as 'Bucks' and a females as 'Does' and their young are referred to as 'kits; 'kit' is an abbreviation of 'kitten'. It is important that you plan your breeding, otherwise you could end up with more weanlings than you can cope with. It is very easy to get over crowded very quickly as rabbits are very prolific breeders. Plan how many weanlings you want to have in a year and how many does you need to reach that goal. One doe can have 4 - 5 nests per year with each time up to 8 kits. When they all stay alive one doe is able to provide you with up to 40 weanlings per year.

It is advisable to keep a breeding sheet on the door of each doe pen. You should record the number of the doe, the date of birth, date of service, the buck used, the date of kindling (giving birth), number of kits reared, any deaths, as well as dates of deworming (You could include a column for 'comments' on the far right of the sheet - i.e., whether the doe adopted another's young or, indeed, had so many kits that she had to foster some of them).

Example of headings on breeding sheet:

It is suggested that these should be posted on the door of every breeding doe, protected by a plastic bag and stapled where the rabbit cannot destroy it. Every breeding doe and buck should have a name and number, which would be at the top of the sheet. If these sheets are kept up to date it is very easy to keep track of your breeding program.

Doe number: 5 (Marie)		**Date of birth (May 2013)**			
Date	**Buck number (Name)**	**Kindling**	**Number of kits born**	**Number of kits weaned**	**Notes**
11 May 2015	12 (Jogo)				together for 10 minutes
11 June 2012		ok	7		+ 1 still born
15 August 2015				6	1 lost after 3 weeks
1 September 2015	12 (Jogo)				15 minutes together, no mating
2 September 2015	12 (Jogo)				together for 10 minutes

Temperature regulation in grown-up and newborn rabbits

Rabbits are very adaptable animals and are able to deal with changes in temperature because they have an inbuilt mechanism for controlling temperature fluctuations. In cold climates the rabbits will curl up to keep warm and in hot weather they will stretch out (with the back legs stretched out behind them) so that they can lose as much heat as possible by radiation and convection.

At the same time their ear temperature will increase for cooling the blood. The ideal temperature is from 10degC - 26degC. They are able to survive in temperatures as low as 0degC and as high as 33degC but their efficiency will be compromised at these temperatures.

Heat regulation of newborn rabbits is, however, different. Kids are born blind, naked and helpless; and it is interesting to note that they are born with teeth. To keep warm they huddle together in a nest made by the mother with fur from her chest. If the temperature rises, the kits will move apart. A sudden drop in temperature can disable their temperature control before they can huddle together again, and a kit can die of cold 10 cm away from the group. The breeder must be watchful for such instances.

Rabbits are sensitive to humidity below 55%. They feel comfortable if the humidity level ranges from 60 - 70%. The problem arises during the rainy season when temperatures and humity fluctuate. Air which is too hot and dry is even more dangerous. This is why it is so important to have sufficient ventilation without draughts.

Reproduction

Gestation Period: On the average 30 - 32 days and the rabbits born on any day between the 28th and 34th day after mating, usually survive. The duration of gestation is also affected by the time of year, the size of the doe and, above all, the size of the litter.

Pseudo Pregnancy: A doe may exhibit pseudopregnancy (behaves as if pregnant when it is not) but the symptoms do not usually last beyond the 18th day. The best way to confirm pregnancy is to palpate the abdomen gently on the 10th - 14th day.

Mating: When a doe is ready to be mated she may become restless and nervous and may have a red and swollen vulva and will be happy to join the bucks. Rabbits are spontaneous ovulators, so can be put in with the buck and covering will take place within minutes. A receptive doe raises her tail and allows mating. The buck will make a growling noise and fall to one side when mating has taken place. The doe should be removed immediately. If mating has not taken place in 15 minutes the doe should be removed and returned later. If left with the buck they will both become bored and the buck will lose interest.

Caring for the Doe: A pregnant doe deserves special care and management if the farmer is to achieve the best results. Although the general care of the doe is the same as that for the entire flock, it involves a slightly different management strategy. Special care should be taken in respect of feeding; environment; kindling and housing as well as the diet.

A balanced diet will ensure better fertilization, reduce the risk of embryonic deaths and ensure better fetal growth; see feeding for more advice also on feeding the pregnant rabbits.

Miracle births

Cases of "miracle births" have been observed. This takes place when a doe produces young when it is absolutely certain that she has not been to the buck. Some does who will not accept the buck may already be pregnant even though they have not been with a buck. It has also been recorded that a doe that is in kit is sometimes able to retain sperm from a different covering, to produce another litter later.

Kindling: The birth of young rabbits is known as 'kindling'. This usually takes place at night and the doe should not be disturbed by noise or frightened by animals. This can cause her to eat or abandon her litter. After birth, the mother will lick her young and let them suckle. The earlier this happens the better their chance of survival. Most does are good mothers and are very protective and careful of their litter.
Occasionally a doe will eat her young. There are factors that can be attributed to this, such as shortage of water before kindling, or noise and fear. If, however, she repeats this behaviour with subsequent litters she should be culled because this trait can be passed on to future generations.

Fostering: This means taking kits to another doe. This could be an option if a mother dies or abandons her litter or does not allow them to suckle. The other reason is if the litter is bigger than 8 kits, when it is advisable to foster the excess to mothers with less than 8 kits.

Litter size and frequency: Under good management, a doe can produce 4 to 5 litters per year with 7 to 10 kits per litter. Usually smaller litters thrive better than larger ones, but larger litters can be sustained with improved feeding. It is essential, therefore, to ensure that your does receive adequate concentrate feed, plenty of green fodder, supplements and plenty of clean drinking water. It should be remembered that a doe has 8 teats. If she produces more than 8 kits the smaller kits may not receive sufficient food. It is very easy to put the weaker kits with a doe who has fewer babies of the same age. Does are very accepting of 'outsiders'.

First breeding: With good feeding practices the well-developed doe should be ready to breed at 5 months of age. With poor feeding practices this may not happen till 7 to 8 months of age. Some first time mothers will eat their first litter, or abandon them. The dead kits should be removed immediately and disposed of. The doe should be rested for at least a week before being returned to the buck. If a doe has three unsuccessful breedings, she should not be used for breeding and retire.

Breedings after wean: Mature does can be served one week after they wean.

Weaning: At weaning (one month) the kits must be sexed and kept separate as they are able to breed from a very young age. If you allow your rabbits to breed too young the result will be small and weak off-spring. They could even be born with birth defects and a young mother

may not be able to look after her offspring properly, or she may even eat them all at birth or she herself may die.

If one month is gestation and one month is for rearing young, the doe could not be taken to the buck more than once in two months. But this way you could have a continuous supply of meat. Depending on how many does you keep, you can work this out:

- Gestation is one month
- One month is with the mother
- 3 - 4 months to slaughter.

Production period: when does and bucks perform well, they can be kept for 4-5 years after which time their production should be assessed. If the doe is still producing decent sized litters with healthy kits, it is possible to keep her for a further year, **after that she should retire and be kept as a pet.** The same applies to the buck. It has been noted that older bucks may start to produce small or weak kits, **in which case they should retire and kept as a pet.**

Care of the young: A couple of days before giving birth the doe will start collecting hay in her mouth to make a nest. She will then pull hair from her chest and under her neck to line the nest. She will pull out more hair after haven given birth and cover the babies. This is the time that the young have to be watched carefully:

- Kits are born blind and naked. The first 35 days of their life are crucial. They are usually confined to the nest for at least two weeks, sometimes longer. They should not be separated from their mother before 4 weeks of age. If they are weaned early they may die of separation shock.
- For the first 20 days the only food for the kits is their mother's milk. The mother feeds her young only once in 24 hours and only for 3 - 5 minutes. The doe must, therefore, have access to plenty of good food and water to ensure that she has enough milk for the litter.
- It is essential that the kits not get cold, especially in the first few days after birth. The nest needs to be checked to ensure that the babies are not carried out of the nest by the mother after feeding (check early mornings as feeding normally takes place during the night). It is quite safe to handle the young and return them to the nest.
- If they are found outside the nest and cold, (the kits will feel cold and the skin will be wrinkled and 'sticky' to the touch) it is essential to warm them up quickly or they will die.
- Once they are warm (the kits will become a healthy pink colour, warm to the touch) they can be returned to the nest. Warming them can be done by wrapping them lightly in a

cloth and putting this on top of a hot water bottle in a box. Make sure that the kits are protected from the plastic cover. They should be turned a couple of times to make sure that they are properly warm.

- They will start to squeak and wriggle once they are warm enough. Remember that every dead kit is a lost life.
- The kits will start coming out of the nest after 15 - 16 days and will start trying to chew green matter and concentrate whilst still suckling. They will gradually eat more solid food and suckle less.
- At one month the kits should be weaned and the males separated from the females as they can start breeding at a very young age. Determining the sex of the kits is not easy, but practice makes a master: Lay the kit on its back in your hand and gently blow on the hair around the genital area and, with 2 fingers, gently separate the genitalia towards the tail. The males will show a small upwards protrusion while the females will show a small opening. This is easier done by two people. One holding the kit and one doing the sexing. Kits generally lie very still when laid on their backs. It is essential that they are treated gently to avoid injury.
- The kits should then be put in separate weaning houses. A double pen of 90 x 180 cm can comfortably house 6 young rabbit growers. Remember there are now more rabbits in each cage, so they must be fed more food accordingly and given more water if they are to grow well.
- At weaning it is advisable to routinely (no preventive treatments in organic rabbit production) treat the weaners with coccidiostat (the same one used for chicken). 1 ml dawa/litre of water for 3 days will protect them from diarrhea and stress after weaning.
- It is also advisable to deworm them a week later with 1/4 ml of Albendazole administered by mouth with a small syringe (without needle) is enough for each one month old rabbit. Be careful, not to put the syringe too far into the mouth or you may damage the throat. Death will almost certainly be the result of rough handling.

Management: Handling, Slaughter

Handling

Rabbits should always be handled gently but firmly. If the rabbit feels insecure or afraid it will damage itself and, in all probability, the handler.

NEVER lift a rabbit by the ears. The most common and safest method is to grasp the ears close to the head with one hand, while the other hand takes the full weight of the rabbit. The hand

holding the ears restrains the rabbit and prevents it from struggling, without damaging the joints where the ears meet the head.

When handling kits, they should be picked up by placing the whole hand, gently, over the kit and curling the fingers around it. Care should be taken not to squeeze the kit as they are very fragile and it is very easy to damage them.

When handling rabbits, of any size, for whatever reason, the easiest and safest way is to wrap the rabbit in a cloth and pick it up. The cloth or sack will give the rabbit a sense of security and it won't struggle.

Viciousness in rabbits

It occasionally happens that a rabbit becomes vicious and attacks those who attempt to handle it. A doe may become very aggressive when she has young - this is a natural instinct and should be respected. Bucks can also become aggressive for no obvious reason. However, aggression is almost always as a result of bad handling or teasing. It can also be the result of lack of water - so make sure that water is always available.

There are instances where a rabbit may become aggressive for none of the above reasons. If this behaviour becomes habitual, culling should be considered. A rabbit has the ability to open its mouth very wide, their teeth are very sharp and their bites are deep and painful.

Slaughter

It is important that the rabbit is killed very quickly and in the most humane way possible.

The quickest and kindest way to do this is:

- Hold the rabbit in your left hand by its back legs. With your right hand hold the rabbit's head between your index and middle fingers, under the chin and against the base of the skull. Lift your right hand to shoulder height, stretching the rabbit, and pull the head quickly and sharply. If you try to do this any other way it will not work.
- When the rabbit is dead, it should be hung by one back leg. The head is removed. The feet are clipped off. A small slit should be made on the inside of the back leg that is not attached to the slaughter post. The skin is peeled off this leg. The skin is then gently loosened round the body and front legs. You will then be able to take the skin off the remaining back leg, and by pulling down, so that the skin is now inside out, you will be able to peel the skin off like a sock. The rabbit is then gutted and entrails removed.

Housing

The rabbit unit should be located in a peaceful environment, away from the noise and bustle of human and animal noise. The unit must fulfill the following function:

a) protection from extreme influences of weather and noise, which could interfere with the performance of the rabbits
b) protection from predators including birds, snakes, insects and rats.

While planning a unit, the following should be taken into consideration:

- The exterior should provide protection against heat but at the same time it should be properly ventilated without draughts.
- There should be separate units for the does and bucks. Breeding stock should be kept in one unit and the 'meat' unit should be separate.
- Three or 4 does and one buck would be more than sufficient to keep a household supplied with meat all year round. You would therefore need:
- A pen for the buck
- A pen for each doe
- At least 2 weaning pens - one for females and one for males

If there are more does, you need more pens for the does but also more weaning pens. When the weaners are growing not so fast because of lower feed quality, they stay longer and more weaning pens are needed.

To grow healthy, rabbits must be kept clean because dirty rabbits are unhealthy rabbits. It is best to house them off the ground as follows:

- The house should be 90 cm off the ground, should be 90 cm high and 90 cm wide. As roofing sheets come in 2.5 meter lengths it makes sense to build blocks of houses 1.8 m wide so one roofing sheet can be used to cover 2 houses.
- The floors should consist of chicken wire (with the smallest size holes) so that droppings and urine fall through to the ground. This can then be swept up daily and used to mix with compost.
- The house should have a layer of hay/dried grass or straw as bedding. This is a very important part of the rabbit's diet. They will eat a lot of this bedding during the night.
- Rabbits do not tolerate windy conditions, so houses should be placed in sheltered areas and windbreaks provided where appropriate.

- Rabbit houses should be cleaned every day. Wet bedding should be removed and replaced with dry material. If rabbits are left with soiled beddingt, hey will not eat the bedding material and it will encourage flies and diseases to multiply.
- Dirty or wet houses will result in a very strong 'rabbit' odour which will taint the meat. A soiled pen is stressful for the rabbit and it will also mean that the pelts become soiled and 'felted' which makes them unusable.
- Mud hutches and thatched houses can also be constructed but they should be off the
- ground and kept clean as described above.
- NEVER be tempted to try and save space by constructing houses in 'tiers' (one on top of another). This will lead to all kinds of problems as the lower houses will become fouled by the droppings and urine from the upper level.
- Exposure to light plays an important role in reproductive efficiency. Bucks exposed to light for 8/24 hours are more sexually active. It also improves the productivity of the doe. It is possible to make up this light requirement using artificial light, but this is an expensive way of solving the problem.

Feeding

Rabbits are coprophagous animals which means that they form two kinds of fecal pellets. One type is what the farmer will see on the floor of the hutch or below the cage. The other is the one that the rabbit swallows whole directly from the anus. Coprophagy is a peculiar physiological and natural habit which increases the digestive efficiency, especially from protein. The fecal pellets eaten contain three and half times more crude protein than the normal pellets which is probably why they instinctively eat these fecal pellets.

The feed conversion ratio of rabbit is considered to be half as efficient as that of cattle, due to the rapid rate of passage of food. More so because microbial digestion of fibre takes place in the hindgut rather than in the rumen. The digestive tract of a rabbit is known to be adapted to fibrous feed, but the hindgut is selectively able to excrete large fibre particles in feces, and retain the smaller particles. Rabbits are able to consume large amounts of forage - greens of many types - which people do not eat. They convert this forage into meat which people do eat. Anyone with fields or a garden will have maize stalks, sweet potato vines, fruit peelings, peanut vines, cabbage or lettuce leaves, carrot tops or any number of other greens in addition to lots of wild plants and kitchen garbage on which rabbits thrive. Many of these greens would otherwise go to waste. They would need, however, a bit of grain each day. If rabbits are not fed well they cannot give the best returns In large rabbit farms the bulk of expenditure incurred in breeding, producing and keeping rabbits is on concentrated feeds.

Interestingly, when available, rabbits prefer green fodder which is low in crude protein and is easily digestible. If they are forced to eat less preferred plant parts the feed intake may decrease drastically. The large capacity of the rabbits digestive organs enables it to compensate for seasonally lower concentrates in feed during cold periods and, during the warmer weather by a correspondingly higher intake. It is for this reason, accompanied by corpophagy, that the chances of survival during feed and water deficiencies are improved.

Rabbits can survive on a wide range of feed, thus enabling the keeper to adopt a feeding program to suit the prevailing local circumstances. There are different types of foodstuffs that are used as rabbit feed. On small holder farms, where pelleted feeds are not available and/or are to expensive, rabbits can produce on many kinds of available local feeds. In large rabbit farms, pelleted feed are most used which is more balanced and which will cut down on wastage.

Feeds can be grouped as:

- roughages, including hay, green leaves and weeds. As a precaution, if wild herbs are to be offered, a knowledge of poisonous plants is necessary.
- succulent foodstuffs, including green grass, carrots and other green food
- concentrates, including all cereals
- compounded feeds such as complete pelleted feed

Rabbits require different quantities of food at different stages of growth. In Table 1 is shown that rabbits producing milk and pregnant rabbits needs most feed (protein and minerals). Non-producing rabbits have least requirements. The amount of feed what should be supplied depends on the type of feed. A lactating doe will need 350g - 380g concentrates per day. When fed with green fodder, she needs much more and up to 1.5 kg (and takes with that feed also a lot of water). When hay is fed (with a lower energy content) she needs to eat 700 grams a day or more.

A pregnant doe requires 0.60 Mj digestible energy. That can be eaten in the form of green forage or as concentrates or as a mixture of both types of feed. Concentrated feed can be grains or other feed with a high feeding value (low moisture content). The maximum intake of a pregnant doe is about 600 grams of dry matter per day. From concentrates with 90% dry matter the doe will eat 660 grams to satisfy her needs. From fresh green grass with 25% dry matter, the doe has to take 2400 grams to ingest 600 grams of dry matter. That is a too big amount and part of the ration should consist of high dry matter feed (e.g. grains) According to table 1, the 600 grams dry matter should roughly contain 90 grams of crude protein, 12 grams of crude fat, 80 grams of crude fibre, 3 grams of lysine, 6 grams of calcium and 4 gram of phosphorus.

There must be adequate amounts of vitamins A, D, E, K and B.

	Growth	Maintenance	Gestation	Lactation	Does & Litter
Digestible energy (Mj)	10.5	8.9	10.5	10.9	10.5
Crude fibre (%)	13	15	13	11	14
Crude protein (%)	16	12	15	17	17
Crude fat (%)			2		
Calcium (g)	4.5	6.0	6.2	9.2	9.2
Phosphorus (g)	2.6	4.0	4.0	6.0	6.0
Vitamine A (IU)	6000		12000	12000	10000

Minerals

Minerals are essential for proper growth and should include calcium, phosphorus and sodium chloride. On average the diet should include 0.5% - 0.7% phosphorus and 0.7% - 1.0% calcium. Lactating does require a slightly higher amount of phosphorus or calcium. It is a good idea to put minerals in the feed (for instance Coopers Macklic powder).

Vitamins

Vitamins are an integral part of the feed. In a mixed ration there will be enough vitamins to supply the rabbits needs. Vitamins are abundant in roughages. Concentrate feeds also contain vitamins.

Hay/straw

- Crude fibre is an integral part of the diet and is essential for the digestive system and the well being of the rabbit. A good farmer will notice that the rabbit eats much of its bedding during the night and will replace it the following day when the pens are cleaned. The average concentrate intake of an animal ranges from 120 g to 150 g per day. The concentrate feed should be supplemented with green food or hay. The roughage is best fed in the evening as rabbits are much more active at night.
- Roughages and greens should be available all the time. Rabbits eat most vegetable matter such as potato and carrot peelings, vegetable scraps etc. They thrive on weeds (especially chick weed, amaranth and thistles).
- Other examples of good rabbit feed include lucerne, chopped napier grass, sweet potato vines and fresh green grass if it is available.
- After the rains there is usually an abundance of wild herbs and weeds that rabbits will enjoy but ensure at all times that your rabbits have a varied diet of roughage and greens.

Concentrates (rabbit pellets or rabbit mash) should be fed twice a day as follows:

- 0 - 16th week after weaning give 65 - 100 g/day
- Pregnant does give 225 g/day/doe
- Active Buck give 90 - 100 g/day

It is recommended that a square piece of plastic or sacking is placed under the feed bowl to catch and reuse spilled feed. The most food and water efficient food bowls are made of clay with an inward lip. These are too heavy for the rabbits to turn over and the lip prevents spillage. The water bowls should be scrubbed at least once a week to prevent algae growing. This will foul the water.

NOTE: Do not feed rabbits with tops of tomato or Irish potato nor with mint as they are poisonous.

Feeding Time

Rabbits are very 'time conscious'! They expect food at the appointed time and you may find them waiting by their doors at that time. A haphazard feeding schedule will cause distress to their digestive system. It is best to feed them twice a day: morning and evening.

Cleanliness and Hygiene

Feed, bedding and water should all be fresh. If concentrates are fed they should be stored in weather/vermin proof containers (drums with lids and old deep freezes make excellent feed stores). Keeping the feeders and water bowls clean can yield dividends to a farmer. Failure to maintain hygienic conditions will result in frequent disease outbreaks.

Tip: A spray bottle of 50/50 white vinegar and water makes a gentle disinfectant for wiping off surfaces and reducing odour.

Economic feeding of rabbits

A balanced diet made up of high quality feed ingredients, and hay, is recommended for use in large scale units. Mash feeding alone might lead to a low conversion ratio resulting in higher feed intake. That can only be economically interesting when feeds are low in price.

Most rabbit farmers in East Africa are dependent on commercially made complete rations. Efforts should be made to supplement this with green roughage, depending on availability. This will go a long way to keeping the cost of feeding down, as this is a major expenditure for the

small farmer and should be kept at the barest minimum without compromising the requirements and welfare of the rabbits.

Water

Rabbits need plenty of fresh water. It is wrong to assume that rabbits obtain sufficient water from their green food. Rabbits consume a surprising amount of water and it is important that this is readily available. Place a small water bowl with a solid base to avoid being overturned in each cage, and fill the bowl with water twice a day. Alternatively, in large enterprises a drip water system could be useful. This is more expensive, it saves time, the rabbits have water at all times they learn very quickly how to use it

Common Rabbits Diseases

Good health in the rabbitry comes from keeping the environment clean, dry and well-ventilated and avoiding overcrowding.

The problem of disease is two fold in domestic rabbits. The first and most important part is prevention, the second concerns elimination and treatment of disease when it occurs. A healthy rabbit should recover rapidly from minor ailments and the keeper must direct every effort to assist the recovery and also to enable the rabbit to resist disease. Hygiene and sanitation play a big part in good management.

Quarantine new rabbits

- Rabbits should be allowed direct access to sunlight as it also acts as a germicide besides having a beneficial effect
- Destroy the affected rabbits in any outbreak. These complications can only be overcome by the keeper's vigilance.
- Prevention of disease is not a subject to which one should turn only when disease appears, that is usually too late. It must form part of the rabbit keepers day to day management.

Some diseases spread so quickly that action must be taken immediately. Complete isolation of sick rabbits is essential. Early treatment is the only effective method of dealing with disease. A decision has to be made as to whether the rabbit can be saved and, if it can, is it financially viable to do so. If the rabbit is to be destroyed, it should be done humanely, away from the rabbit unit, and the carcass should be incinerated without cutting it up as this could spread bacterial infections through the unit.

A farmer may well be able to diagnose the problem, but it is advisable to seek veterinary advice

in the event of a disease outbreak. Prevention and treatment of common disease, along with hygienic measures are necessary to avoid outbreaks. One can often draw conclusions from the symptoms with regard to the location and type of disease, along with the chances of recovery.

Early recognition of disease is most important as there is more chance of recovery if the treatment is started early. It is quite useless to commence treatment when the disease has progressed to the stage that the rabbit is obviously dying. A watchful rabbit keeper will be quick to notice any change in appearance of any of his stock.

- A fall in weight is one of the first signs that all is not well. The reason for slow weight gain, loss of weight or lack of appetite should be sought.
- A good keeper will notice any change in the feces.
- The coat is a good indication of a healthy rabbit. A dry, dull, harsh or patchy coat indicates something is wrong. A sleek, glossy coat indicates good health.
- A healthy rabbit is alert. Any sudden noise or movement will awaken its immediate interest. The rabbit's movements should be free and easy and it should not sit huddled in a corner.
- It's breathing should be even. The respiration rate of an adult rabbit is 30 - 50 breaths per minute. Shallow (rapid) breathing is an indication that something is wrong.
- The eyes should be bright with no discharge from them or from the nostrils, mouth, vent, anus or teats.
- The rabbit should not feel 'bony' and the muscles along either side of the spine should be firm and full, with no swellings, which are indicative of cysts or abscesses.
- A healthy rabbit is full of vitality and the farmer should aim to keep his rabbits like this.

Causes of diseases

Diseases may be caused by:

- **Bacteria**: Diseases of the rabbit caused by this group though relatively rare, include pasteurellosis in various forms and tuberculosis.
- **Viruses**: Few diseases are caused by these organisms, the most common being myxomatosis which is not seen in East Africa
- **Animal parasites**: Includes single celled animals or protozoa which produce coccidiosis, flukes, flatworms and roundworms. In this group are also fleas, lice, ticks and mites which can produce disease such as ear canker or, alternatively, can carry disease.
- **Nutritional deficiencies**: A shortage of vitamins, minerals and other essential items of food which give rise to ailments such as rickets, reproductive failures and other problems.

The spread of diseases

Diseases can be spread by physical contact, confinement of healthy animals with diseased stock, contamination of feed, by rodents and birds and through water and the air. Many potentially harmful organisms are present in the animal's body in such small numbers that symptoms of disease do not manifest themselves, provided the animal has a good resistance and a well working immune system. The disease will only appear if the rabbit is subjected to challenges such as bad feeding, cold or any other stress factor

Common Rabbits Diseases

Some of the commonly occurring diseases in rabbit units are:

a) Coccidiosis

This is probably the most common disease in rabbit units. Once a farm is infected with coccidiosis, it is very difficult to eliminate it completely or permanently. It is difficult to cure hepatic coccidiosis.

Symptoms:

- Anorexia (not eating)
- Pendulus and distended abdomen followed by progressive weakness, diarrhea, constipation and jaundice

Prevention:

- It is best prevented in well constructed rabbit units, where the rabbits are not living in cramped, crowded or dirty conditions.
- Cages should be disinfected at regular intervals and cleaned daily. Nest boxes should be disinfected between kindlings.
- Water bowls and feeders must be cleaned and disinfected regularly.

Treatment:

All the drugs used are prophylactic (preventing infection) and should be given when there is risk of disease. There are many coccidiosis preventative drugs on the market in East Africa, most of them for poultry, but these are suitable and effective in rabbits.

b) Pasteurellosis (snuffles)

The bacterium *Pasteurella multocida* causes a variety of diseases in rabbits. These include:

snuffles, pneumonia, otitis media, conjunctivitis and abcesses. Snuffles is not a fatal disease but the animal can develop pneumonia, pleurisy or acute pasteurellosis as secondary infections. The disease may migrate from the nasal cavity through eustachian tube to the middle ear, causing inflammation and may lead to torticolis, uncoordinated gait, inability to take food and water and loss of weight. This particular disease does not respond to treatment.

Symptoms:

- In snuffles, the main symptom is a thick sticky, white discharge from the nose which the animal wipes away with its fore legs.
- There is also constant sneezing, which will encourage the spread of the disease.

Prevention:

- Avoid cold draughts in the house.
- Construct rabbit hutch according to the recommendations.

Treatment:

Snuffles and pneumonia can effectively be treated by a combination of penicillin and streptomycin administered intramuscularly by injection.

c) Pneumonia

It is caused by poor housing, overcrowding and poor ventilation especially in cold areas. Ensure that there is sufficient bedding to prevent draughts coming through the floor, and that the rabbits are not subjected to cold winds, especially at night. It is advisable to have the ends of the units protected with plastic or heavy duty shade netting. It is also advisable to have roll down 'curtains' over the front of the unit, made of plastic or shade netting, that are let down at night to keep the whole unit warm.

d) Conjunctivitis

P.multocida goes from the nasal cavity to the eye through tear duct and causes reddening of the conjunctiva and a discharge from the eyes.

Treatment:

- It can be treated with antibiotic ophthalmic ointments and drops.

e) Abcess

Subcutaneous and visceral abscesses are quite common in rabbits. Subcutaneous multiple abscesses may be found on the face, body and lower jaw containing thick cheesy pus. Visceral abscesses however, may be found on the liver, heart and lungs. They may cause sudden death

Prevention/ Treatment:

- Drain the abscess of all pus.
- Irrigate with a solution of hydrogen peroxide and water, flush again with saline and then irrigate with iodine. If the abscess has been drained completely, one treatment may be sufficient. The hole will close spontaneously.

f) Sore hock

Ulcerated sores will develop on the back leg joint (the hock).

Prevention/ Treatment:

- Keep the cages clean. Dirty wet cages are the source of the infection.
- Open the ulcerated sores and clean thoroughly.
- Apply antiseptic dressing.
- Failure to treat will certainly be fatal.

g) Heat prostration

If the temperature soars beyond 35 degrees centigrade, the rabbits will become restless. They will start panting and blood will ooze from the nostrils followed by death.

Prevention:

The only way to prevent this is to transfer the animals to a cooler situation.

h) Hind quarter paralysis

Sudden disturbance, fear or excitement may leave rabbits paralysed. They become helpless creatures and their activity is restrained. There is no cure for this deadly disease. The breeder should avoid strangers entering the unit for curiosity and fun.

i) Hairball occlusion

Sometimes fur and wool are accumulated in the stomach, blocking normal passage of food. This may be cured with mineral oil or surgery.

k) Incurable diseases

The following diseases are incurable and culling is the only way out:

- Infections arthritis (thickening of the knee, hip, shoulder)
- Kidney fibrosis
- Leucosis (enlargement of liver, spleen, lumph nodes, whitish tumour foci in liver)
- Uterus carcinoma (tumour in uterus and lungs)
- Rabbit pox
- Paralytic tremor
- Epilepsy
- Encephalitis
- Spinal column injuries
- Syringomyelia

Parasites

a) Ecto-parasites

These include ear mange or canker, skin mange, mites, fleas, ticks etc.

Ear Canker and Mange

Ear Canker and Mange are caused by two types of mites - *Posroptes communis var. cuniculi and Chorioptes cuniculi.* The mites attack the inside of the ear and cause inflammation and severe irritation. The animal will be restless and will shake its head from side to side. It is possible that the ears will become damaged from banging against the side of the pen. This can lead to 'cauliflower' ear which look like bubbles under the skin on the inside of the ear. At the onset the ear will feel hot and will be painful to touch. With time, the blisters (which can be quite big) will become very hard.

Treatment/Prevention:

- It is essential that the mites are dealt with as mites travel from one animal to another.
- Ears of the entire unit should be checked at regular intervals.
- Remove the crusts, scales with the help of cotton wool and then apply ear canker preparation (readily available in veterinary outlets). Alternatively, use ear drops.
- Until the mites are dealt with, the rabbit will continue to shake its head. You can easily test for them by gently inserting a cotton bud into the ear and wiping it round. If there are mites they will be stuck to the cotton bud with a brown substance. The mites look like tiny fleas. They cause a lot of distress to the rabbit and will spread if left unchecked.

- Alternatively, dust the rabbits with recommended chemicals or try diatomite powder if available. If you keep your houses clean and dry, the risk of infestation by the above is minimalized

Body or Skin Mange

This is not quite as common. It is caused by one of two species of mites: *Sarcoptes cuniculi* and *Notoedres cuniculi*. The mites burrow into the skin causing intensive irritation. Scratching will cause open sores. If the disease is not treated the animal is sure to die within a few weeks.

Prevention/Treatment:

- Keep the environment clean. Dirty units will harbour and encourage the spread. Hygiene cannot be emphasized enough.

b) Endo-parasites

These include Tapeworms, roundworms, etc.

Prevention:

- Deworm rabbits regularly with recommended drugs which are readily available in EA. It is advisable to do this every three months. This is a good time to check the teeth. Sometimes rabbit develop crooked front teeth. This greatly inhibits their eating. The crooked teeth should be clipped with nail clippers. Be careful not to cause injury to the jaw. The best clippers are those used by vets to clip dogs nails.
- It is also a good time to check the claws, which tend to grow very long and sharp because the rabbit is on wire. These should also be clipped if they are too long.

Products

Rabbit meat is becoming more popular in some of the more upmarket restaurants, especially where they are catering to European (French, German, Italian and Belgium) markets. However, it is still a relatively new market.

Meat

Rabbit meat makes an excellent roast meat if cooked quickly. It is a tender meat and cooks very quickly. If the meat is being sold into butcheries or restaurants, it should be well presented and it is essential the carcasses have been cleaned properly. This can be done in three ways:

- Lie the rabbit on its side. Push the back legs into the empty cavity and under the breast bone. Fold the front legs down, and pack into plastic bags.
- Lie the rabbit on its chest with its front legs together in front of it and the back legs folded underneath (as if it is crouching), and pack into plastic bags.

- Debone the flesh and cut into neat pieces or mince. This is a fiddly job and mincing rabbit meat can be difficult as it is soft and tends to block the mincer.

Hides

These are more often referred to as pelts. Most tanneries in Kenya will not accept rabbit pelts for tanning as they are considered too delicate. They are probably one of the most difficult skins to tan, but are much sought after. Pelts for tanning should be left inside out, no more than 4 together, packed into strong plastic bags. The air should be squeezed out of the bag and it should be securely tied. The bags can then be frozen for delivery to the tannery.

- The heads, spleens, kidneys and heart make excellent dog food. The liver is a delicious delicacy and highly nutritious
- NEVER feed rabbit bones to dogs. They are very brittle and will splinter, either becoming stuck in the throat or piercing the intestines. The bones do, however, make very good stock for soup. Make sure the bones are then disposed of safely.

Manure/Compost

Rabbit manure is one of the most valuable manures of all livestock. Sweep all the droppings and soiled bedding into a pit or a neat, square heap every day. If possible sprinkle with water or, better still, with effective microorganisms (EM1). After two weeks turn it over and keep moist until you have a lovely dark compost. If you keep other livestock (cattle, sheep, goats, donkeys and chickens) their droppings can be added to this compost for an even better end product. This would give you an endless supply of good compost for your shamba or, alternatively, a by product that you can sell.

TOPIC 2.3.4: GOAT REARING

LEARNING OUTCOMES

The learner should be able to:

a) identify the breeds of goats reared in Uganda and understand their qualities and the value of goat products in financial and nutritional terms
b) understand how to choose a goat breed for rearing
c) understand the different systems for mating and breeding goats
d) show skills in caring for goats, male and female, and kids
e) show skills in producing and conserving pastures for goats
f) understand the importance of weaning kids and how to rear kids
g) show skills in processing and marketing of goats and goat products
h) show entrepreneurial skills in goat rearing

Goat farming is the raising and breeding of domestic goats (Capra aegagrus hircus). Goats are raised principally for their meat, milk, fibre and skin. Goat farming can be very suited to production with other livestock such as sheep and cattle on low-quality grazing land.

Goat farming can be very suited to production with other livestock such as sheep and cattle on low-quality grazing land. Goats efficiently convert sub-quality grazing matter that is less desirable for other livestock into quality lean meat. Furthermore, goats can be farmed with a relatively small area of pasture and limited resources

Goats are purposely kept for meat and milk.

Breeds of goat: Most breeds are indigenous and can be divided into two groups;

The Somali goats (dual purpose)

The small East African goats.

Dairy goats: Jamnapati, Nubians, Saanen, Kamorai, Toggenbergmeat **Goats:**Somali, Turkana, Angola, Kamorai, small East Africa

Hair goats: Mohar, Boer, Angola, Kashmir

Goat management

In a well-managed flock, mating should first take place 15-18months of age. Gestation periods last for 150days, therefore a goat can give birth twice a year

Meat producers: If the goats are kept for meat production, the young ones are left with mother until they are weaned.

Milk producers: The young ones should be removed from their mothers as soon as they are born and bottle/ bucket feed.

The kids should be fed3times during the first 3weeks and reduced to 2times per day until weaned 4-6months. A kid will need ½ litre of milk per day solid feed should be included from 2-3weeks after birth.

Post weaning

After weaning kids will need good quality feed if they need to be fattened satisfactory, dipping and vaccination.

Goat feeding

Goat brouse rather than grazing, during rainy season, they feed on green leaves and young shoots. As drying follows, they feed on fallen leaves, pods and sees, dry flowers, keads of grass and twigs.

In confined conditions, meat producing goats may be fed on cut forages e.g. sweet potatoes, vines, green maize etc.

Crop residues are also used particularly after cereal harvest.

Milk producers are fed on similar way as in dairy cattle but in addition they will feed on roughages e.g. hay and silage.

Concetrates should be fed on lactating goats to correct any mineral deficiency and roughage. Browsing: Feed on grass, shrubs and leaves.

Gut closure: Is the process whereby the gut becomes impemiable to absorption of immunoglobin especially 3 days.

Setting up a good farm for the goats takes a step by step process and the following can be done to achieve a good goat farm.

The budget

This determines how many goats you are to start with and how much money will be needed. You do need to start with a lot of goats if you have limited money, it is advisable to start with one buck and two does. Through the mating and feeding, the number will keep on increasing.

Search for a good farm area

When you choose to start goat farming, you need to get the best land for it and this should have the following which make goat rearing easy

The land should be fertile for easy growth of other greenery and grass that can be used for feeding the goats.

Transportation to and from the farm should be easily accessible.

There should be availability of clean and fresh water on the farm for both goats and the labor.

The farm should be located in an area where you can easily access labor because sometimes you cannot take care of the goats and an isolated area will hinder this.

Lastly, the farm should be located almost near the market area. This means one can easily buy products to be used on the farm and sell their byproducts from the farm.

The goat house

When constructing the goat house, make sure you build it according to the number of goats that you have a leave a bit of space for future livestock to be got. A good goats' house should averagely be 1.5 to 2.0 square meters per goat.

The house should be with different segments that separate the weaning goats, the does and the bucks from each other.

If you are into goat rearing for the milk, then they should be separated into a room where the milking can take place and the rooms should be kept clean and the ventilation should also be good.

Lastly the housing should be constructed on a raised area so that the manure droppings drop under the house and well facilitated if you want to reap big from goat farming.

BREEDING IN GOATS

Select the right goat breed

There are different species that can be reared in Uganda and these include:

The Saanen and Toggenburg breeds which is commonly raised for milk and other dairy products. This has an average normal weight of 91 kilograms for the buck and 68 kilograms or more for the doe.

The sebei goat, this is raised mostly in mountainous area and can be raised for both meat and milk. The good thing about this goat is that it can withstand cold temperatures.

The kigezi goat is found in the kabaale hills. It's characterized with short legs, can withstand the cold weather and is raised for both meat and milk purposes.

With the few listed above, you should be able to choose the breed that will suite your purposes.

Vaccination for the goats

There are different diseases that attack the goats like goat pox, brucellosis and anthrax among others but there should be proper vaccination that is vaccinate the goats at five months of gestation period if they have not yet been vaccinated. PPR should be vaccinated at five months to the kids

A farmer should always take care of their goats by vaccinating them regularly and in the right doses. This prevents spread of unwanted diseases and hazards on the farm and below is a table showing the vaccines that need to be given to the goats and in what dozes for some of the diseases.

Vaccine Name	**Dosage**	**Method of application**
Anthrax	1 ml	Injection under the skin
PPR	1 ml	Injection under the skin
Foot and Mouth Disease	2 ml	Injection under the skin

Security and fencing

This might not be important to some people but if you want to keep your goats safe, then you need to take security seriously and construct a fence.

The fence keeps the animals inside the farm and the unwanted predators and people out of the farm. This reduces the loss of goats due to theft and attacks from predators.

The fencing also reduces spread of diseases from the other farms hence keeping you goats safe.

Feeding of the goats

Food is also an important aspect when it comes to rearing goats. The goats can be fed on green pastures found in gardens or around the house and you can get them maize bran, and salt blocks known as Ekisula. This helps the goats have a balanced diet and stay healthy.

Marketing of the goats

This is very important because you cannot rear goats without a targeted market. You need to research more about your market, which group of people are you intending to sell the goats' products to. You can also get international market if you have goat products like ghee that can be exported.

Goat products like meat and milk has a huge local and global demand and popularity. Almost all types of people like goat milk and meat.

So, a good market is already available in almost every place of the world. You can easily sell your products in your nearest market. Commercial producers can target the international market and export the products in foreign countries.

Care for the goats

Although goats can take care of themselves in form of feeding, taking care of their kids they still need to be taken care of by the farmer.

If you are feeding your goats make sure that the food being given to them is clean and not contaminated, the water should also be clean.

You should clean the farm house everyday if possible in the morning and evening to avoid spread of diseases among the goats.

During the mating, make sure it's a different buck mounting the doe. A buck should not mount more than two bucks in a single day to avoid breeding from the same buck. This increases the quality of the breed.

You should separate the kids from the bucks and does and does from bucks especially if you are into commercial farming. This will ease the overseeing of all the goats on the farm and will reduce congestion. You must also keep the kid with their mothers a few weeks after birth for nurturing.

What can be done when a doe is giving birth?

A female goat also known as a doe has a gestation period of months and the farmer should monitor it while it is pregnant so that they get to know the due date.

A bed should be prepared and it should be free from all infections and this is where the doe will give birth from.

The room from where the doe is going to give birth from should be warm and not cold and iodine should be used in case there is an infection to prevent the kid from falling sick.

After the doe giving birth, you should make sure that they start breast feeding within 48 hours from the mother and if the kid is born on pasture, transfer it to a warm conducive room.

Advantages of goat farming in Uganda

Goat products like milk can be used to make different foods like ghee and scientifically it is more digestible than the cow's milk for the humans.

Goats relatively take up minimal space due to their small nature and this means that you can spend less money when setting up the goat farm.

Goats have no taboo when it comes to rearing pigs making it easy to rear them and earn profits.

Goats can easily adapt to the weather, food provided and when they can also look for their own food. They can tolerate both hot and cold weather conditions unlike other livestock.

Goats are good for rearing since they reach their maturity age faster at 7 to 12 months than the other animals and hence early slaughter and more money for the farmer.

Goats breed faster than other animals and this increases the number of goats being reared on the farm. Expansion of the farm increases money for the famer.

It is not too expensive to set up a goat farm therefore less capital is needed and it also reduces unemployment by providing jobs to the laborers on the farm.

In conclusion, goat rearing is known to be a less risk business and they have been reared since time immemorial but it is liked because of the fast growing rate of kids. If you want to mint money then goat farming is the way to go since you can earn from the milk, the meat and the skin and you need to do to get good quality breeds is to feed them and continue feeding them on a balanced diet. Good luck with as you start goat farming.

Goat farming is not a new enterprise. Rearing goats is a profitable business. Goat has been rearing since the time immemorial. Generally goat farming means rearing goats for the purpose

of harvesting milk, meat and fiber.

At present, goat farming has become a profitable business and it requires a very low investment because of its multi-functional utility. Commercial goat farming business is contributing greatly to the economy and nutrition of a country.

Goats are multi-functional animals. You can produce a wide variety of products from goats, such as milk, meat, fiber, manure etc. Goat's milk is used for producing full cream goat powder, skimmed goat milk powder, goat butter, goat milk cream, fresh goat milk etc.

Goat meat is a great source of consumable meat which is very testy, nutritious and healthy. And goat's wool is being used in many purposes and skin of goat plays a vital role in leather industry.

However, here we are describing more about the advantages of goat farming business and the required steps for starting a lucrative business.

General advantages of Goat Farming

There are many advantages of goat farming business. You can also raise goats along with your other livestock animals. Goats have been considered as poor man's cow (mini cow) for the poor people because of it's immense contribution in rural economy and national income. Goat products like milk and meat is not only nutritious and easily digestible food but also a great source of regular income for the poor, landless and marginal farmers.

As goats are small sized animal, so they are easily maintained. Even they are easily maintained and cared by women and children. For successful goat farming business, you need to do some common tasks such as feeding, milking and caring. These simple tasks do not require much equipment, capital, labor or hard work. The main advantages of starting goat farming business are described below.

Starting a goat farming business requires low initial investment or capital.

Goats don't require huge area for housing because their body size is comparatively smaller than other livestock animals.

Usually goats are very friendly in nature and very lovable.

Goats are good breeders and they reach sexual maturity within their 7-12 months of age and give birth of kids within a short time. And some goat breed produce numerous kids per kidding.

Risks are less for goat farming (even in drought prone areas) than any other livestock farming business.

Both male and female goats have almost equal value/price in the market.

No religious taboo against goat farming and meat consumption.

Goat meat and milk are cholesterol free and easily digestible.

Goat milk is used for making various types of foods and it's very easy to digest than milk of cows.

Commercial goat farming business has created a potential way of employment for unemployed people.

Goats are multi purpose animal. They can produce milk, meat, skin, fiber and manure at the same time.

There is no need of a high end housing system for goats. Even they can easily share their living place with their owners or his/her other livestock animals.

Goats are very suitable for mixed farming with other domestic animals.

Diseases are less in goats than other domestic animals.

Goats are easily available, comparatively cheaper in price, easy to maintain and always have a friendly disposition.

They are capable of adopting themselves with almost all types of agro climatic environments or conditions. They can tolerate high and low temperature throughout the world and live happily. They also can tolerate hot climate more than other animals.

According to the investment per unit they produce more than other domestic animals. And the ROI (return of investment) ratio is very good.

Goats are generally smaller in size but reach slaughter age faster.

Goats are called the “foster mother of human”. Because their milk is considered as the best milk for human consumption than any other species of livestock animal’s milk. And their milk is low cost, nutritious, wholesome and easily digestible. All aged people from child to old one can easily digest goat’s milk. Goat milk also has lesser allergic problems. And used as an Ayurvedic medicine for the people who are ailing with diabetes, asthma, cough etc.

Goat milk is suitable for preparing various types of milk products. And goat meat has a huge demand and high price in the local and international markets. Even you can consider exporting your products to the foreign countries for more profits.

Goats can be milked as often as required. This also prevent refrigeration costs and milk storage problems.

You can use the goat’s manure as a high quality natural fertilizer in crop field. This will directly help to maximize crop production.

As goat farming business is very profitable, so many govt. and non govt. banks are providing loans for starting this business.

This business require less labor and you can easily use your family labor for raising goats.

Commercial goat farming business is a great source of employment and income. So unemployed educated people can easily create a great employment and income source through raising goats commercially.

Along with the above advantages, there are also many advantages of raising goats commercially.

Total Expenditure & Profit

Total expenditure and profit from goat farming business depends on the farming system, location, breeds, feeding cost and some other factors. By good planning and proper management you can easily make goat farming business profitable. Small scale farming require less investment and profit can contribute your regular income.

On the other hand, large scale or commercial production require high investment and some other additional costs.

Some Essential Tips for Goat Farming

For getting desired production and profit from goat farming business, you have to know properly how to raise goats. Here are some tips for raising goats and making maximum profit.

Always try to keep your goat healthy and strong.

Always choose the right and high productive goat breeds for your business.

Try to learn more about goat farming business from the nearest livestock training center or expert producers in your area.

Ensure a big area so that your goats can roam freely, because they like to live in groups.

Make sure the availability of all equipment which is essential for goat farms.

To produce better milk, meat and to keep the goat free from diseases, make sure a well-bred conduct.

Provide them sufficient clean water, food and fresh grasses according to their daily demand.

Be more careful about goat feeding. Never feed them contaminated food or polluted water.

Take some extra care to the pregnant doe, breeding buck and kids.

Feed the buck some extra nutritious food during the period of mating.

To improve your goat's health contact with a veterinarian regularly (if possible).

Give salt and mineral with a lot of water during the summer season.

Keep your goats away from cold and rain to avoid mass death.

In short, goat farming is a traditional, profitable, risk-less and very easy business because of its multi utility and fast growing rate. Goats also can be used as a tool for poverty reduction and play an important role in the economic growth of a country. Although some risks go with every business. Proper care and good management can ensure better production and high profit. Wish your success

THEME: CROP PRODUCTION

TOPIC 2.4: PERENNIAL CROP PRODUCTION

TOPIC 2.4.1: BEVERAGE PRODUCTION

Competency: The learner should be able to produce and market perennial crops profitably

LEARNING OUTCOMES
The learner should be able to:

a) know the value of coffee/tea /cocoa to the Ugandan economy, and the key markets for these products
b) understand the general geographical areas in which coffee/tea/cocoa is grown in Uganda, and the soil and climatic requirements for propagating and growing
c) understand how to establish and manage a coffee/tea/cocoa nursery and coffee garden
d) show skills in applying financial management principles to coffee/tea/ cocoa production
e) show skills in the preparation of the soil for growing coffee/tea/cocoa seedlings
f) show skills in transplanting coffee/tea/ cocoa seedlings into the garden(a,
g) show skills in managing coffee/tea/cocoa plants until harvesting
h) to harvest and process coffee/tea/cocoa for the market
i) roast/cure, grind and serve coffee/tea/ cocoa
j) understand the importance of taste, recognize and describe the differences in taste and smell as functions in cupping specialty coffees/teas and cocoa
k) m. show entrepreneurial skills in coffee/tea/ cocoa production

Introduction

Perennial crops are crops which are alive year-round and are harvested multiple times before dying. Perennial plants are not new to agriculture; plants such as apples and alfalfa are perennials that are already commercially grown and harvested.

Perennials are crops which take more than one year from the time of planting to the first harvest. They have repeated yield cycles and have a long lifespan.

Types of Perennial Plants

Most botanists recognize five types of perennials. They include **herbaceous**, **woody, monocarpic, deciduous,** and **evergreen.**

Herbaceous perennials are typically grasses that grow in fire-prone areas and on prairies.

Woody perennials are found all over the world and include vines, shrubs, and large towering trees that take years to grow completely.

Monocarpic perennials are plants that flower and make seeds, then die. They are perennials because it takes them more than one year to complete this process.

Deciduous perennials are plants that shed their leaves in the fall of the year.

Evergreen perennials are those plants that live long lives and keep their foliage during the fall and winter months.

Examples of perennial crops

- Tea
- Coffee (Arabica)
- Coffee (Robusta)
- Cocoa
- Cashew nut
- Sugarcane, etc.

Advantages of perennials

- The cost of establishing perennial crops is spread over a number of years and so can be lower than annuals on per annual basis
- After establishment, harvesting is continuous. This eliminates the arduous practice of preparing fresh land every year and ensures regular income for the farmer.
- The cost of controlling pest and diseases is generally lower than annuals
- They may be used as security in acquiring loans from bank

Limitations of perennials

- They require a lot land because of their wide spacing
- The processing of these crops might have to be done on the farm that might be expensive for the farmer
- Some crops require irrigation, so a permanent water source might be necessary
- Perennials take long to mature and take up the land that would be used for other enterprises
- Some perennials do not have seeds and must therefore be propagated vegetatively
- Average yields of most perennials are low

- Perennials are difficult to improve because breeding programs are long terms and very expensive

TEA ***(CAMELLIA SINENSIS)*** **PRODUCTION**

Tea (*Camellia sinensis)* is native to mainland China, South and Southeast Asia, but it is today cultivated across the world in tropical and subtropical regions. It is an evergreen shrub or small tree that is usually trimmed to below two metres (six feet) when cultivated for its leaves. It has a strong taproot. The flowers are yellow- white, 2.5-4 cm in diameter, with 7 to 8 petals. The leaves are 4-15 cm long and 2-5 cm broad. Fresh leaves contain about 4% caffeine. The young, light green leaves are preferably harvested for tea production; they have short white hairs on the underside. Older leaves are deeper green. Different leaf ages produce differing tea qualities, since their chemical compositions are different. Usually, the tip (bud) and the first two to three leaves are harvested for processing.

Field production of Tea: Ecological growth requirements

Altitude: Tea is grown in an altitude range of 1500-2200 m above sea level. Below 1500 m yields increase but the tea flavour decreases.

Temperature: The ideal growing conditions for tea are average annual temperatures of 18-20°C and an average daily amount of sunshine of 4 hours per day.

Soil: Tea performs best in soil of volcanic origin. Areas with bracken (ferns) are indicators of suitable ecology. The soil should be deep (1.8-2.0m), well-drained and aerated. Nutrient-rich and slightly acidic soils are best (optimum pH-value 4.0-6.0). Outside this range, basic nutrients are rendered immobile, i.e. above pH 6, calcium restricts the uptake of potassium and below pH 4, and phosphorus is fixed (locked in).

Rainfall: Tea requires an optimum of 2000-2200 mm of rainfall distributed evenly throughout the year. Higher rainfall causes erosion through soil run off especially on steep slopes. A minimum of 1400 mm of rain is required but tea can grow adequately with less rainfall in areas with frequent mists and low clouds or under irrigation. Relative humidity should lie between 70 and 90%.

Preparation **of tea planting materials**

Mother trees are allowed to grow for about six months after pruning.

This allows the development of long stems for cuttings.

The stem cuttings should have single leaf internodes although experiments show that two or three leaves tend to establish faster under polythene.

Cut a mature stem and discard the top two or three internodes on each stem, since they are generally very soft.

Similarly, discard the internodes towards the base of the same which has rough bark as opposed to the desired smooth reddish brown bark.

Use sharp knives and make slanting cuts both at the top and bottom. The cuts should be as close as possible to the auxiliary bud.

Allow a length of 2.5 — 3.8 cm of stem below the leaf. Avoid any damage to the leaves or to the stems. Keep the cuttings shaded preferably in water up to planting time.

The cuttings are planted in polythene sleeves. This allows minimum soil disturbance when the seedlings are transferred to the field. Fill the sleeves with the rooting medium.

Nursery care for tea seedlings

The cuttings grow well when they are under a shade and are protected from the wind.

Keep the sleeves under high humidity by covering them with polythene sheets whose edges are covered in the soil to prevent moisture loss and to keep the humidity high.

The nursery should be shaded with either grass on top of a frame structure or tree branches and leaves. The cuttings will mature within three months as long as the polythene cover is fixed tightly to prevent moisture loss.

Hardening off is done when the roots are 10cm long and the shoots are well developed. Remove the shade and the polythene gradually, starting with the polythene first.

The cuttings are ready for transplanting into the field when the roots have developed and reached the bottom of the sleeves and their tops are 20cm high.

Generally, the duration in the nursery is 6-10 months.

Raising plants in seedling boxes

Some young seedlings and cuttings may be planted directly in the field.

The use of seedling boxes or pots is essential to start off some plants. It is also becoming a more popular alternative for field growers especially in horticulture and agro-forestry.

The seedling box or the potting container should have uniform potting mixture of good texture. It should have sand, some organic matter e.g. peat with an addition of loam soil.

The pots or seedling containers should be made to allow excess water to drain off.

The potted plants should be shaded where necessary and watered regularly.

The soils used i the pots or containers should be treated against soil borne diseases and pests.

Types of seedling boxes

Flats: These are made of plastic, wood, or of metal trays with drainage holes at the bottom. They are used for root cuttings and for germinating seeds. They are easily portable

Earthenware/clay pots: The clay pots are generally more porous and lose moisture faster. Due to their round and thick shapes they tend to occupy more space hence not very commonly used on large scale propagations.

Plastic pots: May be of round or square shape. They are non-porous, lighter in weight and can be compacted in small space.

Polythene bags: These are the most commonly used propagation containers especially in agro forestry and horticulture. They are cheaper to buy than other containers.

The common materials for rooting medium mixtures

Sand: this is essential in the preparations of rooting medium as it improves aeration.

Peat: Peat is from the remains of vegetation along the sea shores, or Construct marshy areas and normally partly decomposed under water.

Compost: these are decomposed organic wastes under controlled conditions

Characteristics of rooting medium

- The medium should be stable and firm to secure the cuttings or seeds firmly.
- It should have good water retention capacity to reduce the need for regular watering.
- It should be well aerated or porous for better drainage and aeration.
- It must be weed and pest free or treated against weeds and pests.
- It should provide the plants with sufficient amount of nutrients.
- The soil should be screened for uniform particle sizes.
- Moisten the materials to allow faster moisture absorption.
- The soil used should not be wet or sticky.
- Arrange the various ingredients in layers and turn using a shovel.
- It should be fumigated against soil borne diseases, pests and weeds
- The mixture should be slightly moist at the time of use to avoid crumbling and adequately wetted to avoid forming a ball when squeezed in the hand.

Transplanting of tree seedlings to seedling boxes

- Transplanting or "pricking out" is the transfer of seedlings from the seedbed to the plant trays (boxes) or transplant beds.
- The plant trays should be about 41 cm square and 15 cm deep. Fill about 5 cm of the box with decayed compost at a ratio of 60% forest soil, 10% ordinary red soil, 10% sand and 20% decayed organic matter.
- Pack the tray tightly and level the soil to avoid surface run off. Tree seedlings are ready for transplanting at 3-4 weeks post germination date.
- At this stage, seedlings are approximately 25 mm tall. Plant the seedlings 60mm apart in rows and do not grasp the seedling by the stem but by the seed leaves.
- Cut the tap root to approximately one third of the total length, to encourage proper root

development. Firm the soil around the roots, but not around the stem or the neck. Water each tray adequately to keep the son moist. Avoid excess watering.

- Keep the trays in the shade house out in the open. Before planting in the field, prune the roots.

Care of Tea seedlings after transplanting

Domesticated and wild animals can cause untold damage to the tree seedlings and unless great care is taken the seedlings may not grow well.

The animals eat some species of seedlings. While eating them, they may end up uprooting the seedlings since the roots are not yet firmly established.

As animals graze, they trample over the seedlings thereby breaking them and killing many of them or weakening them. This retards the growth of the seedlings.

Application of shade. Where the weather is very hot it is necessary to apply shade to individual seedling.

Shade material can range from any form of organic matter to synthetic material. Usually, the shades are temporary and last for a short time.

Seedlings should be protected from damage by animals and human beings by erecting. Mini-fences round them.

Different types of fences are used including stakes alone or stakes

The planting holes should be spaced according to the recommendation of specific tree species. The holes should be dug up 60cm deep and 60cm wide.

The depth of the hole will depend on the nature of the soil. Keep the top soil separate from the sub soil. Remove the roots of dead plants from the holes. The holes should be dug early enough to allow them to weather.

It is advisable to check on the colonies of ants which might cause damage to the tree seedlings.

The nests of the ants should be treated with recommended pesticides.

Apply decomposed organic manure mixed with the top soil which had been removed from the hole. Phosphate fertilizers may be applied according to the soil demand.

Remove the polythene bag containing the seedling before transplanting to allow root development. Open the hole and put the seedling into the middle of the hole up to the height of soil coverage while in the polythene bag.

Fill up the hole with top soil mixed with manure then firm the soil and water liberally using a watering can.

Depending on the weather conditions, the seedlings should be mulched to conserve moisture and to reduce the frequency of watering.

Routine field practices

Rogueing: This is the removal of diseased or pest infested plants from the field or plot. The removed plants are destroyed to prevent the spread of diseases or build-up of pests.

Gapping: When seeds are planted, some may fail to germinate or may be destroyed by pests. To avoid having a patchy field, the gaps left should be filled by planting similar planting materials within a reasonable period of time to avoid a wide variation in growth rate.

Earthing-up: This is a field practice which is necessary after planting or transplanting. It is commonly carried out in root crops such as cassava or Irish potatoes to provide more soil cover around the root. This not only provides support for the root but also helps to conserve moisture.

Crop protection: This includes weed, disease and pest control. Failure to control weeds, pests and diseases may lead to total loss of the crop or producing a crop with low market value.

Pruning: For proper growth and production, the plant should have enough foliage and branches in relation to the whole plant make up. Excessive branches and leaves lead to higher competition for nutrients, light and water. Excess leaves create a micro-climate for pests and diseases. Occasionally, the plant may have broken or has old shoots which are uneconomical to carry. Pruning is the removal of the unwanted branches of the plant.

Pruning Tea

Frame formation: This is the process of bringing young tea into bearing. It involves encouraging the young tea plants to several lateral branches which will establish a frame for

the plucking table. There are two methods of frame formation namely, formative pruning and pegging.

Formative pruning: This method involves capping the plant at different heights to discourage vertical growth and encourage lateral growth.

Multiple stem pruning: In the multiple stem pruning, the aim is to establish two or three main upright stems laterals to bear the crop.

Methods of multiple stem pruning

Capped multiple stem pruning: This is done by capping the main stem at 38 cm, and then allowing two or three sucker grow up to a height of 1.5 m - 1.8 m. Thereafter, the suckers are each pruned in a sin way as in single stem pruning.

Non-capped multiple pruning: The main stem is capped at 38 cm above the ground level. The suckers are allowed to grow then two or three suckers are selected and the rest are removed. The selected suckers develop laterals which bear the fruits. After the laterals have borne two or three crops, the 4 pruned from the bottom of tree upwards.

Precautions in pruning tea

A tea bush which was brought to bearing by formative pruning should be cut back to 50 cm above the ground level after three to four years, while tea bush brought to bearing by pegging, should be pruned at different heights to prevent large lumps of callous tissue from forming an unhealthy environment.

Since after each pruning the plucking table rises by about 5 cm, there is need to prune tea back to45 cm after several cycles so as to prevent the plucking table becoming very high.

Pruning should be done just before the start of the dry season; this is the period within which the plant has higher amounts of reserved starch in the roots.

Avoid cutting back the side branches growing below the pruning height since this affects the spread to the bush and lowers the yield.

Do not cut the outer edge of the bush to a higher level than the centre of the bush. Avoid pruning the bush to a dish-shaped frame.

Use a measuring stick to determine the height and prune the bush top parallel to the ground level.

Make straight cross cuts and not slanting cuts which increase wounds leading to higher risks of disease infection.

Remove the smaller branches and twigs by hand and avoid clearing up the tops with pangas or knives.

In some areas, it may be necessary to place the pruned branches on top of the frame to provide shade during dry period. This should be removed at the start of the rains when the new shoots emerge.

The pruned branches should be left in the field to provide mulch and decompose into humus.

Harvesting Tea

Stage of harvesting

It takes 2-4 years for tea to mature depending on the method of bringing young tea into bearing.

Method and Procedures

Tea harvesting is known as plucking.

Fine plucking: 2 leaves and a bud are removed.

Coarse plucking: 3 leaves and a bud is removed.

A straight stick is used to guide the plucker on the plucking table.

Tipping is done by cutting off shoots that appear above

Precautions in harvesting of tea

- Plucked tea is placed in woven, well ventilated baskets to prevent fermenting before it reaches the factory.
- The plucked tea should be kept in a cool place awaiting transport.
- It should be processed within the same day of harvesting.

- Harvesting is done on a weekly basis under wet conditions and once after every two weeks under dry conditions.

TOPIC 2.4.2: FRUIT CROP PRODUCTION

LEARNING OUTCOMES

The learner should be able to:

a) know the varieties and value of fruit crops grown in Uganda
b) understand how to select an appropriate fruit crop for growing
c) show skills in the methods of planting fruit trees
d) understand the soil and climatic requirements for propagating a selected fruit tree
e) propagate fruit tree crops
f) show skills in the preparation of the soil for growing selected fruit trees
g) show skills needed in the planting of seeds and seedlings/cuttings
h) understand and apply the principles of good management of fruit trees
i) carry out basic fruit tree nursery tending operations
j) show skills in applying financial management principles to fruit production
k) establish and harvest fruit tree crops in the field
l) perform vegetative propagation in fruit trees
m) exercise disease and pest control
n) know how to market fruits products
o) show entrepreneurial skills in fruit growing

Definition of Fruit

Fruit make up a large portion of our diets. Did you know many foods that we consider to be vegetables are actually fruits? The botanical definition of fruit is a seed-bearing part of a flowering plant or tree that can be eaten as food. By those standards, foods such as avocados, cucumbers, squash, and yes, even tomatoes are all fruits. From a culinary viewpoint, a fruit is usually thought of as any sweet-tasting plant product with seeds, whereas a vegetable is any savory or less sweet-tasting plant.

Types of Fruit

Fruits can be eaten raw, frozen, stewed, cooked, or dried. All fruits may be classified into three major groups: simple, aggregate, or multiple.

Simple Fruits = one fruit that has developed from the ovary of a single flower. Simple fruits may either be fleshy, like plums and peaches, or dry, such as walnuts and hazelnuts.

Aggregate Fruits = a fruit formed from several ovaries of one flower that produces many tiny fruits clustered tightly together.

Multiple Fruits = a fruit formed from the fusion of the ovaries of many different flowers which develop closely together to form one bigger fruit.

Note: False fruits or accessory fruits are another kind of fruit that is not formed from the ovary, but from a different part of the flower. These fruits may be simple, aggregate, or multiple fruits. For example, strawberries would be considered an aggregate fruit, as well as an accessory fruit since much of the fleshy fruit part does not come from the ovary.

Examples of Fruit

Fruits can be fleshy like tomatoes or peaches, or they can be dry like coconuts or peanuts. They can have many seeds in them like cantaloupe and watermelon, or they can have one single seed in them like avocados, almonds, and cherries. Fruits may be very large, like pumpkins, or very small, like blueberries. Here are some examples of each type of fruit.

Simple fruits can include fruits like apples, pears, plums, tomatoes, peaches.

Apple Tree

Aggregate fruits can include fruits like raspberries, blackberries, strawberries.

Strawberry Flower

Multiple fruits can include fruits like pineapples, figs, breadfruit, mulberries.

Pineapple Plant

PINEAPPLE GROWING (*ANANAS COMOSUS*)

Pineapples fruits are one of the important commercial fruit crops which are not only wonderful and delicious in taste but are also easy to grow with little care and management of them. So, it is a good idea to grow pineapples as a business plan and earn a million from it. Pineapple farming can be a really profitable business if cultivated with proper care and good farm management skills.

It is most demanded by the people throughout the world for its delightful flavor and yummy taste. It is consumed in large quantity by the foodies because of they are the excellent source of Vitamins A, B and also full of vitamin C. Also, pineapples are also a good source of minerals such as potassium, calcium, magnesium, and iron along with a digestive enzyme named; Bromelain. Pineapples fruits are eaten as fresh as well are canned and also processed in various forms to meet it market demands.

The "scientific name of pineapple" is "Ananascomosus"

Historically, Hawaii was the biggest producer of pineapples. But presently, pineapples are most cultivated by the Brazil in the Philippines, and Costa Rica.

How long do pineapples take to grow? It totally depends on the cultivar and climate condition of the atmosphere. But, generally, **in about two years**, a pineapple becomes ready for harvesting. The fruiting season of this yummy fruit start from March and runs until the June. And you can collect numbers of fruits per each tree which can be eaten as fresh, can be cooked, juiced and also preserved. The leaves of pineapples are used as ceiling insulation and also as wallpaper. Pineapples are most popular for their use in alcoholic beverages as the flavor.

Pineapple Health Benefits

- Pineapples fruits and its juices are enjoyed usually by the people for the plentiful health benefits of pineapple these include
- Pineapples are the excellent source of vitamins A, B, and C.
- Pineapples are also a good source of minerals such as potassium, calcium, magnesium, and iron
- Eating pineapples regularly will help you in getting rid of the digestive problem.
- Pineapples are also helpful in healing wound faster….
- Consuming Pineapples is also beneficial in improving the Bone health
- Pineapples also healing the cough and cold problems.
- Pineapples also prevent from some of the cancers.
- Consuming pineapple is also beneficial in establishing good blood circulation.
- Consuming Pineapples is also beneficial in improving the Oral health
- Pineapples are also good for improving eye health.

- Pineapples also helpful in controlling high blood pressure.

The flesh of this pineapple is yellow.

Besides consuming as fresh fruits, pineapples are also used for cooking. Also, are canned, processed and preserved to meet it exclusive market demand.

Pineapple Varieties

Growing pineapples is not a hard working job, but it requires more dedication and proper care to achieve excellent yield as production from it. The pineapple yield is depended on some common factors of which the variety, used for cultivation is also one of these important factors. So, select a high yielding and fast growing pineapple variety for pineapple farming as business plan.

So, here below is the list of some common varieties of pineapples that are used for cultivation in the different region throughout the worlds. Learn them

Pineapple Variety or Cultivar	Specification
Smooth Cayenne	It Is a spineless pineapple cultivar that is most cultivated throughout the world
Giant Kew	This is a large fruited pineapple cultivar
Abacaxi	This is a spiny and disease resistant pineapple cultivar
Queen (Common Rough)	It is a compact and dwarf pineapple cultivar which has better tolerance to cold and also disease than the **Smooth Cayenne** cultivar
Red Spanish	It is a tough pineapple variety grown in the Mexico, West Indies, and Venezuela. Its fruits are high in fiber and are light yellow, and also aromatic

A red Spanish pineapple

Note: All the above-mentioned pineapple variety or cultivar have the different growth rate in different climate condition.

Where Do Pineapples Grow?

Before starting pineapple farming, it is a good idea to learn **where do pineapples grow in the worlds?** So, here below is a guide for you to learn…. In Which climate condition and soil, pineapples grow well in the following section.

Agroclimatic Condition for Pineapple Farming

Pineapples are tropical fruits crop which can be cultivated throughout the world. However, Regions with heavy rainfall are considered as the best for optimum pineapple growth. Since a supporting climate condition can play a vital role in obtaining optimum fruit production so cultivating them in such area is always beneficial.

An Optimum rainfall of 1500 mm per year is sufficient enough for their best growth. However, they can be also cultivated in areas having rainfall 500 mm to 5550 mm per annum. So, Pineapples are best suitable for doing cultivation in humid and surrounded tropics. Also, this fruit can also grow well near the coastal area as well the interior portion, where there is not too hot weather.

So, growing pineapples in temp.ranging between 15.5 ‘C to 32.50 ‘C is supposed to be the best temp for pineapple cultivation. Note that extreme low temp. Bright sunshine along with total shades are harmful to this commercial crop. However, they can grow well up to 1500 MSL height.

Best Soil for Pineapple Farming

Pineapples can be grown in any soil types which have free draining capacity. However, for optimum production, a soil which is slightly acidic and has soil pH ranging between 5.5 to 6.0 is considered as the **best soil for pineapple.** It should have good drainage and light texture.

Note that soil having heavy clay are preferred more for pineapple farming. However, they can grow well in sandy, laterite, and also alluvial soil.

How to Grow Pineapples

Planting of pineapple in black polythene mulch

Pineapple Plantation

As mentioned earlier, pineapples are humid tropical crops that can grow well in the plain area as well as elevations up to some limit. Note that this commercial fruit crop neither can tolerate extreme temperature nor the frost. So, always select a suitable land for planting pineapple where it is too hot summer or frost conditions occurs usually in that specific region.

Ways of Propagation

Pineapples are usually propagated with the help of **slip, suckers and crown planting materials**. Slips and crown planting materials having age about six months can bear flowers after about a one year of plantation. Whereas crown planting material can bear flowers about 18 months of planting them on the main field. Nowadays, with the help of advance pineapple farming techniques, it is available to produce pineapple plants with the help of tissue culture.

Spacing or Density Plantation in Pineapple Farming

To achieve higher production, it is a good idea to go for high-density plantation in commercial pineapple farming. So, here below is a guide for idle spacing and planting density for pineapple farming.

For subtropical area having mild humid conditions, the spacing of **23 X 60 X 75 cm** is considered as idle spacing and is sufficient enough grow more than **60,000 plants** per unit hectare. And

For farming pineapple in hot and humid condition, a spacing of **25 X 60 X 90 is best**. By this, one can plant more than **50,000 plants** per unit hectare.

But, hilly area with high fertility, the spacing should be somewhat less than it. In such area, planting around 30,000 plants per hectare is sufficient enough to obtain a good yield.

How to Plant Pineapple

There are 4 different systems of the plantation in pineapple farming. These four different planting methods are

- Flat-bed planting method
- Furrow planting method
- Contour planting method and
- Trench planting method

However, planting system in pineapple farming varies in accordance with soil type and rainfall in particular region.

Note that in slopes or hilly region, contour planting or **TERRACING** is should be adopted.

Most beginners start pineapple growing by planting the tops of shop bought pineapples.

That's a good way to play around and doesn't cost anything. If you eat pineapples you have the tops left over anyway.

However, growing pineapple tops is a slow way to grow pineapples. Tops take at least 24 months to flower, and then it takes another six months for the fruit to mature.

Suckers (or pups) and slips grow up and fruit a lot quicker. You may have to wait for your first top grown plants to produce such offspring.

But if you live in a pineapple growing area you should be able to get hold of some suckers.

Pineapples growing in the garden

Growing Pineapples From Suckers

A pineapple plant flowers only once, and produces one pineapple. Then it dies. But before it dies it also produces offspring.

Suckers or pups are little plantlets that grow between the leaves of the mature pineapple.

Some varieties will produce more suckers than others, some will start earlier and others later.

But **they all produce at least a few suckers or pups** before they die.

If you leave the suckers in place you get what is called a "ratoon crop". That is the least amount of work for the next crop, just do nothing. But it has a few disadvantages.

The plants start to crowd each other out and to compete for food, light and water. As a result the next lot of pineapple fruit is much smaller.

The other disadvantage is that if you leave the suckers in place you only get a few. The original pineapple plant thinks it has fulfilled its purpose in life and reproduced, and it dies.

Keep taking the suckers off and the plant keeps growing more of them.

The timing is not critical. I have accidentally broken off tiny baby plants and they survived. It is best to wait though until they are a reasonable size, say about 20 cm/8 inches long.

Once they look like the one in the picture above it is definitely time to take them.

Grab hold of them as close to the base as possible, and twist and pull at the same time. They usually come off easily. And then plant them like you plant pineapple tops. Just stick them in the ground. They'll grow :-).

Pineapple suckers ready for planting.

Pineapple Growing From Slips

Pineapple slips:

Slips are the tiny plantlets that grow at the base of the fruit on the fruit stalk.

Note that not all pineapple varieties produce slips.

Shop bought pineapples are usually of the variety "Smooth Cayenne", and they grow few if any slips. (They also produce few suckers and take a long time to do so.)

The Rough Cayenne produces much smaller but very tasty fruit, it has very prickly leaves, and lots of slips below the fruit.

Slips can be carefully snapped or pulled off. Do it as soon as they are big enough to handle (say about 10 to 15 cm/4-6 inches) because slips develop at the expense of the fruit! This means if you leave them on, your fruit will be smaller.

Your pineapple plant will not continue to produce more slips if you remove them as it does with suckers. Once you take the slips off you are done and the plant will put all its energy into the fruit.

Pineapple Growing Strategies

Initially you will carefully plant out every single sucker and slip your pineapple plants produce. But soon your garden will be full of pineapples and you can afford to be more selective.

Mark the plants that produced the biggest, sweetest and juiciest fruit so you know those suckers are worth planting.

Avoid the plants that produce long fruit stalks, like the one in the picture below. The fruit should grow as low as possible or it just falls over and gets sunburned.

While it's tempting to initially select for plants that produce lots of slips, keep in mind that the slips develop at the expense of the fruit. You get bigger, better fruit of plants that produce fewer slips.

Pineapple plants have a tiny root system and rely a lot on their leaves for water and nutrition. Therefore they don't mind being dug up and transplanted.

You can use that to your advantage by planting your small suckers and slips into a "nursery bed". They won't stay there for long so you can plant them very close together.

Wait for them to grow to about a foot high before you plant them in their final position. That way all the pineapples in a clump or row are of similar size and you don't get the big ones crowding and shading the littlies.

Smooth Cayenne is by far the most popular variety across the world and the most common in the shops. It's a very reliable producer of large and great tasting fruit and it has the smoothest leaves.

(If you haven't mulched your pineapples well and have to deal with weeds amongst them you very quickly learn to appreciate that!)

Some of the best tasting pineapple varieties don't ship or keep well and you don't usually get them in shops. So if you see any, or know of someone who grows them, go get them.

There are also red pineapples, blue pineapples, pineapples with variegated leaves, miniature pineapples, all sorts of pretty and interesting varieties. Have fun trying them out.

Irrigation in Pineapple Farming

Pineapples are water-loving plants and is mostly cultivated in good rainfed areas. An Optimum rainfall of 1500 mm per year is sufficient enough for their best growth. However, water should be supplemented to obtains good sized pineapple fruits for good profit.

Nowadays, it is possible to planting pineapples throughout the whole year to obtain year-round production. Take care while irrigation. Provide water to your crop, time to time on the basis of requirements.

Application of Manure and Fertilizers in Pineapple Farming

Farming Pineapples in soil having good organic matter and high fertility is always beneficial in getting more production. However, a pineapples crops require a minimum of 15 gm of Nitrogen and Potassium per each plant. This crop does not require phosphorous for its healthy growth. However, if your soil is less fertile, then application of 4gm of P2O5 is also beneficial for getting a higher yield.

Care while application of Nitrogen. Apply Nitrogen in six equal split doses. The first dose should be applied after two months of plantation whereas the last one is to be applied at about one year of planting pineapples on the main field. Follow the same for application of Potash.

Pineapple | Insects, Pests, and Diseases

This commercial crop is totally free from insects, pests, and diseases. However, mealy bugs and scale insects have some exceptions. Also, the disease of stem rot is also an exception. Controlling measures of these pests and disease include good drainage capacity and dipping of the suckers in the mixture of Bordeaux before planting pineapples.

Intercultural Activities in Pineapple Farming

Intercultural activities help in enhancing the good plant growth. So, it is essential to perform some of the intercultural activities such as weedling. Earthing up in pineapple farming is an essential activity to perform to the good encouragement of good plant growth. As the roots of this commercial crops are much shallow, plants should be eventually lodged particularly for the flat-bed planting method in rainfall areas.

Lodge plants when fruits are in their growing stage will results in lopsided growth, also better development and fruit ripening. Handling this intercultural activity is more important in

the ratoon crops, because of the plant base shifts-up, during crop after crops. However, Planting with high-density plantation can reduce the necessity of this intercultural operation up to some extent since the plants propping with each other prevent the lodging in this commercial crop.

Harvesting Pineapples

Usually, pineapple plant starts flowering after about 12 to 15 months of the plantation. **How long do pineapples take to grow?** Is totally depends on the cultivar, time of plantation, type of planting material along with size and also the climate condition of the atmosphere of your farm. But, generally, **in about two years after planting on the main field,** the pineapple crop becomes ready for harvesting. The fruiting season of this yummy fruit start from March and runs until the late June.

However, under the natural climatic condition, this yummy fruits comes for harvesting from May to August. The fruit ripening process is the long lasting process. Usually, fruit ripening takes about 5 to 6 months of the plants flowering. It is a notable point that irregularity in flowering can leads to longer harvesting time. So, for this, make use of Ethrel (@ 100 ppm) solution to the plant, about one month before the flowering start. This will give you over 80 % uniform flowering in the main season.

For canning, this fruits should be harvested or collected when a slight change appears at the fruit developing base. And for table purpose, they should not be collected till they achieve attractive golden yellow color.

Depending on the soil type, harvested plant crop can be maintained as ratoon crop for about four years. Ratooning crop in high-density plantation yield fruits weighing around 90 % and 80 % of the crop in the 2nd and 3rd year respectively. The plant yield can reduce up to 50 % of production in the following years of ratooning.

Yield

Presently, with the help of advance pineapple farming techniques and good farm management skills, it is available to produce more than 80 tonnes of pineapple fruits per unit hectare depending on the spacing and intercultural activities.

The economic life of the pineapple farming is about 5 years after which the main field should be uprooted and should be used for replantation of pineapple farming or can be utilized for farming another commercial crop.

Marketing

Pineapples have great demand in the market; both local and also international because of its delicious flavored taste. Apart from being eaten as fresh, this yummy fruit is also used for cooking, canning, processing, etc

After collecting delicious fruits, look firstly for the local market. But, if want to earn more profit from it, then you can go to export this.

How to grow pineapples in Uganda

The pineapple is a tropical and sub-tropical fruit grown in many African countries. Locally the fruit is known as “Enanansi”. The fruit is trade-able and generates a lot of income for farmers who grow it.

In Uganda pineapples are mainly grown south of Lake Kyoga and in western Uganda.

Common Pineapple cultivars grown in Uganda

Smooth cayenne; it’s by far the most important cultivar throughout the tropics. **Queens;** this cultivar is smallest and sweeter than the cayenne.

The Red Spanish; it's a semi spineless cultivar; its fruits are intermediate of smooth cayenne and Red Spanish.

Soil requirements for Pineapple growing

Pineapples grow well on well drained fertile sandy loam soils. The soils should be rich in humus with a pH range of 4.5 to 5.5.

How to Propagate Pineapples on your farm

Pineapples are vegetative propagated using the following pineapple plant parts. **Suckers**; these are off shoots and take about 17 months to fruit.

Slips; these are under growing of a pineapple plant and they take about 20 months to fruit.

Crowns; this is the top spike or leafy part of a pineapple; it takes about22 to 24 months to fruit.

How to plant Pineapples in Uganda

Crowns are currently the preferred planting material used by Ugandan farmers. These are twisted from the fruit at the time of harvest or after eating the pineapple.

The wound on the crown i.e. the downer part is allowed to dry (cure) for 1 to 2 weeks.

Alternatively the crowns can be trimmed to remove the fruit tissue high in sugars and then dipped in a fungicide for direct planting.

A spacing of 2ft (60cm) between the rows, 1 ft (30cm) between the plants and 4ft (120cm) between adjacent double rows.

And this will give approximately 36,250 plants/ha mark your rows with a string and pegs then dig shallow holes of 7 to 10 cm deep in the ground and then plant the pedal part of the crown and firm the soil around it. Plant the propagules at the ground level and later ridge to help provide a deep bed for better root growth.

Fertilizers; Nitrogen is the nutrient most used by pineapples.
It can be applied at the rate of 50 kg per hectare by top dressing. Potassium is also essential as its deficiency would lead to poor quality fruits.
The best method to apply potassium is by broad casting into holes before planting.

Weed off your pineapple field to prevent host of disease causing pests less the competition for nutrients with your main crop.

How Best to Harvest Pineapple

Pineapples should mature in 15 to 24 months depending on the planting material used.

When harvesting its best to cut rather than to break the fruit from the stalk. Under adequate management the main crop should yield about 70 tons per hectare.

About the Pineapple Market in Uganda

Pineapples do have a wider market on local markets shelves, supermarket fruit and vegetable sections and even processing companies.

The fruit is also exported to the neighboring countries like Rwanda and Sudan.

Quick Tips for growing Pineapples in Uganda

- Clear up land meant for planting by deep cultivation.
- Treat the crowns with fungicide and insecticide before planting.
- Mark your field using the 2ft and 1ft spacing for planting.
- Place the crowns 3cm deep in to the field and gently firm with soil.
- Spray the plantings with foliar fungicide and pesticide.
- Also water a bit the crowns for proper growth.
- In about 15 to 24 months you will be able to harvest your pineapple fruits.

BANANA GROWING IN UGANDA

Importance of Banana in Uganda.

Banana is one of the major and economically important fruit crops of Uganda. Banana occupies 20% of the area among the total area under crop in Uganda. Most of Banana is grown by planting suckers. The technology development in agriculture is very fast, it results in developing a Tissue Culture Technique. The Tissue Culture Banana is very tasty.

Banana Plantation in Uganda

Scientifically bananas are classified in the Family; musacae, with genera; ensete and musa. Bananas are perennial herbs and grow up to 5m or more. Banana is one of the major food security crops in Uganda as the crop supplies food to people almost all the time. Aside of food, bananas in Africa are used to produce local brew, and these crops also supplement animal feed.

Banana varieties in East Africa

We have three main groups of banana plants in East Africa:

The East African Highland Banana: these are the most dominant in the region especially in Uganda. They include the cooking type (Matooke) and the brewing type (Mbidde) and these two types are physically similar.

The plantains: (e.g. Gonja) these are mostly grown in the high lands of Kasese in Uganda, the crop is not widely grown and is eaten roasted.

The cultivars of the East African coast: these include the edible Sukalindizi dessert banana eaten ripe, kisubi a brewing type, kayinja also a brewing type and kivuvu a cooking and brewing type.

Environmental factors you will need to grow Bananas

You will need the appropriate climate, the right soils and your land should be well prepared.

Agro Climate; Banana grows best at a temperature of about 27°C. The grow bananas and flowering are negatively affected at lower temperatures. Banana grows best when they receive 1500-2500mm rain per year which is well distributed over the year. The crop grows best where relative humidity is at least over 60%.

Soil requirements; Banana requires a deep, well drained loam soil with high humus content. Banana best grows in soil pH ranging from about 5.6-7.5. It doesn't tolerate acidic soil. The crop needs an adequate supply of potassium, nitrogen, magnesium, calcium and phosphorus.

Land preparation: land should be slashed and prepared without burning to protect organic matter. About two ploughings are sufficient to provide a good seed bed for banana. The drainage channels or soil conservation bunds are established along the contours.

Suitable Climate for Banana Farming:

Banana, basically a tropical crop, grows well in a temperature range of 15ºC – 35ºC with a relative humidity of 75-85%. It prefers tropical humid lowlands .In Uganda, this crop is being cultivated in climate ranging from humid tropical to dry mild subtropics through a selection of appropriate varieties. Chilling injury occurs at a temperature below 12ºC. The high velocity of wind which exceeds 80 km /hr. damages the crop. Rainfall is most important for vigorous

vegetative growth of banana. At higher altitudes, banana cultivation is restricted to a few varieties.

Deep, rich loamy soil with a pH between 6.5 – 7.5 is most preferred for banana farming. Soil for banana should have good drainage, adequate fertility, and moisture. Saline solid, calcareous soils are not suitable for banana cultivation. A soil which is neither too acidic nor too alkaline, rich in organic material with high nitrogen content, adequate phosphorus level and plenty of potash is good for a banana

Suitable Soil Type for Banana Farming: In Banana Farming, Soil for banana should have good drainage, adequate fertility, and moisture. Deep, rich loamy soil with pH between 6-7.5 are most preferred for banana cultivation. Ill drained, poorly aerated and nutritionally deficient soils are not suitable for the banana. Saline solid, calcareous soil is not suitable for Banana cultivation. Avoided soil of low lying areas, very sandy & heavy black cotton with ill drainage. A soil that is not too acidic and not too alkaline, rich in organic material with high nitrogen content, adequate phosphorus level and plenty of potash are good for the banana.

Field plantation

Land Preparation for Banana Farming:

Prior to planting banana, grow the green manuring crop like daincha, cowpea, etc. and bury it in the soil. The land can be ploughed 2-4 times and leveled. Use rotavator or harrow to break the clod and bring the soil to a fine tilth. During soil preparation, a basal dose of farmyard manure (FYM) is added and thoroughly mixed into the soil.

A pit size of 45cm x 45cm x 45cm is normally required. The pits are to be refilled with topsoil mixed with 10 kg of FYM (well decomposed), 250 gm of Neem cake and 20 gm of conbofuron. Prepared pits are left to solar radiation helps in killing the harmful insects, is effective against

soil-borne diseases and aids aeration. In saline-alkali soil where PH is above 8 Pit mixture is to be modified to incorporate organic matter.

Addition of organic matter helps in reducing salinity while the addition of purliteimproves porosity and aeration. An alternative to planting in pits is planting in furrows. Depending on soil strata one can choose an appropriate method as well as spacing and depth at which plant is required to be planted

Planting Material in Banana Farming:

About 70% of the farmers are using suckers as planting material while the rest 30% of the farmers are using tissue culture seedlings. Sword suckers with well-developed rhizome, conical or spherical in shape having actively growing conical bud and weighing approximately 450-700 gm are commonly used as propagating material.

In Banana Farming, suckers generally may be infected with some pathogens and nematodes. Similarly, due to the variation in age and size of the sucker, the crop is not uniform, harvesting is prolonged and management becomes difficult. Therefore, in-vitro clonal propagation i.e. Tissue culture plants are recommended for planting. They are healthy, disease free, uniform in growth and early yielding.

Plant material

Advantages of Tissue Culture Planting Material:

- True to the type of mother plant under good management.

- Pest and disease free seedlings
- Uniform growth, increases yield.
- Early maturity of crop – maximum land use is possible in low land holding countries
- Round the year planting possible as seedlings are made available throughout the year.
- Two successive ratoons are possible in a short duration which minimizes the cost of cultivation.
- No staggered harvesting.
- 95% – 98% plants bear bunches.

Planting Method in Banana Farming:

Pit planting is commonly followed in the garden system of cultivation. A pit size of 0.5 x 0.5 x 0.5 m. is normally required. Small pits are dug in case of ridges and furrows. The pits are to be refilled with topsoil mixed with 10 kg of FYM (well decomposed), 250 gm of neem cake and 20 gm of carbofuran. Prepared pits are left open for 15-20 days for solar radiation to kill all the insects, soil-borne diseases and for aeration before refilling. In saline-alkali soil where the pH is above 8, pit mixture is to be modified incorporating organic matter and gypsum.

The suckers are planted in the center of the pit and soil around is compacted. Plants are planted in the pits keeping pseudostem 2cm below the ground level. The soil around the plant is gently pressed. Deep planting should be avoided. The field is irrigated immediately after planting.

Banana Irrigation

Irrigation or Water Management in Banana Farming:

Banana, a water-loving plant, requires a large quantity of water for maximum productivity. But Banana roots are the poor withdrawal of water. Therefore under Uganda condition banana

production should be supported by an efficient irrigation system like drip irrigation. Water requirement of banana has been worked out to be 2000mm per Annum. Application of drip irrigation and mulching technology has reported improved water use efficiency. There is saving of 56% of water and increasing yield by 23-32% under the drip. Irrigate the plants immediately after planting. Apply sufficient water and maintain field capacity. Excess irrigation will lead to root zone congestion due to the removal of air from soil pores, thereby affecting plant establishment and growth. And hence drip method is a must for proper water management in Banana.

Application of Manure and Fertilizers in Banana Farming:

Banana requires a high amount of nutrients, which are often supplied only in part by the soil. The nutrient requirement has been worked out on be 20kg FYM, 200gm N; 60-70gm P; 300gm K/plant. Banana requires heavy nutrition. The banana crop requires 7-8 Kg N, 0.7- 1.5 Kg P and 17-20 Kg K per metric tonne yield. Banana responds well to the application of nutrients. Traditionally farmers use more of urea and less of phosphorous and potash. In order to avoid loss of nutrients from conventional fertilizers i.e. loss of N through leaching, volatilization, evaporation, and loss of P and K by fixation in the soil, application of water-soluble or liquid fertilizers through drip irrigation (fertigation) is encouraged. A 25-30% increase in yield is observed using fertigation. Moreover, it saves labor and time and the distribution of nutrients is uniform.

Intercultural operations in Banana Farming: The Root system of banana is superficial and easily damaged by cultivation, use of intercrop which is not desirable. However short durational crops (45-60 days) like mung, cowpea, daincha are to be considered as green manuring crops. Crops from cucurbitaceous family should be avoided as these carry viruses.

Weeding in Banana Farming: Spraying of Glyphosate (Roundup) before planting at the rate of 2 lit/ha is carried out to keep the plantation weed free. One or two manual weedings are necessary.

Micronutrient Foliar Spray: Combined foliar application of $ZnSo^4$ (0.5%), $FcSo^4$ (0.2%), CuSo4 (0.2%) and H_3Bo_3 (0.1%) can be adopted to improve morphological, physiological and yield attributes of banana. The micronutrient spray solution is prepared by dissolving the following in 100 litres of water. Zinc sulphate – 500gm – For every 10 liters of mixture 5-10 ml of sticker solution such as Teepol should be added before spraying. Ferromsulphate – 200

gm – For every 10 liters of mixture 5-10 ml of sticker solution such as Teepol should be added before spraying. Copper – 200 gm – For every 10 liters of mixture 5-10 ml of sticker solution such as Teepol should be added before spraying.

Removal of male buds:(Denavelling) Removal of male buds helps fruit development and increases bunch weight. Male buds are removed from the last 1-2 small hands with a clean cut keeping a single finger in the last hand.

Bunch Spray: Spray of monocrotophos (0.2%) after the emergence of all hands takes care of the thrips. Thrips attack discolors the fruit skin and makes it unattractive.

Bunch Covering: Covering bunch using dried leaves of the plant is economical and prevents the bunch from direct exposure to sunlight. Bunch cover enhances the quality of fruit. But in rainy season this practice should be avoided.

Sleeving of the bunch is done to protect fruits against dust, spray residue, insect, and birds. For this blue plastic sleeves are preferred. This also increases the temperature around developing bunch and helps in early maturity.

Dehandling of false hands of the bunch: In a bunch, there are some incomplete hands which are not fit for quality produce. These hands should be removed soon after bloom. This helps in improving the weight of other hands. Sometimes the hand just above the false hand is also removed.

Propping: Due to the heavy weight of bunch the plant goes out of balance and the bearing plant may lodge and production and quality are adversely affected. Therefore they should be propped with the help of two bamboos forming a triangle by placing them against the stems on the leaning side. This also helps in uniform development of bunch.

Harvesting in your Banana farming:

Banana should be harvested at the physiological maturity stage for better postharvest quality. The fruit is climacteric and can reach the consumption stage after ripening operation

Maturity indices: These are established on the basis of fruit shape, angularity, grade or diameter of the median figure of the second hand, starch content and number of days that have elapsed after flowering. Market preferences can also affect the decision for harvesting a slight or fully mature fruit.

Removal of the bunch: The bunch should be harvested when figures of second hand from the top are 3/4 rounded with the help of sharp sickle 30cm above the first hand. Harvest may be delayed up to 100- 110 days after the opening of the first hand. Harvested bunch should generally be collected in a wellpadded tray or basket and brought to the collection site. Bunches should be kept out of light after harvest since this hastens to ripen and soften. For local consumption, hands are often left on stalks and sold to retailers. For export, hands are cut into units of 4-16 fingers, graded for both length and girth, and carefully placed in poly-lined boxes to hold different weight depending on export requirements.

Post-harvest management of Banana farming:

At collection site injured and over-mature fruits are discarded and for a local market, bunches should be delivered through lorries or wagons. However, for more sophisticated and export market where the quality is predominant, bunches should be dehanded, fruits are cleared in running water or dilute sodium hypochlorite solution to remove the latex and treated with thiobendasole; air dried and graded on the basis of size of fingers as already stated, packed in ventilated CFB boxes of 14.5 kg capacity or as per requirement with polythene lining and pre-cooled at 13-15ºC temperature and at 80-90% RH. Such material should then be sent under cool chain at 13ºC for marketing

The yield of Banana:

Harvested Fruits.

The planted crop gets ready for harvest within 11-12 months of planting. First ratoon crop

would be ready by 8-10 month from the harvesting of the main crop and second ratoon by 8-9 months after the second crop.

Thus over a period to 28-30 months, it is possible to harvest three crops i.e. one main crop and two ratoon crops. Under drip irrigation combined with Fertigation yield of Banana as high as 100 T/ha can be obtained with the help of tissue culture technique, even similar yield in the ratoon crops can be achieved if the crop is managed well.

What to plant when you want to grow bananas in Africa

You can propagate/Plant your Bananas vegetatively or by breeding. The vegetative method however is the commonest among our farmers, and you will be able to use any of these planting materials below:

Peepers; these are very young suckers appearing above the ground with scale leaves only.

Sword suckers; these are formed from buds or eyes low on corm and bear narrow elongated leaves, these are usually 30-60 cm tall with. These are the most preferred material as they are usually firm in the ground.

Maiden sucker; these are relatively old with greater than 60cm and when are used for propagation it's advised that the leaves should be cut off to try minimize water loss.

Bits of large corms; they are obtained from corms which have bared a bunch. They are dug up; the upper parts are removed and are cut in two or more pieces each containing one or more eyes.

Water suckers; these are young with broad leaves and arise from the top parts of the corms. Always avoid planting these types of suckers as they are usually easy to dislodge from the mother plant and are usually weak.

Before planting, you should ensure that the suckers are clean, and free from pests and diseases. Your suckers should be cleaned by paring (cutting off all the roots and peeling off the outer layer of the corm). Paring should be done until all tunnels made by weevils have been removed. The pared suckers should be hot water treated to kill nematodes.

Nowadays suckers raised by tissue culture are available, are clean and good planting materials for bananas.

So how best should you Plant your bananas in the soil

The best time for planting your bananas will depend on your local climatic conditions.

In areas with pronounced dry season and yet irrigation is not possible, you will typically plant at the beginning of the rains.

You will plant your bananas in holes dug by hand. Your banana holes should be roughly (45x45x45) cm, with a recommended spacing of (3x3) cm.

Mix well rotten manure or compost (1-2) tins with top soil and return it to the hole.

Put the sucker in the middle of the hole and cover with the rest of the soil.

If you chose to use corm bits, be sure NOT to bury your corms deep; cover with just a 5cm layer of soil.

How to Manage your Banana plantation in Uganda

Here we discuss how you will Desucker, how to mulch, how to stake, how to Bag , how to deflower and how to apply fertilizers on your plantation.

Desuckering; this involves uprooting of excess suckers from a banana mat, you will this in order to suit the harvest frequency. Removing of the side shoot is done until the emergence of flowers 1-3 stems at most per mat (i.e. the bearing one, the follower and the sucker). Sucker management is important to avoid high mats and to maintain proper spacing. High or many suckers per mat could easily fall.

Mulching; this is used to conserve moisture in the soils, and to reduce rainfall runoff to avoid erosion. Mulch also improves the soil as the mulch material rots. However, mulch is known to serve as breeding place for banana weevils and other pests. Additionally, if you placed your mulch too close to the mother plant it will affect the growth of the young suckers. The means you need to work out a balanced approach to mulching your banana plantation in Uganda.

Staking; Bananas are susceptible to winds and should be staked to provide extra support to the banana stems. Banana cultivars that bear very big bunches are most susceptible to heavy winds. You normally do your banana staking using a forked pole.

Bagging; this involves majorly covering the banana bunch with a treated polythene bag to minimize sooty mold (Furry growth of fungus), insect damage and abrasion injury to the fruits.

Deflowering; once all the fingers have developed the rest of the inflorescence including the male flower bud) should be removed to reduce incidences of fungus and insect attack.

Fertilizer requirements: Bananas absorb a lot of nutrients from the soil. Therefore there is need to for you to replenish the soil using external sources like the farm yard manure, crop residues, homestead and kitchen refuse. You should however avoid applying metals or polythene on your banana plants. You should never apply manure too close to the banana mat as this would encourage banana weevils to breed and will also result in the high mat condition.

How to harvest your Bananas in Uganda

Your bananas should mature within 3-6 months.

Mature bananas are hard; the flower bract is dry and breaks off easily from the fruit tip.

Harvest your banana bunches with a curved knife, or a sharp panga, you will need to cut the bunch stem carefully.

Quick Tips for growing your Bananas in Africa

On a prepared land dig up pits of size of (45x45x45) cm.

Leave the pits exposed for some time to enable soil pests get exposed to sunshine.

Refill the pit with soil mixed with farmyard manure (10Kg).

Put suckers in the middle of the pit and soil around it compacted to keep it firm.

Water immediately to provide moisture to the planted sucker.

TOPIC 2.4.3: AGROFORESTRY/WATERSHED/PERMACULTURE PRODUCTION

LEANING OUTCOMES

Learners are expected to:

a) know the meaning of the terms: agroforestry, watershed, and permaculture; understand their importance to the environment and value to the Ugandan economy
b) understand the rationale for eco-friendly farming techniques in managing and caring for the environment and natural resources, and show appropriate skills in agroforestry, watershed and permaculture development
c) design an agroforestry, a watershed and a permaculture model plan for the area
d) understand how to select appropriate tree species and crops for an agroforestry garden, a watershed development area and a permaculture garden
e) understand how to establish and manage an agroforestry garden, a watershed development area and a permaculture garden
f) show skills in applying financial management principles to planning an agroforestry garden, a watershed development area and a permaculture garden
g) know how to harvest and process the products of agroforestry, watershed and permaculture
h) know how to market agroforestry, watershed and permaculture
i) show entrepreneurial skills required to make a success of agroforestry, watershed and permaculture

Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components.

This definition implies that:

Agroforestry normally involves two or more species of plants (or plants and animals), at least one of which is a woody perennial;

An agroforestry system always has two or more outputs;

The cycle of an agroforestry system is always more than one year; and

Even the simplest agroforestry system is more complex, ecologically (structurally and functionally) and economically, than a mono-cropping system.

Objectives of agroforestry

The system of agroforestry involves growing tree with crops on permanent basis in order to meet food, fuel, fodder and fibre needs of the farmers. It has the following aims.

Biomass production: The maximum production of biomass per unit area in time is the primary objective of AF in watershed management.

Conservation: Enormous loss of valuable, fertile topsoil is taking place with sediment and water. It has been estimated that on an average soil is displaced at the rate of about 16 t/ ha/ year and washed in to the reservoir, which is much higher than the permissible limit. Some of the barren portion and wasteland of the watershed can be provided with a cover through agroforestry interventions **in** the watershed management programme.

Soil improvement: In addition to conservation of production based agroforestry practices enrich soil by nitrogen fixation and addition of organic matter. In this way, this programme helps in meeting nutrient requirements of plants growing in association with trees and at the same time, the soil structure and infiltration rates are also improved.

Moderation of microclimate: The micro-climate in the neighbourhood of trees is moderated by adopting agroforestry systems and the field crops growing in association with trees get the benefit in various ways. Its pronounced effect is observed in semi-arid and arid regions.

Agro-based cottage industries: An agroforestry programme in watershed management helps in promotion of agro-based cottage industries, such as paper pulp, herbal drugs, fibre, poultry, piggery, dairy, bee-keeping, sericulture cultivation etc. This will provide gainful employment and raise the standard of living of small and marginal farmers.

Suitable agroforestry systems for watershed management

1) Agri-silvicultural systems, which manage land for the production of agricultural crops and forest products. Example:

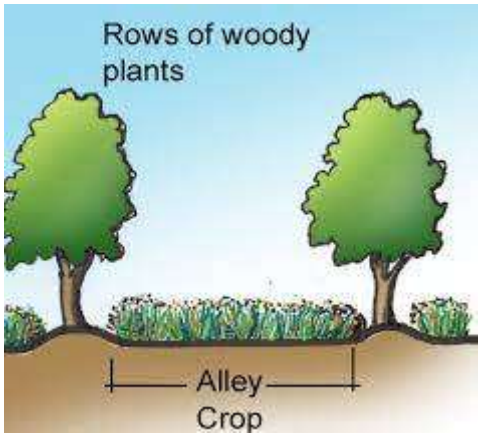
Maize agroforestry

Maize + fertilizer trees, which are pruned back several times so that leaves and biomass are incorporated, back into the soil which helps in:

- Soil fertility
- Weed growth is suppressed
- Soil carbon increases
- Water filtration

Maize agroforestry

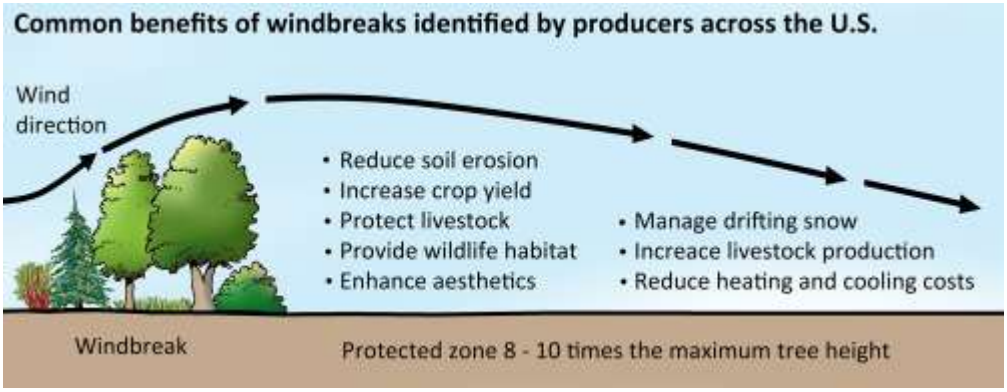
Alley cropping: practice of growing arable crops between hedge rows of shrubs and trees, which are periodically pruned to prevent shading of inter-crops, when there are no crops, the hedge rows are allowed to grow freely or cut to meet the fodder needs. MPT's like *Leucaena latisiliqua*, *Sesbania grandiflora*, *Albizia lebbeck* are used in alley cropping practices.



Alley cropping

Wind-breaks are the strips of trees and/or shrubs planted to protect fields, homes, canals or

other areas from wind and blowing soil /or sand.



Wind-break

Boundary planting

It is simple but effective practice particularly for small farmers. It includes planting trees all along the boundaries between the fields and farm or along the margins of footpath, roads and canals. It is also called four-sided forestry with object of gaining production from trees, whilst having no adverse effect on adjacent crops and possibly a beneficial effect through fertilization by trees or their leaf litter, protection from wind or aiding soil conservation i.e. watershed protection.

Boundary plantation

2) Silvi-pastoral System

This system is primarily meant for augmenting the scarce fodder supply. This system integrate pasture and/or animals with trees

- Protein bank
- Living fence of fodder trees and hedges
- Trees and shrubs on pasture

3) Agri-silvi-pastoral system

This is a mixture of the two systems above, which produces tree products, crops, and livestock

➢ **Other systems**

- **Agri - horticultural system**

Woody component of the system is fruit trees. It is also called as food-cum-fruit system in which short duration arable crops are raised in the interspaces of fruit trees. Some of the fruit trees that can be considered are guava, pomegranate, custard apple, sapota and mango. Pulses are the important arable crops for this system. However, depending on the requirements, crops like sorghum and pearl millet can be grown in the interspaces of fruit trees.

Fig 18. Agri-horticulture

- **Agri-Horti-Silvicultural system**

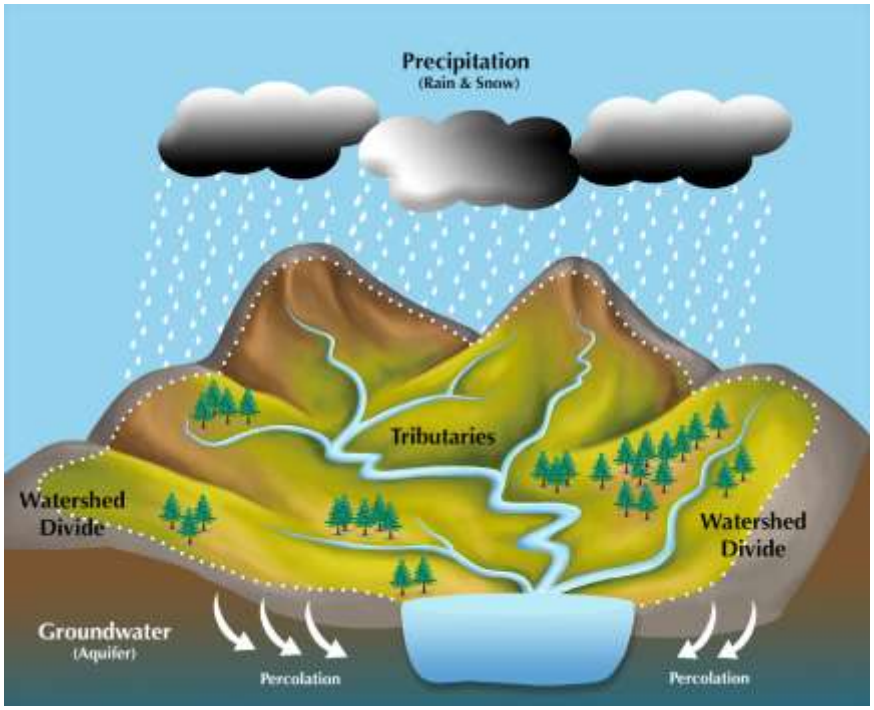
Growing legumes or other inter-crops (Shade tolerant-ginger and turmeric) in the interspace of fruit plantation has been a very old practice. Arable crops are grown in inter-spaces till the trees (fruits or MPT's) develop canopy or bear fruit or there is reduction in the crop yields

- **Horti-pastoral system**

Introducing suitable grasses like Dinanath grass (*Pennisetum pedicellatum*) or Napier grass (*Pennisetum purpureum*) or Anjan grass (*Cenchrus ciliaris*) etc.

WATERSHED CONCEPT

- A watershed is technically considered a geo-hydrological unit or an area that drains to a common point. **OR**
- The watershed, catchment and drainage basin are synonymous term indicating an area surrounded by a ridge line that is drained through a single outlet. More specifically, it supplies water by surface or sub-surface flow to a given drainage system or body of water, be it a stream, river, wetland, lake or ocean (Fig. below).
- The watershed is the product of the interactions between land and water, particularly its underlying geology, rainfall patterns, slope, soils, vegetative cover and land use. "Watershed hydrology," as a term, encompasses these interactions.
- The availability of water and its flow is a critical determinant in the various production functions in a landscape, especially since it is open to interference by human agency.



Typical watershed

Watershed is not necessarily upland or a mountainous land form. There are upland and lowland watersheds. Watershed is a terrestrial ecosystem consisting of interacting biotic and abiotic components such as land, water, plants, animals and minerals

Watershed Management

The process of creating and implementing plans, programs, and projects to sustain and enhance watershed functions that affect the plant, animal, and human communities within a watershed boundary.

It involves management of land, water, energy and greenery integrating all the relevant approaches appropriate to socioeconomic background for a pragmatic of a watershed. It also involves the greening of watershed through proper management of land water and energy systems. resource.

The main components of watershed management are resource conservation, crop production and alternate land-use

Principles of watershed management

The principles of watershed management based on resource conservation, generation and utilization are:

- Utilizing the land based on its capability
- Protecting fertile top soil
- Minimizing silting up of tanks, reservoirs and lower fertile lands
- Protecting vegetative cover throughout the year
- In situ conservation of rain water
- Safe diversion of gullies and construction of check dams for increasing ground water recharge
- Increasing cropping intensity through inter and sequence cropping
- Alternate land use systems for efficient use of marginal lands
- Water harvesting for supplemental irrigation
- Maximizing farm income through agricultural related activities such as dairy, poultry, sheep, and goat forming
- Improving infrastructural facilities for storage, transport and agricultural marketing
- Improving socio - economic status of farmers

Objectives of watershed management

The different objectives of watershed management programmes are:

- Recognition of watersheds as a unit for development and efficient use of land according their capabilities for production

- Flood control through small multipurpose reservoirs and other water storage structures at the head water of streams and in problem areas
- Adequate water supply for domestic, agricultural and industrial needs
- Reduction of soil and water pollution
- Efficient use of natural resources for improving agriculture and allied occupation so as to improve socio-economic conditions of the local residents
- Expansion of recreation facilities such as picnic and camping sites

Permaculture

The word "Permaculture," broken down into its components, means "Permanent Culture ", and implies a system that can truly sustain the needs of current and future generations. Culture, is mostly interpreted as food production culture, given the origin of permaculture. However, the permaculture movement has embodied a multifaceted view.

What is Permaculture?

- Permaculture is an innovative framework for creating sustainable ways of living.
- It is a practical method of developing ecologically harmonious, efficient and productive systems that can be used by anyone, anywhere.

By thinking carefully about the way we use our resources - food, energy, shelter and other material and non-material needs - it is possible to get much more out of life by using less. We can be more productive for less effort, reaping benefits for our environment and ourselves, for now and for generations to come.

This is the essence of permaculture - the design of an ecologically sound way of living - in our households, gardens, communities and businesses. It is created by cooperating with nature and caring for the earth and its people.

Permaculture is not exclusive - its principles and practice can be used by anyone, anywhere:

- City flats, yards and window boxes
- Commercial and industrial premises
- Educational establishments
- Suburban and country houses/garden
- Allotments and smallholdings
- Community spaces
- Farms and estates
- Countryside and conservation areas

- Waste ground

Permaculture Ethics

- These 3 broad ethic principles are part of permaculture thinking.
- Care for the earth (husband soil, forests and water)
- Care for people (look after self, kin and community)
- Fair share (set limits to consumption and reproduction and redistribute surplus).

Principles of permaculture

Following on the 3 ethic principles, a set of guidelines are made:

- Observe and interact. Take time to engage with nature, so we can design solutions for our particular situation.
- Catch and store energy: Develop systems that collect resources when abundant, & use them in times of need.
- Obtain a yield - Ensure that you are getting truly useful rewards as part of the work that you are doing.
- Apply self-regulation & accept feedback - Discourage inappropriate activity so systems continue to function well.
- Use and value renewable resources and services - Make the best use of nature's abundance.
- Produce no waste - Valuing and make use of all the resources available to us, so nothing goes to waste.
- Design from patterns to details - Step back and observe patterns in nature and society. Details come after.
- Integrate rather than segregate - Put the right things in the right place, so relationships and support develop.
- Use small, slow solutions - easier to maintain than big systems, better use of local resources, more sustainable.
- Use and value diversity - reduces vulnerability to threats and takes advantage of the environment.
- Use edges & value the marginal - often the most valuable, diverse and productive elements in the system.
- Have a positive impact on inevitable change by carefully observing, and then intervening at the right time.

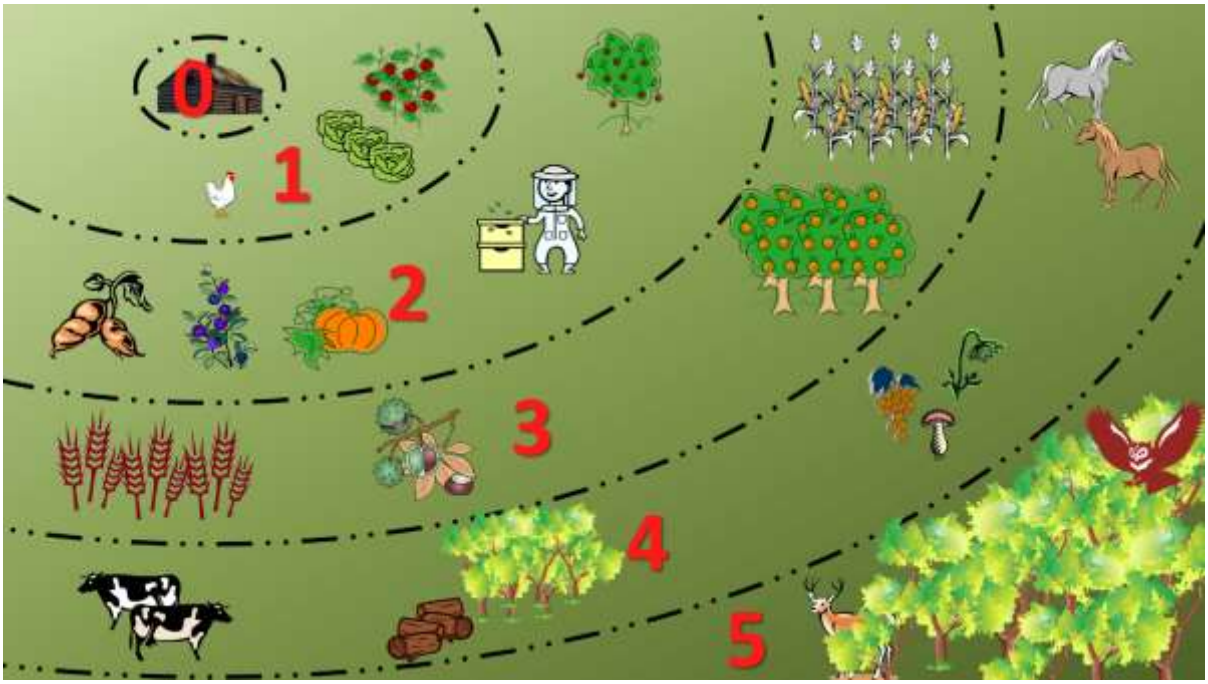
These are principles used and taught by the pioneers of permaculture - they are not universal truths. E.g. re "Use small, slow solutions": in certain contexts, big and fast-acting solutions

may be best; however the principle reminds us that great impacts can come in ways that require patience and are not flashy.

Zoning

Zoning means dividing a certain piece of land into several zones, with the family house in the center. All of these have a function to the owner of the land. Although this generally creates a rather artificial vegetation pattern, it creates an environment that has benefits both for the owner of the land, as well as well as for nature (to some degree). A more serious issue of permaculture (namely the use of non-indigenous and sometimes domesticated species of fauna/flora) can be reduced with zoning however. This, by placing domesticated (and generally more efficient) species near the center/home, and using indigenous species in the zones further away from the center.

Permaculture Zones are a way of organizing design elements in a human environment on the basis of the frequency of human use and plant or animal needs. Frequently manipulated or harvested elements of the design are located close to the house in zones 1 and 2. Less frequently used or manipulated elements, and elements that benefit from isolation (such as wild species) are farther away. Zones are about positioning things appropriately. Zones are numbered from 0 to 5.



Permaculture Zones

Zone 0: The house, or home center. Here permaculture principles would be applied in terms of aiming to reduce energy and water needs, harnessing natural resources such as sunlight, and generally creating a harmonious, sustainable environment in which to live and work.

Zone 1: The zone nearest to the house, the location for those elements in the system that require frequent attention, or that need to be visited often, such as salad crops, herb plants, soft fruit like strawberries or raspberries, greenhouse and cold frames, propagation area, worm compost bin for kitchen waste, etc. Raised beds are often used in zone 1 in urban areas.

Zone 2: This area is used for siting perennial plants that require less frequent maintenance, such as occasional weed control or pruning, including currant bushes and orchards. This would also be a good place for beehives, larger scale composting bins, and so on.

Zone 3: The area where main crops are grown, both for domestic use and for trade purposes. After establishment, care and maintenance required are fairly minimal (provided mulches and similar things are used), such as watering or weed control maybe once a week.

Zone 4: A semi-wild area. This zone is mainly used for forage and collecting wild food as well as timber production.

Zone 5: A wild area. There is no human intervention in zone 5 apart from the observation of natural ecosystems and cycles.