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S.5 NOTES on soil and animal science

PHYSICAL PROPERTIES OF SOIL. (continuation from where we stopped).

SOIL COLOUR

Soils have different colours,suchas black,pink,white,grey,red, brown,etc.

The colour of soil depends on the following:

✓The type of parent material from which the soil originated. For example, black soils originated from rocks called amphiboles. Quartz gives white soils, while rocks rich in carbonates produce grey or chalky soils. Rocks containing a lot of iron produce red soils.

✓The presence of organic matter. Soils with a lot of organic matter are darker in colour, while those with less organic matter appear grey or red in colour. Top soils contain high organic matter content, and thus are usually darker than the sub-soils.

IMPORTANCE OF SOIL COLOUR

✓Soil colour influences the temperature of soil. Dark soils absorb heat leading to a rise in soil temperature. Thus soils with a lot of organic matter are usually warmer.

✓ Soil colour canbe used to tell whetherthe soil is fertile or not. Dark soils are usually considered fertile due to presence of 'organic matter. Sometimes, farmers select crops to grow on certain parts of their

farms basing on the colour of soil.

✓Soil colour indirectly influences the rates of chemical reactions and microbial activities in the soil. Dark soils absorb sun's heat readily and are usually warmer.

✓Therefore, the rates of chemical reactions and microbial activities are higher in dark soils.

BULK: DENSITY AND PARTICLE DENSITY OF SOILS

Bulk density is the weight per unit volume of a dry sample of soil with its natural structure intact.

Bulk: density =Weight of a given soil

Volume of the same soil

The bulk density of a soil is influenced by:

✓Organic matter content: Organic matter is very light and spongy and so encourages porous condition in the soil, which results in a low bulk density.

✓Soil texture: Sandy soils have higher bulk densities than other soils. This is because the particles in sand generally lie in closer contact than those of finer textured surface soils. Also, sandy soils generally contain less water and organic matter.

✓ Soil depth: Bulk density tends to increase the deeper one goes into the soil profile. This is due lower organic matter content, less aggregation and. root penetration and the compaction caused by weight of the overlying layers of soil.

✓Level of cultivation: Intensive cultivation increases the bulk density

because it causes rapid break down of organic matter and also causes compaction of the soil,

✓System of soil management: The addition of manures in large amounts to the soil lowers the bulk density of the soil.

✓Cropping system: Continuous cropping reduces the amount of organic matter in the soil and increases bulk density. Fallowing on the other hand increases the amount of organic matter and reduces the bulk density.

PARTICLE DENSITY

This is the mass per unit volume of the soil solids. The oven - dried soil is compressed and then its particle density found using the formula Soil particle density =Weight of the soil solids (gm^3)

Volume of the soil solids

Particle density is largely influenced by:

✓ The nature of the minerals present in the soil: Presence of heavy minerals in the soil increases the particle density of the soil.

✓ Organic matter content: Organic matter reduces the particle density of soils because it is less dense.

EXPERIMENTS TO DETERMINE DIFFERENT SOIL PROPERTIES

PERCOLATION: This is the ability of water to pass through *a* soil sample.

The experiment is aimed *at* determining the differences in rates of

percolation.

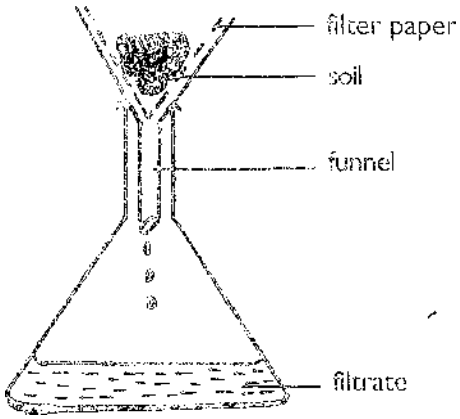
EXPERIMENT TO DETERMINE THE RATES OF PERCOLATION OF SAMPLES OF SOIL

Apparatus/material

Funnels, filter papers/cotton wool, beakers/conical flasks, measuring cylinders, water, soil sample, stop clock, *beam* balance.

Method/procedure

- ✓ Weigh equal amounts of crushed dry soil samples.
- ✓ Measure equal volumes of water using the measuring cylinder
- ✓ Beaker s/conical flasks are set up.
- ✓ Cotton wool/filter paper is *put* in the funnels and *put* on the beakers/conical flasks.
- ✓ Weighed soil sample is *put* in the funnel.
- ✓ Pour the water onto the soil sample slowly until it is finished.
- ✓ Set the stop clock working and note the time taken for the first drop to come out.
- ✓ Repeat the experiment for the second and third samples as shown in the diagram.



Observations/results

✓ Water drains through the samples at different rates or the first drop takes a shorter time to come out in one of the soil samples than in the other or more water is collectedin one sample than in the other in a given time.

Conclusion

✓ The soil sample where the water drop comes out faster is quick draining or conical flask/beaker containing more water has the highest

RETENTION

The experiment is aimed at investigating the amount of water different soils can keep.

Apparatus/materials

Funnel, filter paper/cotton wool, beaker/conical flasks, measuring cylinders, water, soil sample, stop clock, beam balance.

Method/procedure

✓ Weigh equal amounts of crushed dry soil samples.

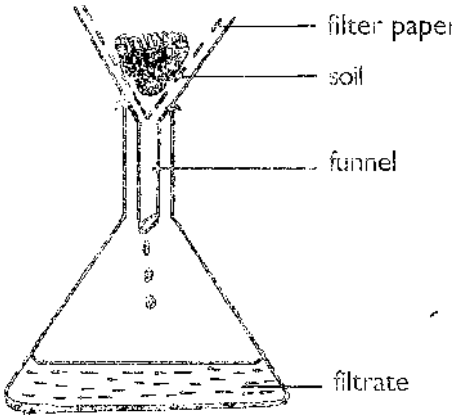
✓ Measure equal volumes of water using the measuring cylinder.

✓ Beakers/flasks are set up.

✓ Cotton wool/filter paper is put in the funnels and put on the beakers/ flasks.

✓ Weighed sample is put in the funnel.

✓ Pour the water onto the soil sample slowly until it is finished. Do the same for the other samples.



Observation/results

- ✓ *The* amount of water collected in the samples is different.

Conclusion

- ✓ *The* soil sample with less/little amount of water collected in the beaker/flask has the highest rate *of* retention.

Retention can *be* calculated *as* follows:

Retention = Volume of water used - Volume of water collected in the beaker.

CAPILLARITY

Capillarity is the upward movement *of* water in the soil.

The aim of this experiment is to find out the capillarity rates *of* soils,

***Exp.* 3: To determine the capillarity of different soil samples**

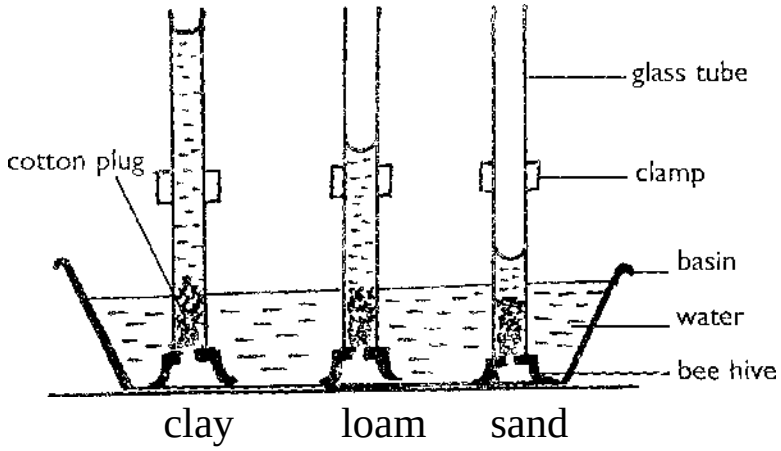
Apparatus/materials:

Capillary tubes, cotton wool, samples *of* soil, basin/ beaker, clamp and water.

Method/procedure

- ✓ Plug the capillary tube with cotton *wool.*

- ✓ Fill each capillary tube/glass tube with equal volumes *of* cay, loam or sand soils.
- ✓ Pack the samples by tapping *on* the sides of the tubes gently.
- ✓ Put the plugged end of the tubes *n a* basin or *beaker of water.*
- ✓ Clamp the tubes and let them stand preferably overnight.



Observation results

✓Water moves upwards in different soils *at* different rates fastest in sand, average in loam and lowest in clay.

✓ After standing over night, the water level is highest in clay, average in loam and *lowest* in sand.

Conclusion: Capillarity is highest in clay, average in loam and lowest in sand.

CHEMICAL PROPERTIES OF SOIL

These are concerned with the chemical substances and chemical compounds found in the soil. *The* chemical properties of soil include soil reaction and the mineral content of soil.

Soil pH; term used to express a degree of acidity or neutrality or alkalinity of the soil.

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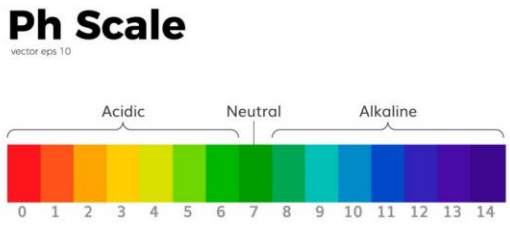
PH is a symbol standing for potential of hydrogen which refers to the hydrogen ion concentration of a soil solution. It's also known as **soil reaction**.

Soils high in hydrogen and aluminum tends to be acidic well as soils high in bases tend to be alkaline. However, soils with Al^{3+}, H^{+} on OH ion with bases balance the soil is said to be neutral.



HOW SOIL PH AFFECTS CROP PRODUCTION

✓Influences the physical and chemical properties of the soil.

✓Affects the availability of nutrients e.g. K, Mg, Zn available at high pH

✓Influences the incidences of soil borne diseases e.g. fungal diseases common at low pH well as bacterial diseases common at high ph.

✓Determine the type of crop to be grown at a given area e.g. tea grows best in acidic soils while Barry and vegetables in alkaline soils.

✓Affects microbial activities.

✓At low pH, Fe^{3+} and Al^{3+} ions become toxic to plants.

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CAUSES OF SOIL ALKALINITY.

✓ Weathering of the soil from alkaline parent materials such as lime stone.

✓ Addition of base containing materials such as lime.

✓ Irrigation water contains salts which release cation that dissolved by soil colloids.

✓ Drought that reduces precipitation that may cause leaching.

MODIFICATION OF ALKALINE SOILS.

✓Applying acidic fertilizers such as sulphate of ammonia

✓Applying acidic organic matter such as pine needles, sawdust.

CAUSES OF SOIL ACIDITY.

✓Presence of acidic soluble salts arising from acidic fertilizers, weathering of minerals.

✓Leaching of bases that are replaced by H^+ and Al^{3+} that causes acidity.

✓Presence of organic matter that produces organic and inorganic acids.

✓Water logging that causes anaerobic respiration increasing carbon dioxide accumulation forming carbonic acid.

✓Uptake of bases by plants.

✓Application of acidic fertilizers such as ammonium phosphate.

MODIFICATION OF ACIDIC SOILS

✓Applying agricultural lime. Liming materials include; $CaCO_3$, Calcium dolomite, magnesium carbonate, CaO/ Quick lime etc.

QUALITIES OF A GOOD LIMING MATERIAL

✓Should have a mild alkalizing effect.

✓Should result into a desirable proportion of cations and dissolved cation exchange sites.

✓Should have a favorable effect on soil structure.

✓Should have objectionable residues in soil.

✓Should be able to dissolve quickly.

✓Should not be too expensive.

FACTORS CONSIDERED BEFORE LIMING.

✓PH of the soil; should only be applied to soils with a low Ph.

✓Buffer capacity; tends to resist the changes in the PH.

✓Percentage base saturation; availability of cations that have capacity to replace h^+ on the exchange sites.

✓Type of crop to be grown; different crops have different pH requirements.

✓Economic returns; should be able to offset the costs of lime.

✓Fineness of the lime stone; for fine lime, small amounts should be applied than when they are rough.

BENEFITS OF LIMING.

✓Improves on soil structure.

✓Neutralizes the organic acids produced by the breakdown of organic matter.

✓Makes clay soils easier to cultivate.

✓Promotes development of a big population of microorganisms.

✓Controls fungal diseases that flourishes in acidic soils.

✓Increases availability of nitrogen and phosphates to plants.

REDUCTION OF OVER LIMING EFFECT.

✓Applying manure.

✓Applying dolomite limestone.

✓Using coarse lime which is milder than fine lime.

LOSS OF LIME FROM SOIL.

✓ Through soil erosion.

- ✓ Through crop removal.
- ✓ Through leaching.

Methods of pH Testing

- ✓ Universal indicator solution
- ✓ pH meter

HOW TO TEST FOR SOIL PH IN THE LABORATORY USING THE UNIVERSAL INDICATOR

- ✓ Assemble all the materials/apparatus to use
- ✓ Get a small amount of soil and place it in a test tube
- ✓ Add barium sulphate to help in breaking soil clods
- ✓ Add distilled water and shake the contents
- ✓ Wait for the contents to settle and then add universal indicator solution
- ✓ Hold the test tube against the color chart on which ph values corresponding to different indicator colors are recorded
- ✓ The exact ph of the soil under investigation is read off the color chart

PLANT NUTRIENTS

A nutrient is an element needed by plants for proper growth.

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Plant nutrients occur in the soil in form of soluble substances.

These substances are taken in by the plants in different quantities depending on their roles in the plant tissues.

They are divided into two broad categories namely:

- ✓ Macronutrients
- ✓ Micronutrients.

MACRO-NUTRIENTS

These are also referred to as major nutrients, required by the plant in large quantities.

They include;

Carbon, hydrogen, oxygen as **basic essential nutrients**,

Nitrogen, phosphorus, potassium as **primary macronutrients,**

Sulphur, Calcium, Magnesium as **secondary macronutrients.**

Nitrogen, phosphorus and potassium are referred to as **fertilizer elements,**

Calcium, magnesium and Sulphur, are referred to as **liming elements.**

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ROLE OF MACRO NUTRIENTS IN PLANTS

NITROGEN; Its absorbed inform of $N0_3$, NH_4 by plants.

Sources include; artificial fertilizers, Organic matter, Atmospheric fixation by lightning and Nitrogen fixing bacteria.

ROLE OF NITROGEN IN PLANTS

- ✓Vegetative growth
- ✓Chlorophyll formation
- ✓Buildup of protoplasm.
- ✓Improves leaf quality in leafy crops such as tea and cabbages

Deficiency Symptoms

- ✓Yellowing of the leaves/chlorosis.
- ✓Stunted growth.
- ✓Premature ripening.
- ✓Premature shedding of the leaves.
- ✓Light seeds.

Effect of Excess Nitrogen

- ✓Scorching of the leaves.
- ✓Delayed maturity.

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Loss of Nitrogen from the Soil:

- ✓Through Soil erosion.
- ✓Through Leaching.
- ✓Through Volatilization.
- ✓Through Crop removal.
- ✓Used by microorganisms.

PHOSPHORUS;its absorbed inform of $HP04^{2-}$**,** $H_2PO_4^-$ by plants.

Sources include; Organic manures, Commercial fertilizers and Phosphate rocks

ROLE OF PHOSPHORUS

- ✓Encourages fast growth and establishment of the roots.
- ✓Improves the quality of the plant.
- ✓Important energy source for cell division.
- ✓Aids in flowering and fruit formation

Deficiency symptoms

- ✓Leaves become grey, purple in Colour especially along leaf margin
- ✓Growth of the plant is slow.
- ✓Dead areas on fruits and leaves.
- ✓Yield of grains, fruits and seed is lowered.

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Loss of Phosphorus from the Soil

✓Through Soil erosion.
✓Through Leaching
✓Through Crop removal
✓Through Fixation by iron and aluminum oxide.

POTASSIUM; it's absorbed in form of K, K_2O by plant roots.

Sources include; Crop residue and organic manures, Commercial fertilizers and Potassium bearing minerals e.g. feldspar and mica.

ROLE OF POTASSIUM IN PLANTS

✓Increases plant vigor and disease resistance.
✓Increases the size of grains and seeds.
✓Aids in flowering and fruit formation
✓Controls stomatal opening.
✓Balances the effect of nitrogen and phosphorus in the soil.

Deficiency Symptoms

✓Plants have short joints and poor growth.
✓Plants lodge before maturing.
✓Leaves develop a burnt appearance on the margin.

✓Leaves at the lower end of the plant become mottled, spotted or streaked.

✓In maize, grains and grasses firing starts at the tip of the leaf and proceeds from the edge usually leaving the midrib green.

Loss of Potassium from the Soil

✓Through Crop removal.

✓Through Leaching.

✓Through Soil erosion.

✓Through Fixation in the soil.

CALCIUM; its absorbed inform of **Ca^{2+}**

Sources include; Crop residues and organic manures, Commercial fertilizers, weathering of soil minerals, Agricultural limes for example dolomite, limestone.

ROLE OF CALCIUM IN PLANTS

✓Important in protein synthesis.

✓Important in elongation of apical meristem.

✓Helps in grain and seed formation.

✓Improves the soil structure.

✓Promotes bacterial activity in the soil.

✓Corrects the soil acidity.

Deficiency symptoms

✓Young leaves remain closed.

✓There are light green bands along the margins of the leaves.

✓Leaves in the terminal bud become hooked in appearance there is a die-back at the tip and along the margins.

Loss of Calcium

✓Through Crop removal

✓Through Leaching

✓Through Soil erosion

MAGNESIUM; its absorbed inform of **Mg^{2+}**

Sources includes; Crop residues and organic manures, Commercial fertilizers, weathering of soil minerals, Agricultural limes.

ROLE OF MAGNESIUM IN PLANTS

✓Forms part of chlorophyll.

✓Promotes the growth of the soil bacteria and enhances the nitrogen fixing power of the legumes.

✓Activates the production and transport of carbohydrates and proteins in the growing plant.

Deficiency symptoms

✓Loss in green Colour which starts from the bottom leaves and gradually moves upwards.

✓The veins remain green.

✓Leaves curve upwards along the margins.

✓Stalks become weak and the plant develops long branched roots.

✓The leaves become streaked.

SULPHUR; its absorbed inform of $\mathbf{S0_4^{2+}}$

Sources includes; Commercial fertilizers, Soil mineral containing sulphides, Atmospheric Sulphur from industries, Rain water

ROLE OF SULPHUR IN PLANTS

✓Formation and activation of Coenzyme-A.

✓Sulphur is a constituent of amino acids.

✓Influence plant physiological processes.

Deficiency Symptoms

✓Small plants/stunted growth.

✓Poor nodulation in legumes.

✓Light green to yellowish leaves/ chlorosis.

- ✓Delayed maturity.

MICRO-NUTRIENTS

Also referred to as trace or minor nutrients, required in small quantities/traces.

They are essential for proper growth and development of plants.

They include; Iron, Manganese, Copper, Boron, Molybdenum, Chlorine.

ROLE OF MICRONUTRIENTS AND THEIR DEFICIENCY SYMPTOMS

Copper

- ✓Role in oxidation-reduction reactions.
- ✓Respiration and utilization of iron

Deficiency symptoms-**yellowing of young leaves.**

Iron

- ✓Synthesis of proteins.
- ✓Takes part in oxidation-reduction reactions.

Deficiency symptoms - **leaf chlorosis**

Molybdenum

- ✓Nitrogen transformation in plants.
- ✓Metabolization of nitrates to amino acids and proteins

Deficiency symptoms -**leaf curl and scathing.**

Manganese - Same as molybdenum.

Zinc

- ✓Formation of growth hormone.
- ✓Reproduction process

Deficiency symptoms - white bud formation.

Boron

- ✓Absorption of water.
- ✓Translocation of sugar

INORGANIC FERTILIZERS

These are chemically produced substances added to the soil to improve fertility Classification According to:

- ✓**Nutrients contained**

Straight - contain only one macronutrient e.g. SSP

Compound fertilizers - contain more than one macronutrient e.g. NPK

✓**Time of application**

Some applied when planting.

Top dressing after crop emergence

✓**Effects on the soil pH.**

Acidic fertilizers.

Neutral fertilizers.

Basic fertilizers.

QUALITIES OF A GOOD FERTILIZER

- ✓ It should be easy to apply
- ✓ It should be easy to handle.
- ✓ It should supply the required nutrients readily to the soil.
- ✓ It should be affordable to buy.
- ✓ It should have long lasting effect in the soil.
- ✓ It should be easy to store.
- ✓ It should have high nutrient content.
- ✓ It should be easy to dissolve in the soil
- ✓ Should be easy to supply nutrients to exhausted soils

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PROPERTIES AND IDENTIFICATION OF FERTILIZERS

NITROGENOUS FERTILIZERS

Examples include;

✓Sulphate of Ammonia that's white crystals, acidic fertilizers Containing 20% N.

✓Ammonium Sulphate Nitrate appearing in yellow orange granules, acidic and contains 26% N.

✓Calcium Ammonium Nitrate (CAN); greyish granules, neutral in nature, and contains 21 % N.

✓Urea which are small whitish Granules, easily leached or volatilized, and contains 45- 46%N.

CHARACTERISTICS OF NITROGENOUS FERTILIZERS

✓Highly soluble in water.

✓Highly mobile in the soil hence it is applied as a top dress.

✓Easily leached because of the high solubility hence does not have residual effect on the soil.

✓Has scorching effect on young crops during wet seasons.

✓Easy to volatilize during hot season.

✓They have a tendency to cake under moist conditions.

✓They are hygroscopic hence should be stored in dry conditions.

PHOSPHATE FERTILIZERS

Examples;

✓Single super-phosphate; Appearing whitish, creamy white granules, containing 20-21 % P, O5

✓Double super-phosphate; Appears dark greyish granules, containing 40-42% P205

✓Triple super-phosphate that are small greyish granules, containing 44-48% P205

CHARACTERISTICS OF PHOSPHATE FERTILIZERS

✓Has low solubility and immobile.

✓Non-scorching.

✓Has a high residual effect hence benefit the next season's crop.

✓Easy to store because they are not hygroscopic.

POTASSIC FERTILIZERS

Examples;

- ✓Muriate of Potash (KCI);Contain

60 - 62% K10, Slightly hygroscopic and amorphous white.

- ✓Sulphate of Potash (50% K10)

CHARACTERISTICS OF POTASSIC FERTILIZERS.

- ✓Has moderate scorching effect.
- ✓Moderately soluble in water.

COMPOUND OR MIXED FERTILIZERS

These are fertilizers which supply 2 or more of the macronutrients. Examples includes; Di-ammonium phosphate, NPK20:20:20, 23:23:23, CAN etc.

Advantages of application of compound fertilizers

- ✓Saves time and money.
- ✓Mixture gives improved storage properties and better handling.

Disadvantages of compound fertilizers application

- ✓Expensive.
- ✓Wasteful.
- ✓Mixing may not be thorough.

✓Incompatibility of the individual fertilizers.

METHODS OF FERTILIZER APPLICATION

✓Broadcasting; fertilizers are randomly scattered using hands or machines

✓Top dressing; fertilizers are applied to the soil after full crop establishment

✓Side dressing; fertilizers are placed a few centimeters on the side of the crop

✓Ring placement; a ring is made around the crop and fertilizers are applied in it.

✓Spot application; particular sites are chosen and fertilizers are applied in them next to the crop

✓Foliar application; fertilizers to be applied are dissolved in water and sprayed to the crop leaves

✓Plough sole method; fertilizers are applied at ploughing and mixed with soil as ploughing takes place

✓Fertigation; in areas where irrigation is done fertilizers are mixed with irrigation water and applied together

✓Band placement; fertilizers are applied between rows of crops in bands

✓Contact placement; fertilizers are put together with seeds in the planting hole at planting time

FACTORS THAT INFLUENCE THE METHOD OF FERTILIZER APPLICATION

✓Level of soil fertility; broadcasting is used when the soil is fairly fertile

✓Amount of fertilizers available; band placement is used when the quantity of fertilizers is low

✓Type of root system of the crop; Broadcasting is used when the crop that is to be grown has spreading roots

✓Crop arrangement within the field; band placement is used when the crops are planted in rows

✓Solubility of the fertilizer; soluble fertilizers are applied using fertigation method

✓Kind of fertilizers; fertilizers containing phosphorus and potassium are not broadcasted since they can be rendered useless

✓Ease of fixation; phosphatic fertilizers are applied using contact placement since they can easily be fixed

✓weather conditions; in hot weather volatile fertilizers are placed near the rooting zone

✓stage of development of the crop; fertilizers that are to benefit young crops are applied using side dressing because at that stage the crops have a narrow root zone

✓Cost of the fertilizers; cheap fertilizers are applied using broadcasting

✓Availability of labor; where labor is scarce, fertilizers are applied using broadcasting

✓Size of land; ring placement is used when the piece of land is small

FACTORS THAT INFLUENCE CROP RESPONSE TO FERTILIZERS

✓Age of the crop/stage of crop growth; young crops respond better to fertilizers than very old crops

✓Texture of the soil; coarse textured soil has poor adsorption nutrients and encourages leaching and therefore leads to poor response to fertilizers

✓type of soil; clays soils encourages fixation of nutrients making them unavailable

✓Ph of the soil; extreme soil ph reduces crop response to fertilizers

✓Method of placement of fertilizers; fertilizers applied near the crop roots are well responded to by crops

✓Amount of water of water in the soil; water helps to dissolve nutrients and therefore when it is present in sufficient quantities, crops respond better to fertilizers

✓Amount of fertilizers applied; response is high when adequate quantity of fertilizers is applied to the soil

✓Rooting habit of the crop; crops with spreading roots respond better to fertilizers since the wide roots can easily absorb the fertilizers

✓Amount of biochemical activities in the soil; when activity is high, crops respond faster to fertilizers since some microbes carry out nutrient transformations making nutrients more available

✓Health of the crop; normal crops respond better to fertilizers as compared to those which are diseased

✓Level of weed infestation; weeds reduce crop response to fertilizers by causing competition for nutrients

✓Solubility of the fertilizers; soluble fertilizers are highly responded to by crops as compared to those which are sparingly soluble

FACTORS WHICH INFLUENCE / DETERMINE THE CHOICE OF FERTILIZER/ MANURE TO APPLY BY THE FARMER

✓Soil analysis: This is important because it expresses the need and type of fertilizers

✓The types of fertilizers available; Different crops require specific nutrients and therefore the fertilizers available in shops should meet the above.

✓Price of a fertilizer, increases use of fertilizers by farmers is determined by the prices and the expected profits after use.

✓Management; The farmer's follow-up of the right application method and period of application affects the results achieved after use.

✓Knowledge and skills of the farmer; Farmers more informed about fertilizers can use more of it

✓Crop value; growing low value crops may not encourage the use of fertilizers since the cost may be higher than the yield expected

DETERMINATION OF FERTILIZER RATES

Contents of fertilizers are expressed as fertilizer grade or fertilizer analysis.

Fertilizer grade indicate the guaranteed minimum of the active ingredients (N, P205, K 20) in the mixture.

It is expressed as a percentage on a weight to weight basis or percentage by weigh

Example 10:20:0 means for every 100kg of the mixture there are 10kg of nitrogen, 20kg of P10 5 and 0kg of K20.

Example

A farmer was asked to apply fertilizers as follows; 60 kg/ha nitrogen (top dressing), 60 kg/ha P205 (in planting hole), 60 kg/ha K20. How much sulphate of ammonia (20%) would be required per hectare? How much double super-phosphate (40%) P2O5would be required per hectare? How much muriate of potash (50% K20) would be required per hectare?

Answer/Solution

- ✓ Sulphate of ammonia (SA) which gives 60kg/ha N

60/20 x 100 = 300 kg SA

- ✓ Double super phosphate (40%P2O5) which gives 60kg/ha P205

60/12 x 100 = 150 kg DSP

- ✓ Muriate of potash (60% K20) which gives 60kg/hK2O

=60/60 x 100 = 100 kg muriate of potash

Example

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A farmer was asked to apply fertilizers as follows: 200kg/ha of DSP (40% P205, 150kg/ha of muriate of potash (60% K20), 150kg/ha of sulphate of ammonia (20% N)

How much P205 did the farmer apply per acre?

How much K20 did the farmer apply per hectare?

How much N did the farmer apply per hectare?

ADVANTAGES OF USING INORGANIC FERTILIZERS

- ✓ They release and supply nutrients quickly in the soil
- ✓ Their application can easily be mechanized
- ✓ They contain a high concentration of nutrients as compared to organic fertilizers
- ✓ They are more convenient to handle
- ✓ They can be stored for a long period of time
- ✓ The nutrients added to the soil are known to the farmer
- ✓ They contain a known concentration of nutrients
- ✓ They can readily be obtained from the shops any time the farmer needs them
- ✓ They can be supplied using a variety of methods
- ✓ They are economical on a large scale

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PROBLEMS ASSOCIATED WITH THE USE OF INORGANIC FERTILIZERS

- ✓ They can easily be exhausted from the soil
- ✓ They can easily be leached from the soil due to their high solubility
- ✓ Their application can alter the soil ph
- ✓ They may pollute the environment especially water bodies as a result of erosion
- ✓ Their application requires some specialized skills
- ✓ They are generally more expensive to buy
- ✓ They are uneconomical on a small scale

ORGANIC FERTILIZERS

These are natural organic substances added to the soil enriched with nutrients. These include; organic mulches, green mature, compost manure, farm yard manure etc.

GREEN MANURE

These areobtained from legume crops grown on a piece of land and then ploughed into the soil at the early flowering phase.

They undergo decomposition to release plant nutrients. Such plants include; beans, g. nuts, clover, peas and desmodium species.

A good green manure plant should have the following characteristics;

- ✓Should be easy to establish.
- ✓Should have a high nitrogen content.
- ✓Should have a faster growth rate.
- ✓Must be highly vegetative to provide a good cover and a high organic matter.
- ✓Should rot rapidly.
- ✓Should be pest and disease free.
- ✓Should be easy to plough into the soil.

BENEFITS OF GREEN MANURE

- ✓Fixes atmospheric nitrogen into the soil since legumes are used.
- ✓Organic matter and humus content rises giving raise to multiplication of microorganisms.
- ✓Provides a cover to the soil thus control of soil erosion.
- ✓Reduces leaching of plant nutrients it absorbs the nutrients during its growth stages.

DISADVANTAGES OF GREEN MANURE

✓Most of the crops used as green manure plants are food crops and so most farmers are not willing to grow crops and then plough them back into the soil.

✓If the crops mature until they are hard and fibrous, may not be easily decomposed.

✓Sometimes green manure crops need a lot of water and leaves little for the next season.

✓Turning the green manure into the soil requires use of machines which is expensive.

✓The method is very laborious.

ORGANIC MULCHES

Materials used to cover the soils in crops. They occur in two forms;

✓Natural mulches such as coffee husks, straws, banana leaves, elephant grass, plant stalks etc.

✓Artificial mulches that are obtained from synthetic materials e.g. polythene materials.

ADVANTAGES OF MULCHING

✓Conserves soil moisture by preventing evaporation of water.

✓Controls soil erosion by reducing raindrop impact and the speed of surface runoff.

✓Increases on the quality of crop products especially in tomatoes.

- ✓They control soil borne diseases by reducing rainfall splash.
- ✓Decompose to form organic matter thus improving soil fertility.
- ✓Improves on soil structure.

DISADVANTAGES OF MULCHING.

- ✓Easily catch fire when dry.
- ✓Act as breeding grounds for pests and disease causing agents.
- ✓They are expensive to buy, cut and transport.
- ✓May encourage rapid weed growth.

FARM YARD MANURE

Also known as pen or kraal manure made from animal excretes i.e. cow dung and urine mixed with plant residues used in feeding and beddings of domesticated animals such as goats, pigs, sheep, fowl etc.

The materials are removed and heaped in a cemented floor shelter to reduce nitrogen loss as a result of volatilization and rain wash. And a layer of soil is added to accelerate decomposition before taking to the garden.

FACTORS AFFECTING QUALITY OF FARM YARD MANURE.

- ✓ They type of animal; non ruminants produce rich manure than ruminants.

✓ The type of food the animal eats; the richer the food in terms of protein and minerals the richer the manure.

✓ The type of beddings used in the animal house; the best materials are those that can absorb animal excretes e.g. cereals/ saw dust.

✓ The method of storage; heavy loss occurs if farm yard manure is exposed to sunshine and rain wash.

✓ Degree of rotting; the longer the manure is allowed to rot, the better its quality.

✓ Age of the animal; mature animals gives richer manures than young ones.

✓ Other factors include; degree of turning, thickness of beddings, degree of wetting etc.

COMPOST MANURE

Composting is the biological decomposition of plant residues, farm animal manure, kitchen refuse and left over foods under controlled conditions.

Once these materials are completely decayed the end product is called compost that's earthy, dark and crumby.

METHODS OF COMPOSTING.

i. THE PIT METHOD;

- ✓ In this method, materials are put in pits in the ground.
- ✓ Five pits, each of 1.2m by 1.2m are dug for a depth of 60cm.
- ✓ Materials are arranged in such a way that slow decomposing materials such as dry straws at the bottom.
- ✓ Followed by a thin layer of ash to supply mineral salts, then a layer of fast decomposing materials such as fresh grass and kitchen refuse.
- ✓ Artificial fertilizers such as phosphatic fertilizers are added to increase on the nutrient content and microbial activity.
- ✓ A layer of top soil or old compost manure follows to supply microorganisms that decompose the materials.
- ✓ These steps are repeated until pit 1 gets full. Then a stick is driven into the pit to monitor temperatures and adding water to the material.
- ✓ A layer of polythene may be covered to reduce leaching of materials.
- ✓ Then after 3-4weeks, materials in pit 1 are transferred to pit 2 for more 3-4weeks until pit 5.
- ✓ As materials are transferred from one pit to another, the empty pits are refilled to allow continuous production of manures.
- ✓ In pit 5, manures are ready to be taken to the garden.

ii. THE HEAP METHOD;

This method is similar to the pit method only that materials are heaped on the surface.

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Signs of a good compost.

✓The stick driven inside the compost pit should be hot

✓Steaming of the materials.

✓Sinking of the materials.

✓The materials should be dark in Colour.

✓The materials should have a good earthy smell as opposed to a bad smell which shows poor aeration.

ADVANTAGES OF ORGANIC MANURES.

✓They often contain all the nutrients required for proper plant growth.

✓Add humus to the soil thus increasing on water infiltration and drainage.

✓They improve on the soil structure.

✓Their decomposition rate is slow and so the residual effect is long and provides nutrients for a long time.

✓They buffer the soil ph.

✓They provide the activity of soil living organisms since they provide them with food and shelter.

✓They modify soil temperature since they produce humus which is dark.

✓They improve on the soil cation exchange capacity.

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DISADVANTAGES OF ORGANIC MANURES.

✓They require much storage space than artificial fertilizers.

✓Exposure to the elements of weather may cause a severe loss of nutrients.

✓They are bulky and thus difficult to transport.

✓It's difficult to determine the effects of the manure on the crop since they are slow releasing.

✓May be a health hazard to humans and animals if not properly treated before use.

✓May transfer pests and diseases to the field.

FACTORS AFFECTING SOIL FERTILITY.

✓Soil depth; fertile soils have to be of sufficient depth for root growth.

✓Soil drainage; soils that are fertile should be well drained and not water logged.

✓Aeration; the soil should be well aerated to provide enough oxygen for the plant root and soil living organisms.

✓Water holding capacity; the soil should be able to build enough water for the crop growth.

✓Availability of plant nutrients; fertile soils should have nutrients which must be in right proportion.

✓Soil pH; the soil should have a favorable pH to enable soil for proper growth of crops and living organisms.

✓Humus content; the soils should have a large amount of humus because humus provides large nutrients.

✓Free from pests and diseases; the soils should be free from pests and diseases which may hinder crop growth.

✓Should have a good soil structure that allows proper movement of air and water in the soil.

LOSS OF SOIL FERTILITY.

✓Through soil erosion that carries nutrients which are washed with soil.

✓Leaching of dissolved mineral salts with water deep into the soil profile beyond the root zone.

✓Removal of nutrients through continuous cropping.

✓Through deforestation that leaves soil bare and erosion power of rain water carries away fertile soil.

✓Excessive drainage that leads to loss of dissolved nutrients.

✓Change in the pH by misuse of some fertilizers that leads to death of some living organisms.

✓Monoculture that causes soil exhaustion and buildup of pests and diseases.

✓Development of soil hard pans a short distance below the soil surface of the soil.

✓Overgrazing that also leaves the soil bare exposing it to the agents of erosion.

✓Over cultivation that causes soil exhaustion.

MAINTAINING SOIL FERTILITY.

✓Proper drainage to reduce leaching and modify soil temperature and aeration.

✓Breaking hard pans to enable proper infiltration of water and root growth.

✓Removal of weeds to reduce competition between weeds and crops.

✓Mulching to conserve soil moisture, control erosion and smothering of weeds.

✓Control of pests and diseases for proper plant growth and proper nutrient utilization.

✓Crop rotation to control soil erosion, weeds and pests and diseases.

✓Addition of organic manures to the soil to improve on soil structure, soil life and adds plant nutrients.

✓Minimum tillage to maintain soil structure, reduces exhaustion of organic matter and controls soil erosion.

✓Bush fallowing to allow the soil to gain some of lost nutrients and structure. It also controls pests and diseases.

✓Practicing agroforestry that prevents soil erosion, recycles nutrients as well as providing organic matter for use by crops.

SOIL SAMPLING

Refers to obtaining of small quantity of soil that is representative in all aspects of the entire farm and taken to the laboratory for analysis.

IMPORTANCE OF SOIL SAMPLING

✓To determine the nutrient content hence find out the type of fertilizer to apply.

✓To determine whether it is necessary to modify the soil pH for a crop.

✓To determine the organic matter content of the soil.

✓To determine the amount of air in the soil.

✓To determine the water content in the soil.

✓To determine the capillary attraction in the soil.

✓To determine the structure and texture of the soil.

✓To determine the drainage for water retention in the soil.

METHODS OF SOIL SAMPLING

✓Transverse/ grid pattern; samples are selected from sites running diagonally from one corner to another of the field.

✓Zig zag/ random method; random choosing of sites to take samples.

Tools used include; soil auger, hand hoe, garden trowel, spade etc.

SOIL SAMPLING PROCEDURE

✓Determine the size of the land area where sampling is to be carried out.

✓Decide which method of sampling to be used i.e. transverse or zigzag.

✓Assemble clean tools and materials to be used during the process.

✓Choose and mark about 20sites for which you're going to take soil samples.

✓Clear the vegetation over the site.

✓Dig out soil at depths of 15-25cm using a soil auger.

✓Place the dugout soil in a clean container and mix thoroughly the soil to get a composite.

✓Dry the composite sample in controlled temperatures.

✓Take a sample from the composite and put it in a polythene bag or container.

✓Make two labels indicating the name of the farmer, location, type of farming, tastes required, dates sampled. One of the tag is placed inside the bag while another is tagged outside the bag.

✓Take or send the samples to a soil laboratory for testing.

Sites to Avoid include; Dead furrows, ditches, Swamps, near manure heaps, Ant hills, Under big trees, near fence lines or foot paths, previously burnt places.

SOIL AND WATER CONSERVATION

These are measures carried out by farmers to promote the efficient use and maintenance of soil and water in the growing of crops.

REASONS/ OBJECTIVES OF SOIL AND WATER CONSERVATION

✓To reduce soil losses by taking remedies against soil erosion

✓To reduce degradation of soil and vegetation

✓To maintain chemical, physical and biological soil properties

✓To reduce soil pollution

✓To maintain soil fertility

✓To sustain soil productivity

✓To lengthen soil productivity

SOIL EROSION

✓This is the removal /washing away of top soil by wind and running water or erosion agents.

CAUSES OF SOIL EROSION

✓Deforestation: trees are cut down on a large scale removing the canopy hence soil is exposed to the agents of erosion

✓Bush burning: this removes the vegetative cover there by exposing the soil to the agents of erosion

✓Overgrazing / overstocking: the vegetative cover is removed as the animals graze

✓Monocropping / cultivation: once crops is planted seasonally on land and land is cultivated continuously, this damage soil structure and the particles are easily carried away.

✓Ploughing up and down a slope: commonly in hilly areas where the speed of running water increases due to the gradient or slope.

AGENTS OF EROSION

Agents of erosion the major ones are;

✓**Water (surface run off):** carry large volumes of soil particles

✓**Wind:** strong wind with a high velocity or speed blows large volume of soil particles in form of dust

✓**Animals:** animals with hooves loosen the soil particles and carry them within their hooves

✓**Human activities:** deforestation, bush burning affects the structure and texture of soil hence encouraging soil erosion.

DANGERS / PROBLEMS OF EROSION ON ARABLE LAND

✓Leads to loss of soil fertility

✓Washes away crops /planting materials

✓Creates gullies that make movement of machinery difficult

✓Causes silting of water bodies

✓Causes pollution by washing chemicals to the water bodies

✓Create s land slides

✓Leads to spread of weeds

✓Leads to spread of pests

✓Leads to spread of water borne diseases

✓Control measures increase cost of production

✓Gullies created reduces the size of the land

✓Changes soil texture/structure

✓Lowers the water table

THE MAJOR TYPES OF SOIL EROSION

✓Rain drop/Splash erosion: erosion resulting from direct impact from rain drops on the soil particles.

✓Sheet erosion: thin top most fertile soil layers are carried away by surface run off

✓Rill erosion: small channels are formed on the surface as a result of too much surface run- off

✓Gully erosion: rills widen and deepen as a result of fast running water.

✓River bank erosion; river widens by running/ flowing water

✓Wind erosion: this is the type of erosion which occurs as a result of strong wind moving at a high velocity or speed over a large or open land

CATEGORIES OF SOIL EROSION

Soil erosion is broadly categorized in to two;

✓Geological erosion

✓Accelerated erosion

Geological erosion

✓This is the type of erosion that occurs naturally without man's influence on land i.e. it occurs where vegetation cover has not been removed

Accelerated erosion

✓This is the type of erosion that occurs as a result of man's interference with land. Man's activities like deforestation, over cultivation, over grazing etc.

✓Open up land or expose land and increase the rate of soil erosion

FACTORS THAT INFLUENCE THE RATE OF SOIL EROSION

✓Over cultivation, loosens soil particles thus increasing the rate of soil erosion

✓Mono cropping ,where crops may not give a good soil cover leads to increased rate of soil erosion

✓Deforestation leaves the land bare leading to increased soil erosion

✓Soil type ,loose /sandy soils are likely to be washed easily

✓Intensity of rainfall ;the higher the intensity of rainfall the higher the rate of erosion

✓Ploughing down slope; creates channels which increase the rate of soil erosion

✓Bush burning; leaves the soil bare increasing the rate of soil erosion

✓Vegetation cover; thick vegetation cover reduces the rate of soil erosion

ROLES VEGETATION PLAY IN SOIL AND WATER CONSERVATION

✓It reduces the impact of rain drops on the soil.

✓It reduces the speed of wind and so reduces erosion by wind.

✓The plant roots also have binding effect on the soil particles and so make them harder to erode.

✓It keeps the soil moist and heavy by reducing evaporation and so reduces wind erosion.

✓The plants add organic matter to the soil and this has a binding effect on the soil particles.

✓Some plants have strong roots which penetrate deeper into the soil and open up it increasing the entry of water into the soil and reducing surface run off.

✓It increases surface roughness and so reduces the speed of run off and its erosive energy.

✓Legume vegetation fixes nitrogen into the soil thus maintaining soil fertility.

✓They form shading effects which reduce surface evaporation thus conserve water below to the surface layers.

✓Dead foliage covers the ground and act as mulch.

✓Vegetation aids in water and nutrient recycling.

Roles played by mulching in soil and water conservation

(TRY TO ATTEMPT THAT QTN)

What are cover crops?

✓Cover crops are leafy crops that grow very close to the soil surface

CHARACTERISTICS OF A GOOD COVER CROP

✓It should highly vegetative and leafy

✓It should be drought resistant

✓It should be shade tolerant and therefore compatible as intercrop

✓It should preferably yield eatable grains

✓It should be resistant to pests and diseases

✓It should be easy to establish

✓It should be easy to eradicate from the field

✓It should be highly adapted to the local climatic conditions

✓It should be able to fix nitrogen

✓It should have a faster growth rate

EXAMPLES OF COVER CROPS

✓Beans

✓Ground nuts

✓Pumpkins

✓Water melons

✓Soya beans

METHODS OF SOIL AND WATER CONSERVATION

The methods of soil and water conservation are divided into two namely;

✓Cultural methods

✓Mechanical / physical method

CULTURAL METHODS USED IN THE CONTROL OF SOIL EROSION

✓Mulches are put on the soil surface which reduces surface run off and improve drainage

✓Crops are planted in rotation which cover the soil surface differently and reduces soil erosion

✓Leafy crops/cover crops are planted which form a dense cover on the soil surface reducing erosion

✓Manures are applied which bind the soil particles together and improves on water holding capacity there by reducing erosion.

✓Trees are planted/afforestation which provides a canopy that reduces the impact of rain drops that reduce on soil erosion

✓Intercropping reduces open spaces and crops provide good vegetative cover that protects the soil agents of erosion

✓Strip cropping as eroded soil is trapped by the strip under grass

✓Agro forestry as trees and crops vegetative cover on the soil surface reducing erosion

✓Pastures are planted that bind soil particles together, reducing surface run off

✓Trees are planted on the boundaries of the garden and acts as wind breaks that reduces the effects of wind erosion

PHYSICAL / MECHANICAL / NON CULTURAL METHODS USED IN SOIL CONSERVATION

✓Terracing; terrace are made or constructed on steep slopes to reduce the gradient and increase water infiltration

✓Contour plough; the furrow slices piled a cross the slope will trap soil as water flows down the slope

✓Construction of bunds; heap of soil are constructed across the slope to trap soil

✓Use of gabions or barrages; these are obstructions placed in water channels or trenches to trap soil in water as it flows

✓Diversion channels; these are water channels constructed on the raised part of a field to divert flowing water away from the garden

✓Deep plough; plough is done to sub soil to increase water absorption capacity of the soil

✓Absorption banks/pits; these are channels constructed a cross a slope to trap rain water with soil

✓Grassed water ways; vegetation or grass is planted in water ways so that soil can be trapped to reduce loss

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LAND RECLAIMATION

✓Land reclamation is the process of changing land that had been rendered agriculturally useless to land that is agriculturally productive.

OBJECTIVES/REASONS OF LAND RECLAMATION

✓To increase the size of land available for agricultural production

✓To increase land available for human settlement

✓To control pests and diseases by destroying their habitats

✓To provide and improve the environment suitable for farming

✓To reduce loss of soil through soil erosion thereby reducing land degradation

✓To allow utilization of soil in swamps, deserts, steep slopes etc

✓To control vectors so as to minimize human infections

✓To allow easy movement of agricultural machinery

DRAINAGE

What is land drainage?

✓This is the removing of excess water from land or soil in order to improve the conditions necessary for health crop growth

CAUSES OF WATER LOGGING

✓Excessive rainfall

✓Low evapotranspiration rate

✓High percentage of clay particles in the soil which reduces water infiltration

✓Development of impermeable layers on and within the soil

✓Poor land scape e.g. a valley or flat area

✓Excessive irrigation of the soil e.g. where flood irrigation is carried out

✓High water table within the soil

✓Shallow soil depth

✓Poor farm planning such as unplanned layout of farm buildings

SIGNS OF POORLY DRAINED LAND

✓Presence of water loving weeds

✓Presence water loving soil living organisms

✓Low levels of air in the soil

✓Presence of water flowing on the soil surface

REASONS WHY FARMERS DRAIN THEIR LAND

✓To enable the growing of a variety of crops

✓To promote the activities of soil living organisms

✓To expand agricultural land

✓To enable the use of machines

✓To control water borne diseases

✓To control animal parasites e.g. liver-flukes

✓To enable the utilization of labor throughout the year

✓To improve soil temperature

✓To improve soil aeration

✓To promote organic matter decomposition

EFFECTS OF POORLY DRAINED SOIL

PROBLEMS ASSOCIATED WITH POORLY DRAINED SOIL

✓It leads to flooding and submerging of crops, roads, building foundations and equipments

✓It causes poor aeration leading to suffocation of roots and important soil living organisms

✓Reduces soil consistence making the soil soft and unable to support buildings

✓Makes mechanization impossible on the farm

✓The soil becomes unnecessarily cold

✓It creates a good breeding ground for vectors

✓Causes soil erosion and leaching of nutrients

✓Interferes with free movement of farm animals and people

✓Increases disease incidences on the farm

✓Reduces the economic value and use of land

METHODS OF DRAINING LAND

✓The methods that can be used include:

Surface drainage: This is the removal of water from the surface of the soil by means of open ditches. Open ditches are used to remove excess (surface) water from low laying areas:-

Advantages of surface drainage

✓It is easy to notice the blockages and therefore corrected easily.

✓Open ditches are cheap to construct

✓There are less chances of leaching in this method

✓Does not dry out the soil completely hence preserving soil moisture

Disadvantages

✓They are more prone to gully erosion which may be destructive.

✓The ditches occupy good land which could have been used for crop growing.

✓They interfere with mechanical tillage operation and livestock improvement.

✓They are expensive to maintain

✓Leveling should be done before water can flow into the drains which may be difficult to achieve

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SUB-SURFACE (UNDER GROUND) DRAINAGE / TILE METHOD

✓This is where water is drained away from water logged areas through tiles or drain pipes laid underground:-

Advantages of tile method (sub-surface drainage)

✓It leaves the field free of surface obstruction

✓It does not encourage gully erosion as observed in surface drainage.

✓There is no need to level land to facilitate drainage.

Disadvantages of the tile method:

✓May lead to excessive leaching in areas with heavy rainfall

✓They dry out the land excessively at times and yet be in adequate during wet weather.

✓They are expensive and require skilled Labour to install.

✓They are easily blocked by roots of many perennial crops

SUB-SOILING DRAINAGE.

✓This is the removal of surface water logging caused by the build up of an impervious layer using a heavy cultivation with one or more times that can penetrate up to 90cm deep.The operation cracks and loosens sub soil especially under fairly dry conditions.

USE OF DEEP ROOTED PLANTS

✓Plants like eucalyptuses which have deep rooted that can penetrate impervious sub soil can be used in draining land.

FACTORS THAT INFLUENCE THE CHOICE OF DRAINAGE METHOD TO USE

✓Topography of the land; gently sloping areas are drained using surface drainage methods

✓Cost of the method; farmers prefer cheaper methods

✓The volume of water to be removed; where a large volume of water is to be removed, aerial pumping of water is done

✓Climate of the area; areas with high rainfall intensity require effective methods which can remove a large volume of water in a short period of time

✓Type of soil; areas with clay soil favor surface drainage

✓Economic returns expected; subsurface drainage is used when high economic returns are expected

✓Farmers preference; a farmer uses a method that he / she prefers

✓Possession of technical skills; farmers with adequate skills use subsurface drainage

✓Form of power to use; subsurface drainage is used where tractors are to be used when carrying out farm operations

✓Size of land; surface drainage works best on a small piece of land

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IRRIGATION

✓This is the practice of applying water artificially to the soil in areas where there is no rain or where rain is inadequate.

TYPES OF IRRIGATION

1. SURFACE IRRIGATION

✓This is the application of water over the surface of land. It may include the following methods:

✓Flood irrigation

✓furrow irrigation

✓Border irrigation

✓basin irrigation

- **Flood irrigation:**

✓In this method, water is applied by flooding flat areas. It is the most suitable areas in places with abundant and cheap water.

Advantages

✓Flooding can kill crop pests and diseases

✓It does not need the leveling of land.

✓Good for areas with abundant water supply

Disadvantages:

- ✓If the water flows fast, it may not infiltrate the soil.
- ✓Water logging and leaching of nutrients may occur
- ✓Surface runoff may cause soil erosion.
- ✓Little control of water supplied leads to wastage.
- ✓Excess water causes leaching

- **Furrow irrigation**

✓Here water is supplied to rigid land from a main source through supply canals. The excess water collected from the bottom of the field in drains which lead to a water way.

✓N.B. Crops are normally grown on ridges which must be carefully planned.

Advantages

✓Water infiltrates uniformly

✓This method is suitable for row crops such as cereals since furrows can be made in a row form

✓Can use poor quality water since there are no pipes to be blocked

Disadvantages

✓There is a danger of salt accumulation in the furrow more especially if the water contains salts.

✓It may encourage soil erosion

✓Excess water may cause leaching

✓Movement in the garden by machines is impeded

✓May require grading of land which increases costs of production

✓Sometimes enough water does not reach the end of the furrows.

- **Border irrigation**

✓In this method water from the supply canal is applied to the top end of strips of land which are divided by low earth bunds. Due to even grading of the land, the water flows in a regular uniform sheet down each strip wetting the soil as it advances.

- **Basin irrigation**

✓This is a system used on leveled land to irrigate orchards mainly. A basin is made either for each tree or group of trees depending on the soil conditions and surface slope.

✓The advantages of this system are that the Labour cost is low and it uses less water.

2. OVER HEAD / SPRINKLER IRRIGATION:

✓This involves supplying water just like natural rain. The system consists of a pumping unit which supplies water under pressure and it is sprinkled to the crops and soil.

Advantages

✓Water delivery can be matched with crop requirements.

✓Movement in the garden by machine is not affected.

✓It does not require the leveling of land hence reduce the costs involved in that.

✓It does not encourage soil erosion as observed in the surface methods of irrigation

✓Agricultural chemicals such as fertilizers pesticides and herbicides can be applied uniformly with the irrigation water.

✓Adapts to dry topography.

✓The system does not require special skills to operate it as seen in drip irrigation.

✓Can be integrated with several agronomic practices in the garden.

✓It is an idea method in sandy soils and hilly areas

✓Low maintenance costs.

✓There is adequate infiltration of water into the soil which is important in crop nutrients absorption.

✓Sometimes the high pressures of water from the irrigation system can kill pests.

Disadvantages:

✓The water droplets may have a hardening effect on the soil which hinders further water infiltration.

✓The system requires a high initial capital to install which may not afforded by the peasants.

✓Water does not tend to infiltrate very far into the soil more especially when pumped in small amounts.

✓There is a risk of salt accumulation around the root zone areas.

✓If the weather is windy, the application of water becomes uneven.

✓The system has been known as one way in which pathogens are spread in gardens (pathogens are diseases causing organisms)

3. DRIP / TRICKLE IRRIGATION

✓This is relatively new method of irrigating crops and is mainly used in the USA, Australia and Israel. Water is supplied through plastic pipes to each row of crop plants and a small nozzle allows water to trickle out and provides moisture around the plant roots.

Advantages

✓Water is delivered near the root area so that the crops the crops can get a good supply of water.

✓There is less chances of water evaporation and accumulation of salts as in overhead and surface irrigation.

✓The area between the rows in not invaded by weeds since there is no water supplied there.

✓It is a very economical way of using water since it involves less wastage.

✓Fertilizers can be mixed in the water and supplied to the crops.

✓Low pressure is required to pump the water through the system hence saving energy intake.

Disadvantages

✓It requires a high initial capital to purchase and install the requirement in this type of irrigation.

✓The system requires good quality water which cannot block the pipes.

✓It is unsuitable for steep and uneven areas

FACTORS THAT INFLUENCE THE CHOICE OF IRRIGATION METHOD TO USE

✓Economic returns expected; high value crops are irrigated using overhead irrigation methods

✓Availability of water; surface irrigation methods require a lot of water

✓Cost of installation and maintenance; farmers prefer cheaper irrigation methods

✓Availability of capital; farmers with adequate money use overhead irrigation

✓Size of the farm; sprinkler irrigation is the most effective for a large area

✓Form of power to use on the farm; sprinkler irrigation is used when machines are to be used in carrying out farm operations

✓Topography of the area; furrow irrigation is used when the piece of land is flat

✓Quality of water; overhead irrigation methods are used when the water to be used is free from obstacles

✓Soil type; drip irrigation is the most effective in areas that have sand soil

✓Possession of technical skills; farmers with adequate skills use overhead irrigation methods

✓Farmers preference; farmers with adequate skills use overhead irrigation methods

FARMING SYSTEMS

URBAN FARMING

This is any type of farming carried out in urban centers like towns, municipals and cities. Farming carried out in areas close to urban centers is called Peri - urban farming.It involves growing of annual crops and rearing animals

IMPORTANCE OF URBAN FARMING

- ✓Reduces urban poverty
- ✓Provides employment to urban dwellers
- ✓Provides food to urban people
- ✓Reduces pollution of urban centres through the use of wastes
- ✓Ensures supply of cheap fresh farm products
- ✓Improves nutrition amongst the urban dwellers
- ✓Ensures deity diversification for urban dwellers
- ✓Ensures supply of fresh fruits and vegetables to urban people
- ✓reduces costs of living in urban centres for practicing farmers

ADVANTAGES OF URBAN FARMING

- ✓Requires less initial capital
- ✓Short production cycle hence quick profits
- ✓Use of wastes ensures high yields per acre
- ✓There is ready market for produce
- ✓Reduces waste management costs in towns
- ✓Production costs are low when kitchen and other wastes are used as inputs
- ✓easy access to scientific practices and extension services ensures high yields

CHALLENGES TO URBAN FARMING

- ✓Limited space of production in urban areas

- ✓Easy spread of pests and diseases due to free movement of animals
- ✓Accidents to animals that loiter urban centres
- ✓Poor disposal of wastes from industries can pollute soils
- ✓Theft of produce due to limited supervision
- ✓Control of urban farming by urban authorities
- ✓limited support to urban farming by government and authorities
- ✓Easy spread of zoonotic diseases
- ✓It requires high initial capital
- ✓It requires intensive labor

Forms of urban farming

Micro gardens; these are small spaces where urban farming can be carried out. The farming can be carried in the following places

- ✓Around homesteads
- ✓In parks
- ✓Along roads
- ✓Along railways
- ✓School grounds
- ✓Hospital grounds

ORGANIC AGRICULTURE / ORGANIC FARMING

This is an agricultural production system that sustains the health of soils, ecosystems and people

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SUSTAINABLE AGRICULTURE: is the production of food fiber, or other plant or animal products using farming techniques that protect the environment, public health, human communities and animal welfare. Organic farming is a tool of sustainable agriculture

AIMS OF SUSTAINABLE AGRICULTURE

- ✓Satisfy human food and fiber needs
- ✓Enhance environmental quality and the natural resources base up on which the agricultural economy depends
- ✓Make the most efficient use of non-renewable resource and on farm resources
- ✓Sustain the economic viability of farm operations
- ✓Enhance the quality of life for farmers and society

CONSERVATION AGRICULTURE:

Is set of soil management practices that minimize the disruption of the soil structure, composition and natural biodiversity

PRINCIPLES OF ORGANIC FARMING

- ✓Promote the maintenance of plant health
- ✓Promote the maintenance and enhancement of soil life
- ✓Contribute to a high level of biological diversity
- ✓Produce products of high quality

- ✓Promote high animal welfare standards
- ✓Make responsible use of energy and natural resources
- ✓promote crop and livestock integration on a farm
- ✓Diversify farming system and crops

CHALLENGES TO ORGANIC AGRICULTURE IN UGANDA

- ✓Limited access to markets for the products
- ✓High incidence of pests and diseases that may not be handled using organic means
- ✓Climatic change that affects crop and livestock yields
- ✓Limited knowledge about organic farming amongst farmers
- ✓Limited government support to organic agriculture
- ✓Products are too expensive to the consumers due to high costs of production
- ✓Use of biological agents may be harmful to the environment

AGRICULTURE PRACTICES THAT ENHANCE ORGANIC FARMING / SUSTAINABLE AGRICULTURE/CONSERVATION AGRICULTURE

- ✓Use of manures to improve soil fertility
- ✓Growing pest resistant varieties of crops
- ✓Practicing minimum cultivation or no till of soil to conserve soil biodiversity and properties

✓Use of organic pesticides in pest control

✓Use of biological pest and weed control methods

✓Practice agro forestry to enhance biodiversity inside and outside the fields

✓Control of soil erosion to conserve soil structure

✓Practice crop rotation to maintain soil fertility and control pests and parasitic weeds

✓Carry out mulching to conserve soil moisture, maintain soil fertility and control weeds

✓Make and use biogas as a clean source of energy to conserve forests

✓Practice intercropping to control weeds

✓Produce legumes along other crops to maintain soil fertility

✓Proper integration of crops and livestock to reduce reliance on external inputs (integrated mixed farming)

✓Use drip irrigation that does not waste water

BENEFITS OF SUSTAINABLE AGRICULTURE / ORGANIC AGRICULTURE/ CONSERVATION AGRICULTURE

✓Reduces pollution to the environment by limiting the use of agro chemicals

✓Reduces occurrence of chronic diseases like cancer in humans by limiting use of agro chemicals

✓Reduces farm production costs hence high profits

✓May maintain pest population below economic injury levels

✓May reduce emission of Green House Gasses (GHG) hence controlling Global warming

✓Maintains and improves farm productivity for many years to come

✓Maintains and improves soil biodiversity for good health of soil

✓Conserves natural resources like wetlands and forests for future use

✓Crop products are more nutritious and healthy

✓It uses less energy in the process of production

✓Reduces environmental degradation

AGRICULTURAL PRACTICES THAT INTERFERE WITH THE ECOSYSTEM

✓Use of fertilizers that may alter soil pH

✓Irrigation that increases salts in soils

✓Clearing natural vegetation that emits greenhouse gasses contributing to global warming

✓Over cultivation that destroys soil structure hence soil erosion

✓Use of broad spectrum pesticides that kill pest predators and increase pests

✓Pollution of water bodies by fertilizers and pesticides causes death of fish and other aquatic organisms

✓Bush burning that increases greenhouse gasses and destroys soil organic matter

✓Use of GMOs that may have adverse effects on other organisms

✓Reclamation of swamps for agriculture that may interfere with their biodiversity and purification of water

INTEGRATED FARMING

It's a farming system where all enterprises on the farm support each other in the production process. For example in integrated farming involving crops and cattle, cattle may provide manure to crops as the crops residues are fed to cattle

Advantages of integrated farming

✓May require less inputs hence reducing production costs

✓Production per unit area increases as more enterprises are involved

✓Diversification of production guards against total failure

✓Reduces accumulation of wastes on the farm and environment

✓Ensures maximum use of farm resources for production

BIOTECHNOLOGY

Biotechnology is the manipulation of living organisms to produce goods and services useful to human beings. **Genetic engineering** (manipulation of genes in living organisms) and **Tissue culture** are tools used in biotechnology

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Application of biotechnology

- ✓Production of penicillin by bacteria
- ✓Use of fungus in wine production
- ✓Use of fungus in fermentation to produce alcohols
- ✓Use of microbes in decomposition to form manures
- ✓Use of rhizobia in nitrogen fixation
- ✓Use of bacteria in making yoghurt
- ✓Use of microbes in sewage degradation
- ✓Production of enzymes by some microbes
- ✓Production of hormones like insulin by some organisms
- ✓modification of fruit ripening and tuber shelf life
- ✓Production of vaccines for livestock
- ✓Modification of plant nutrient content
- ✓Repair of tissues and organs in plants and animals

GENETIC ENGINEERING

- It's a technique of choosing desired genes from organisms and moving it between organisms in a fast, accurate and efficient manner . It gives rise to **GMOs**

Genetically Modified Organisms (GMOs)-These are Organisms containing genes that have been artificially inserted into them other than acquisition through a natural process

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Benefits of Biotechnology and genetic engineering

- ✓Reduces wastage of pesticides
- ✓Improves quality of food
- ✓Reduces cost of production in agriculture
- ✓Ensures reduced use pesticides hence control of environmental pollution
- ✓Ensures good health due to healthy eating
- ✓Improves appearance and taste of crop products.
- ✓reduces time taken in breeding process
- ✓improves profitability of farming
- ✓Increasing crop and animal yields
- ✓Increasing flexibility in crops
- ✓Improve nutritional values of crops
- ✓Increases ability of some plants to remove toxins from soil
- ✓Reduces post-harvest losses in crops
- ✓Can eliminate allergies in crop products
- ✓May increase herbicide tolerance in some crops

TISSUE CULTURE

Is the use of plant tissue or cells in multiplication and propagation of crops. Plant tissues or cells are developed into new plants under

controlled conditions in laboratories. The tissue comes from a single parent hence tissue culture can be another form of **cloning**

Challenges to using GMOs / Genetic engineering in agriculture

✓Poor management of the genetic engineering process can affect the environment

✓Modification of genetic material may lead to loss of some species

✓Genes produced can be a problem in nature as some genes are lost

✓It's an expensive technology

✓The modified genes can turn invasive and aggressive to other indigenous species

✓There are some unforeseeable dangers of GMOs

✓Introduction of genes by transformation disturbs the natural genetic balance or order

✓There are ethical issues associated to joining crops and animal genes

✓GMOs may have negative effects on pollinators

✓Genetic erosion may occur as indigenous genes are replaced by new genes

✓The technology is very sophiscated hence requires expensive equipment and high skills to be practiced

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PRINCIPLES OF CROP PRODUCTION:

The principle of crop production refers to the activities / practices that govern crop production to ensure proper growth and high crop yield. These activities are; Seed bed preparation, Selection of planting materials, Crop spacing, Proper weeding of crop plants, Timely planting, Fertilizer application, Pest and disease control, Thinning, Use of recommended planting depth, Mulching, Irrigation, Earthing up, Gapping, Application of fertilizer and manure, Pricking out, pruning etc.

LAND PREPARATION

This is the preparation of land for planting. It includes;

Land clearing /Tillage.

REASONS FOR CARRYING OUT LAND PREPARATION

- ✓ To kill weeds by uprooting and burying them down or by exposing them to the drying action of the sun.
- ✓ To break the soil and improve water infiltration, aeration and ease root penetration.
- ✓ To facilitate secondary cultivation by clearing bushes and uprooting tree stumps.

✓ To break the soil hard pan that impedes root growth. Soil hardpan refers to the hard layer of the soil found below the soil surface.

✓ To kill pest and disease organism that may be in the soil by destroying their life cycle and exposing them to the surface for desiccation.

✓ To destroy the tree shade that cut off light supply to the crop plants.

✓ To mix the organic matter into the soil.

✓ To provide ideal condition for seed germination and plant growth.

✓ To bury the crop residues and organic matter and also increase the speed at which they rot.

✓ Helps in controlling soil erosion by improving on soil structure.

✓ To level the land for planting.

STEPS IN LAND PREPARATION.

1. **Land clearing:** This involve clearing bushes, cutting down trees and removing tree stumps, roots and stones from the ground before actual cultivation.

IMPORTANCE OF LAND CLEARING.

- ✓ It eases movement of machinery and animal during cultivation.
- ✓ To kill weeds.
- ✓ To remove obstacles that damage tyres and destroy the blade of implements.
- ✓ To facilitate primary cultivation.
- ✓ It also act as a basis for land reclamation.

Land clearing can be done through slashing of bushes, controlled burning, cutting down trees, digging out tree stumps, digging out ant hill, removing of stones from the ground etc.

2. Tillage (Land cultivation): This is the act of breaking / digging out soil using various implements before the crop is planted.

METHODS OF TILLAGE OPERATION:

1. Primary tillage / cultivation. This is the initial stage of seedbed preparation. Seedbed is the land that has been prepared well enough for planting crops. The implements / tools for primary cultivation include;

Ox-plough, disc plough, a mold board plough, a sub- soiler, rotovator.

IMPORTANCE OF PRIMARY CULTIVATION

- ✓ To control pest by destroying their life cycle and exposing them to the surface for desiccation.
- ✓ Controls weed growth by damaging their roots.
- ✓ It helps in improving porosity of the soil and drainage.
- ✓ It eases secondary cultivation.
- ✓ Breaks the soil hard pan that prevents water infiltration.
- ✓ Helpsinburyingsurfacevegetationandcropresiduesfromthepre viousseason.
- ✓ Exposes lower soil layers to weathering agents.

2**. Secondary tillage /cultivation.** This is the second operation two weeks after primary cultivation to make the soil ready for planting. The time gap of two weeks is to allow the weed seeds buried during primary cultivation to germinate and hence be killed at their early stage of growth by secondary tillage.

IMPORTANCE OF SECONDARY CULTIVATION.

- ✓ Helps in leveling land for planting
- ✓ It controls weeds by destroying them at their early stage of growth.
- ✓ It creates a suitable soil condition for seed germination.
- ✓ It mixes well the rotten plant materials (organic matter).
- ✓ Mixes fertilizer with the soil.

The tools for secondary cultivation include; Rake, rollers, hand hoes, rotovator etc.

FACTORS THAT INFLUENCE THE CHOICE OF TOOLS AND IMPLEMENTS TO BE USED INCULTIVATION.

- ✓ Soil condition: Hard soil condition like dry soil requires the use of mold board plough and disc plough while light soil requires hand hoes.
- ✓ Soil type: Heavy / sticky soil like clay can easily be cultivated by disc plough while sandy loam soil can be worked upon by hand hoes and ox-plough.
- ✓ Topography: Steep slope does not favor the use of tractor trailed implements like moldboard plough since tractor cannot move on hilly land. Flat land encourage the use of tractor while hilly areas can be cultivated by hand hoes.
- ✓ Nature of surface vegetation: Thick vegetation limits the use of hand hoes and ox plough while moldboard plough can easily crush on tall and thick vegetation. This is because tractor can easily roll through without blockage.
- ✓ Availability of capital: Tractor is expensive to peasant farmers making hand hoes to dominate farming operation.

- ✓ Availability of skilled personnel: Tractor trailed implements e.g. Moldboard plough, disc plough etc. requires skilled personnel to operate unlike hand hoes which does not require much skills to handle.
- ✓ Land tenure system: Fragmented land does not favor tractor trailed implements since tractor cannot move in sub-divided land. Such areas need hand hoes while trailed implements operate best on extensive land.
- ✓ Conservativeness: This limits the use of mechanized equipment by farmers especially in north eastern part of Uganda. This makes farmers to continue using indigenous tools for cultivation e.g. Hand hoes.

FACTORS THAT DETERMINE THE NUMBER / FREQUENCY OF SECONDARY CULTIVATION.

- ✓ Physical condition of the seedbed after primary cultivation: Rough seedbed requires more operations than smooth seedbed.
- ✓ Size of the seed to be planted: Small seeds e.g. will require a finer seedbed than lager seeds like maize seeds. This is because small seeded crops need a fine tilt for smooth establishment during germination.

- ✓ The types of weeds to be controlled: Rhizomatous weeds like couch grass, spear grass are difficult to control and therefore require more cultivation to effectively remove the rhizomes from the soil.
- ✓ Soil texture: Light soil break easily hence requiring fewer operation than heavy soils.
- ✓ Amount of organic matter: Densely vegetated land e.g. sugarcane trash requires more operations than light vegetated land.
- ✓ Moisture content of the soil: Wet soil does not need to be over worked on since it creates puddle which destroys soil structure hence fewer operations.
- ✓ Liability to erosion: If the soil is liable to erosion, less operations is required e.g. on hilly areas.

METHODS OF PREPARING SEEDBED.

1. Hand method: This involves the use of hand hoes, panga etc. and the power is provided manually by man.

ADVANTAGES OF HAND METHOD.

- ✓ It is not expensive
- ✓ No special skills is required
- ✓ Tools are reliable
- ✓ It create employment opportunity

- ✓ It is flexible i.e. can be used to perform varieties of farm operations.

DISADVANTAGES OF HAND METHOD.

- ✓ It is slow in performing farming operations.
- ✓ It operate to a limited depth
- ✓ It is in efficient on hard piece of land.
- ✓ It cannot work properly on thick vegetated land.
- ✓ It can only cultivate a few acreage of land per day.
- ✓ It delays planting program since it is slow.
- ✓ It is expensive over large garden.

2. Mechanical method: This involve the use of motorized machine e.g. Tractor.

ADVANTAGES OF MECHANICAL METHODS OF LAND PREPARATION.

- ✓ The method is fast
- ✓ Large acreage of land can be cultivated per day.
- ✓ It encourages timely farming operations e.g. timely planting.
- ✓ It is effective in hard soil condition.
- ✓ Increases depth of penetration of the plough which improves on drainage.
- ✓ It is effective under thick vegetation cover

- ✓ It is more economical than hand method on large garden.
- ✓ It releases labour to do other farming operation since the use of tractor requires only one person.

DISADVANTAGES OF MECHANICAL METHOD

- ✓ Machines are expensive to buy.
- ✓ It requires technical skills to operate.
- ✓ It creates unemployment.
- ✓ It may lead to soil capping if use intensively. Soil cap is hard layer formed on soil surface due to intensive movement of machine on the land, over grazing etc.
- ✓ Exhaust fumes produced may pollute the environment.
- ✓ Maintenance costs of machinery are high which discourages farmers.

MINIMUM TILLAGE: This is a crop husbandry practice where seedbed is prepared with a little disturbance on soil surface. Minimum tillage is done by;

- ✓ Use of herbicide to kill weeds from the garden where crops will be planted.
- ✓ Mulching the area to suppress weed growth.

- ✓ Digging planting holes for planting and the rest of the land is undisturbed.

IMPORTANCE OF MINIMUM TILLAGE

- ✓ It maintain soil structure
- ✓ It reduces cost of production on the farm since only a small areas need to be cultivated.
- ✓ It conserves soil moisture
- ✓ It also minimize on the death of soil living organism since less are exposed on soil surface.
- ✓ It maintains soil aeration by minimizing on soil compaction.
- ✓ It reduces surface run off thus controlling soil erosion.

PLANT PROPAGATION

Propagation is a way in which plant population is increased by allowing plants to reproduce themselves.

Plants are propagated into two main ways i.e.

- Seed propagation
- Vegetable propagation

Treatment of planting materials

- Seed dressing –coating seeds with pesticides e.g. copper Sulphate.
- Chitting or encouraging sprouting e.g. in potato seeds.

- Inoculation, usually done legumes where seeds are coated with right bacterial for nodule formation.
- Hot water treatment against viral diseases e.g. in sugarcane and cassava.

SELECTION OF PLANTING MATERIAL

In order for a farmer to reduce the expenses the need to select the planting material that he is sure of.

CHARACTERISTICS OF A GOOD PLANTING MATERIAL

✓ Should be readily available within locality to reduce transport expenses and time wasted in looking for it.

✓ It should be pest and disease free to reduce the transmission of such diseases and pest to the seedling.

✓ It should be easy to transport i.e. should not be bulky.

✓ In case of seeds should be of uniform size and shape to allow easy mechanization during planting.

✓ It should be easy to store so that it can use in future when needed.

✓ In case of seed they should have passed the dormancy stage.

✓ The planting material should be highly viable to reduce the costs involved in filling up the gaps where they did not germinate.

✓ Seeds should be of uniform colour to allow easy sorting and planting.

- ✓ The planting material should be of high proven performance give high returns once planted.
- ✓ Materials should be free from contamination by weeds.
- ✓ Should be free from mechanical damage.
- ✓ In case of seeds, should be large enough.

VEGETATIVE PROPAGATION

This is the reproduction of plants from plants part that are not associated with reproductive organs.

ADVANTAGES

- ✓ The offspring is similar to the parent in all ways hence preserve good mother characters.
- ✓ Off springs grows faster and mature early.
- ✓ Off springs are strong and hardly compare with seedling obtain from seeds.
- ✓ Vegetative propagation is the best way for propagating plants with no viable seeds.
- ✓ Daughter plants obtain food from their parents until they are sufficiently strong hence increasing chances of survival.
- ✓ multiplication of the plant population is faster
- ✓ over comes the problem of prolonged dormancy in some seeds

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DISADVANATGES

✓ It may cause overcrowding due to the ability to establish quickly and grow fast.

✓ It may cause overcrowding due to the ability to establish quickly and grow fast.

✓ The planting materials are quite bulky and therefore difficult to handle store and transport.

✓ Due to their high moisture content vegetative materials are difficult to store.

✓ Some vegetative methods of propagation are complex and hence need a lot of skill to execute.

✓ A small hectare can be covered during planting as compared to seed propagation.

FORMS OF VEGETATATIVE PROPAGATION

✓ Stem tuber: This is a swollen underground stem with buds that can develop in to a new plant when used e.g. Irish potatoes, Sweet potatoes.

✓ Suckers: These are plants that develop from the mother plant below the ground level and can be used for planting. It is common in banana

✓ Splits: These are individual shoots that develop in tillering plants especially grasses e.g. Guinea grass, sorghum, etc.

✓ Bulbs: These are underground stem with modified leaves to store food and between the modified leaves are auxiliary buds which grows into a new plant e.g. onion, Gallic etc.

✓ Rhizomes: These are underground stem with nodes and internodes which stores food and are capable of germinating into new plants e.g. Couch grass, spear grass etc. Runners: These are horizontal succulent stem growing above the ground surface producing adventitious roots and new plants at their nodes e.g. in Wandering Jew, sweet potatoes, pumpkin etc.

✓ Corms: These are vertical underground stem with short internodes with scaly leaves. They can be used as planting materials e.g. in Cocoyam.

✓ Crowns: These are vegetative structure which are particularly found on top of a pineapple plants and establishes slower than the suckers when planted.

✓ Bulbils: These are tiny plants produced in the inflorescence at the end of plant's life cycle e.g. in Sisal, nut grass etc.

✓ Stolon: These are horizontal creeping stem above the ground modified to store food e.g. in Star grass.

✓ Root tubers: These are swollen underground roots which can be used for planting e.g. in Sweet potatoes.

✓ Cuttings: These are portion or part of plant that may be cut and use d for multiplying plants e.g. stem cuttings in cassava, sugarcane and root cuttings in guava, apple and spear grass.

✓ Some cuttings are planted directly in to the soil e.g. cassava, sweet potatoes while others are delicate and has to be put in the rooting medium to encourage rapid rooting. The rooting medium includes sand, sawdust soil etc. The rooting medium is first sterilized to avoid infection by soil pathogens.

FACTORS THAT AFFECTS ROOTINGS OF CUTTTING.

✓ Temperature; cool to warm temperatures around the roots promotes rooting because of reduced transpiration. For most species optimum day and light temperatures for rooting are 22 -27°c and 15-21° c respectively.

✓ Oxygen supply; the rooting process requires ample supply of oxygen for respiration to release energy.

✓ Light intensity; soft and herbaceous plants need more light intensity for synthesizing carbohydrates. Hard wood cuttings do well in dark conditions since they have high amount of stored carbohydrates and therefore rooting is excellent in darkness.

✓ Relative humidity; high relative humidity prevents desiccation and encourages rooting.

✓ Leaf area; Soft woods cuttings require a lot of leaves for photosynthesis while hardwood cuttings will produce roots better without leaves.

✓ Chemical treatment; rooting hormones such as indole acetic acid, indole butyric acid promotes rooting in cuttings.

Common rooting hormones includes;

IAA (Indole Acetic Acid)

IBA (Indole Butyric Acid)

NAA (Naphthalene Acetic Acid)

GRAFTING

This is where two different stems are united in woody plants. The upper part of the union is called a scion while the lower part is called a stock.

PRINCIPLES OF GRAFTING

For successful grafting, there are about five principles which must be adhered to;

✓ Compatibility – The scion and stock must be related or close to facilitate sexual hybridization.

- ✓ Cambial alignment – The cambium of the scion and root stock should be aligned for the union form.
- ✓ Timing of the grafting operation – Grafting must be done at a time when the root stock is in a proper physiological state.
- ✓ Avoiding desiccation – After grafting operation make sure that all the surface is sealed off using wax or grafting tape around the joining
- ✓ Pressure – Apply a pressure after aligning the cambium of the root stock and scion such that the xylem stays in contact.

REASONS FOR GRAFTING PLANTS

- ✓ It changes the tree top from being undesirable to desirable
- ✓ It makes it possible to grow more than one fruit or flower in the same plant.
- ✓ Root stocks with desirable character like disease resistance, problem of water logging are used which may be beneficial to the scion and farmer.
- ✓ It helps to propagate clones that cannot be propagated by any means.
- ✓ It helps propagating special plants form e.g. seedless oranges.
- ✓ Helps in change variety for more especially when the acid
- ✓ Virus indexing – Plants having viral infection with no signs will show signs when grafted.

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STEPS FOLLOWED WHEN CARRYING OUT GRAFTING

✓ Select a seed from a mother that is vigorous and well adapted to the soil condition to provide the root stock

✓ Raise the seed in a pot nursery

✓ A seedling is ready for grafting when the stem is pencil thick

✓ Select a dormant shoot from a mother plant with desired qualities and of the same species as the root stock to provide the scion

✓ Grafting should be done on a cool day or in a cool environment

✓ Use a sterilized razor blade to cut the scion and the stock

✓ Make matching cuts on both the scion and the stock

✓ Remove all the leaves from the scion to reduce transpiration

✓ Join the scion to the stock making sure that the cambium tissues of the scion and the stock are in contact

✓ Tie the joint with grafting tape and apply grafting wax to prevent bacterial and fungal infections

✓ Keep the grafted plant in a cool humid environment and away from wind until buds start to grow

✓ Remove the grafting tape after the joint has healed and then transplant to the main

LIMITATION OF GRAFTING

✓ Incompatibility – this failure of grafted material to survive due to a difference in genetic constitution.

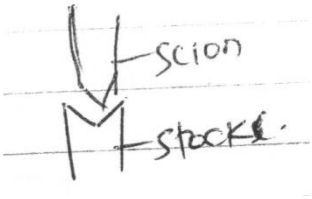
✓ Requires a lot of skills and experience for successful grafting to occur.

✓ Requires a lot of time for tangible results to be got.

METHODS OF GRAFTING

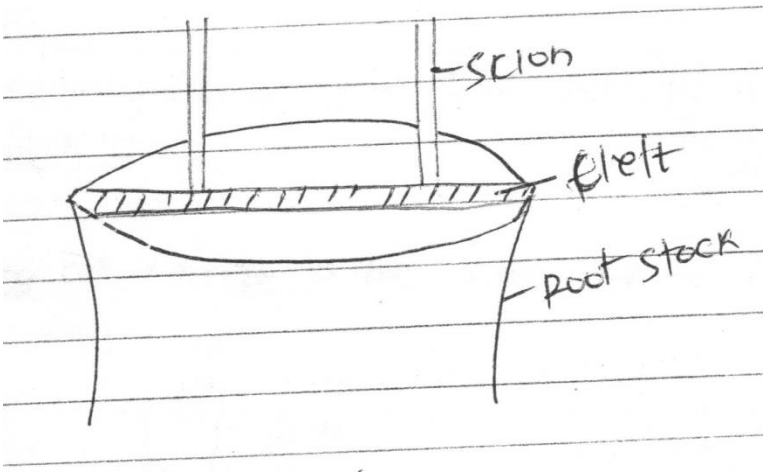
1. Top Wedge

A cut surface of the scion forms a wedge that is inserted into a vertical slit on the root stock that has been slash.



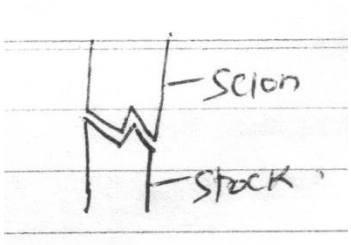
2. Cleft Grafting / Top working.

This involves grafting a scion into a canopy of a relatively large established tree.



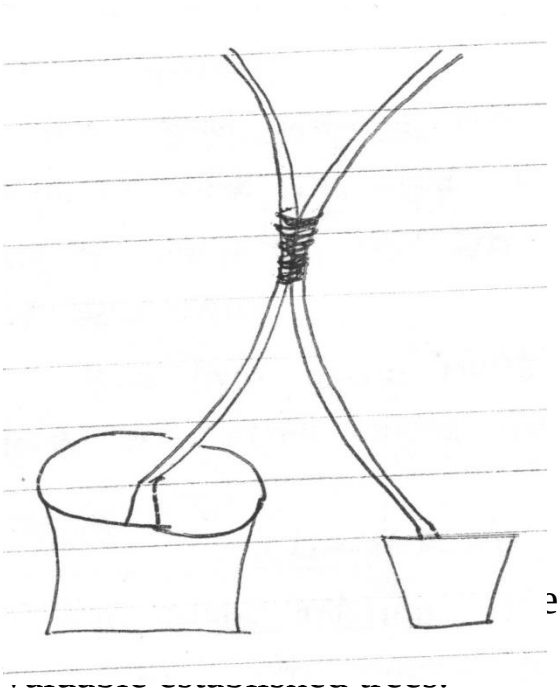
3. Whip and tongue grafting

This is done if the root stock and scion have the same dimensions. A stanty cut is made at the base of the scion top of the root stock. The two are fitted together and waxed



4. Approach grafting

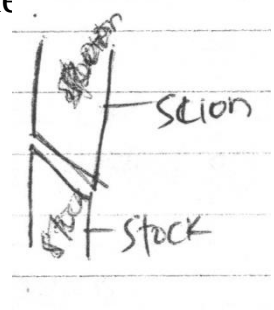
Here both the scion and stock remain attached to another plant until a secure union has been formed.



e free plant normally woody trunks of

6. Splice grafting

A long slanting cut is made in both scion and root stock which are later tied togethe



7. Bark grafting

The bark of the root stock is spit vertically and the prepared

BUDDING

This type of vegetative propagation the bud or scion is united with a seedling or a mature tree.

TYPES OFBUDDING

1. T-BUDDING

A t-Shaped cut is made on the back of the root stock and a bud is made on the back of the root stock and the bud fitted in

2. PATCH BUDDING

A rectangular piece of bud is cut of the root stock. A matching piece of bark with a bud is cut from the bud wood and matched into the prepared root stock.

3. TOP BUDDING

Buds from young plants are inserted at desired location on the stock and after setting the original branches are cut.

PROCEDURES OF BUDDING

- ✓ Select suitable tree species and get their buds and stocks.

✓ Make a T-cut on the stock and bark gently separated from the wood.

✓ Insert the bud into the T-cut

✓ The bud is bound on to the stock with polythene paper or tape to prevent water entry

✓ Apply wax or Vaseline on the outside of the wrapping to reduce bacteria or fungal entry.

✓ After two weeks remove the wrapping

✓ If the bud is green, then the process is successful and if the bud is brown the process is not successful.

✓ When the green bud produces the shoot, the end part of the root stock is cut off to reduce transpiration.

✓ The buds are then transplanted to the field.

LAYERING

This involves inducing a part of plant usually a branch to produce roots while still attached to the mother plant,

TYPES OF LAYERING.

1. SIMPLE LAYERING

This involves bending a stem and covering it with soil to produce roots.

2. TIP LAYERING

The whole shoot is bent and covered in the soil

3. COMPOUND LAYERING (SERPENTINE)

This is achieved by bending a stem several times and sometimes at a point of covering.

4. MOUNT / STOOL LAYERING.

A stem is cut just above the ground and the under shoot starts

5. TRENCH LAYERING

Here a trench is dug near the plant and a branch is layered on the trench to facilitate root development.

6. AIR / MACOTTING LAYERING.

The bark of a tree is open at a point and a wet mass is placed around the ring bar to keep it open. This stimulates root to develop at that point.

SEED PROPAGATION

This is where seeds of mature plant having desirable qualities are used for planting.

ADVANTAGES

- ✓ Seeds are not bulky and therefore are easy to handle and convenient to transport.
- ✓ They can be stored for a long time while retaining viability

✓ Seeds are easy to treat against pest and seed borne diseases

✓ Seeds are easy to use during machine planting.

✓ Seed planting is a quick method of increasing a crop population in a short period.

✓ Some crops are difficult to plant vegetatively.

✓ Plants raised from seeds have a longer life span than those raised vegetatively.

DISADVANTAGES

✓ Some seeds are delicate hence difficult to handle during planting.

✓ Seeds require special field preparation before planting more especially those with small seeds.

✓ The method may introduce undesirable in the plant population.

✓ Some seed may not breed true to type hence disappoint farmers

✓ The formation of seeds requires special condition during pollination and fertilization.

✓ Due to interference during pollination seeds may be formed but of a high degree of variability.

✓ Crops raised from seeds take a longer time to mature.

SEED SELECTION.

This refer to the process of choosing good quality seeds to be used for planting.

Qualities of a good seed for planting

✓ Seed vigor. The seed should be able to germinate freely over a wide range of environmental condition i.e. the seed should be strong enough to resist any climatic changes e.g. drought.

✓ Cleanliness. The seed should be free from any contamination by weed seeds which lowers its quality.

✓ Maturity. It should be matured enough with well-developed embryo in order to germinate quickly.

✓ Freedom from pest and diseases. The seed should be free from pest and disease since they reduces seed viability by eating up seeds.

✓ Size and shape. The seed should be large enough, larger seeds have large embryo and large food reserve which stores enough food for germination. Small sized seeds have low percentage of establishment once planted since the food reserve might get depleted before emergence of crop plants.

✓ Good genetic makeup. A good seed should be from a variety that is high yielding, resistant to prevent pest and diseases, high germinability and early maturing. It should have correct moisture

content. Some seeds require proper drying before they could be planted.

✓ The seed should be plumped enough i.e. it should be well filled since wrinkled seeds lacks the necessary food reserve for germination.

✓ It should not have mechanical / physical defect, this reduces seeds viability

✓ The seed should have a long shelf life i.e. should be stored for long without getting spoilt.

✓ It should not be dormant

✓ It should be picked from a healthy plants.

SEED VIABILITY / GERMINABILITY.

✓ Seed viability is the ability of seed to germinate if provided with all the necessary conditions after planting.

Conditions for seed germination.

✓ Suitable temperature

✓ Enough supply of water.

✓ Good internal conditions.

✓ Adequate supply of oxygen.

✓ Good physical and chemical conditions.

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Conditions which hinders seed germination /factors affecting germination Efficiency.

Germination Efficiency refers to the proportion of seeds that germinate out of the seeds planted.

- ✓ Physical damage to the seeds
- ✓ Shallow planting which expose seeds to pest and prevent seeds from obtaining enough moisture for growth.
- ✓ Deep planting which make the food reserve within the seeds to get depleted before germination.
- ✓ Immaturity of embryo.
- ✓ Pest and diseases also lowers seed germination.
- ✓ Good soil temperature is required. Very high and very low temperature reduces seed germination.
- ✓ Good soil aeration. Seeds need ample supply of oxygen to generate enough energy for germination process.
- ✓ Soil type. E.g. clay resists penetration of roots and establishment of shoot above the ground level.
- ✓ Soil moisture, good soil moisture is required.

Analysis of seed purity: This refers to the process of determining whether the purchased or processed seeds have got any contamination e.g. Weed seeds, other crop seeds etc. It is determined using the formula Percentage

Seed purity = Weight of seeds only*100%

Total weight of seed sample

MEASURES / WAYS OF INCREASING GERMINATION EFFICIENCY OF SEEDS.

- ✓ Proper drying of seeds before storage to reduce on the moisture content
- ✓ Maintaining optimum temperature within the seeds during storage to avoid seed dormancy.
- ✓ Proper seed bed preparation especially for small sized seeds to increase germ inability.
- ✓ Soaking the seeds in water over night before planting to soften seed coat and allow oxygen and water entry into the seeds.
- ✓ Proper seed treatment to control attack by pest and diseases.
- ✓ Soaking seeds in growth stimulants / hormones to stimulate growth.
- ✓ Pre chilling of seed with hard seed coat to ease entry of oxygen and water.
- ✓ Avoid storing seeds for planting for a long period of time.

METHODS OF TESTING SEED VIABILITY / GERMINATION TEST.

There are mainly 3 methods;

- ✓ The germination test method.
- ✓ The lackon technique.
- ✓ Using potassium permanganate solution.

i) Germination test.

- ✓ Get a sample of seeds from the seed lot you wish to plant
- ✓ Count a known number of seeds from a seed lot
- ✓ Plant the seeds
- ✓ Provide suitable conditions for germination
- ✓ Continue watering until the seeds germinate
- ✓ Calculate the viability i.e.
- ✓ Viability = $\frac{\text{No. germinated} \times 100}{\text{No. planted}}$
- ✓ If the percentage is above 70 the seeds are good for planting

ii) The tetrazolium test.

- ✓ Get a sample of seed from a seed lot
- ✓ Count a known number
- ✓ Soak the seeds in a tetrazolium salt test over night
- ✓ Remove the seeds from the solution
- ✓ Cut open the seeds to expose the embryo
- ✓ Observe for the Colour change of the embryo i.e. pink or red

- ✓ Count those with coloured embryos
- ✓ Calculate the viability i.e. viability = $\frac{\text{No. coloured} \times 100}{\text{No. planted}}$
- ✓ If the percentage is above 70 the seeds are good for planting
- ✓ N.B. tetrazolium salt is a colorless liquid

(iii) Use of potassium permanganate

Procedure

- ✓ Put a counted number of seeds in a beaker containing potassium permanganate solution.
- ✓ Heat the seeds in the beaker for some time to break the testa so that they can release the liquid in them.
- ✓ Potassium permanganate solution is usually purple in color and will get discolored if the seeds are viable.
- ✓ Note
- ✓ In this method, calculation of germination percentage is impossible because it is difficult to identify the seeds that release the liquid and those that have not.

Importance of testing seed viability before planting

- ✓ Seeds for planting are selected from the best seed lot
- ✓ Reduces on the expense of buying seeds which are not viable

- ✓ The correct seed rate can easily be determined. (Seed rate refers to the number of planting materials / seeds put in a hole)

THE MECHANISM OF SEED GERMINATION

✓ Imbibition: The initial stage in germination is absorption of water through the microphyl by osmosis.This is called imbibition and as a result, the embryo becomes hydrated and this activates the enzymes.

✓ Metabolisation of food reserve: This cause rapid transformation and expansion of food reserve i.e. the food reserves are broken / hydrolyzed into simple soluble products that can be moved to growing area e.g. Protein to amino acid by protease enzyme, starch to glucose by amylase, and lipids to fatty acid and glycerol by lipase.

✓ Translocation: The soluble products are translocated and used in respiration and synthesis of new tissues e.g. Glucose and amino acid for ATP production

✓ Cotyledon swells: Expansion of food reserved due to imbibition will also create pressure in the cotyledon of the seed making the seed coat to rapture there by allowing entrance of oxygen inside the seed; oxygen will increase on the necessary energy for germination process.

✓ Cell division and cell differentiation: The plumule and radical elongate out through the seed coat and develop into primary shoot system and root system respectively. Plumule emerge out above the ground due to rapid elongation of epicotyls, get exposed above the sun light and the formation of leave starts (primordial leaves) to aid photosynthesis.

SEED DORMANCY

This is the condition where seeds fail to germinate when provided with necessary conditions for germination

CAUSES OF SEED DORMANCY

- ✓ Thick/ hard seed coats which prevent entry of air/oxygen intake
- ✓ Mature embryos that need a period of rest to undergo certain changes before germination
- ✓ Shortage of growth stimulating hormone e.g. gibberellins
- ✓ Presence of seed coat hairs which interfere with oxygen absorption
- ✓ High temperature during seed maturity which may induce dormancy
- ✓ Germination inhibitors like abscisic acid

- ✓ Immature embryos which have not reached full development at harvest time.

METHODS USED TO BREAK SEED DORMANCY

- ✓ Seed extraction where seed are removed from the fruit when fresh and washed e.g tomato and orange seeds
- ✓ Scarification /breaking the hard seed coat by rubbing between sand papers
- ✓ Acid treatment where seeds are placed in concentrated acid 3-5 minutes, removed, washed and dried
- ✓ Cutting off the seed coat / hair to allow entry of air/water
- ✓ Chilling where seeds are soaked in cold water for some time before planting this softens the testa
- ✓ Soaking seeds in growth stimulating hormone like gibberellins.
- ✓ Exposing seeds to light as light increases the gibberellins in the seeds.

FIELD PRACTICES USED IN GROWING CROPS (THE AGRONOMIC PRACTICES)

1. Planting: This refers to the actual placement of seed in the nursery bed or the actual garden.

Note: Planting materials refers to any plant's part that is used to raise a crop e.g. seed or vegetative part.

Nursery bed refers to a small portion of land prepared for raising seedling before transplanting, it's always one meter wide with a length of any reasonable degree while a seed bed on the other side refers to a piece of land varying in size from hundred or even thousand hectares which has been prepared and ready to receive planting materials where they can grow up.

IMPORTANCE OF A NURSERY BED.

- ✓ Many seedlings can be raised in a small area.
- ✓ Makes it easy to carry out routine management practices.
- ✓ It provides the best conditions for growth e.g. fine tilt.
- ✓ Small seeds can be planted and raised into a form that can grow independently.
- ✓ Excess seedlings can be sold by the farmers for income.

FACTORS TO CONSIDER WHEN SELECTING SITE FOR NURSERY BED.

✓ Water source: It should be near permanent water source to facilitate watering, seedlings requires a lot of water at early stage of growth.

✓ Type of soil: The soil should be deep, fertile and well drained.

✓ Topography: Sites for nursery bed should be gentle slopping to avoid soil erosion and flooding.

✓ Security: the site should be well protected from wild animals, birds and thieves.

✓ Distance from home: Site for nursery bed should be near home stead since seedling requires intensive management by the farmer.

✓ Pest and diseases: The site should be free from pest and diseases.

METHOD OF PLANTING

There are basically two methods of planting crops i.e. broad casting and row planting;

Broad casting Method: This refers to random spreading of seeds as even as possible at the seed bed and then covered lightly with the soil.

Advantages of broadcasting seeds

✓ It saves time and labor

✓ It requires less technical skills

✓ If done carefully and skillfully, an even crop stands at correct spacing can be achieved

✓ In pasture management it allows over sowing without any damage to the existing plants

✓ Planting inaccessible areas is possible such as steep slopes and water logged soft soil where mechanical planting would be impossible.

Disadvantages of broadcasting seeds

✓ It is almost impossible to distinguish a crop like finger millet from closely related weeds in the young stages

✓ Use of machinery in farm tasks is almost impossible

✓ If done by inexperienced person it can lead to uneven crop stand

✓ Some seeds may fall and get buried in deep furrow thereby preventing germination of seeds

✓ Because seeds are left on the soil surface, they can easily be picked by birds, rodents etc

✓ Some seeds do not get good contact with moisture and so they do not germinate

Row / Line Planting: This refers to planting of crop seeds in line.

Merits of planting crops in rows / line planting

✓ It is easy to use machines in practices such as weeding, spraying etc

- ✓ It ensures optimum crop population in the field for greater yields
- ✓ It ensures maximum utilization of growth requirements
- ✓ It allows uniform placement of seeds at uniform depth which allows uniform germination
- ✓ It allows sufficient working space to the farmer when carrying out management practices
- ✓ It reduces wastage of seeds as in the case of broadcasting
- ✓ The plant population in the field can easily be established thus allowing estimation of the crop yield
- ✓ It makes weed control easy as farmers can easily differentiate weeds from crops

Demerits of row planting

- ✓ It requires more skilled labor than broadcasting
- ✓ It encourages soil erosion on steep slopes
- ✓ It requires more time as compared to broadcasting
- ✓ It reduces the crop population in the field
- ✓ The method is of little practical value for small seeded crops such as millet and wheat

FACTORS INFLUENCING THE PLANTING DEPTH OF THE PLANT

✓ The size of the seeds; large seeds because they have large seed reserves can be sown deeper than small seeds

✓ Soil moisture content; when the moisture content is high, shallow planting is done

✓ Light; crop seeds whose germination is facilitated by light are planted near the surface

✓ Type of soil; in light soils such as sand seeds are put deep into the soil to enable them to access water

✓ Weather conditions; during very hot weather, seeds are put into the soil to enable them access water

✓ Effect of pests; large seeds which are highly vulnerable to field rodents and insects should be planted deeper to prevent them from being eaten by rodents and insect pests

BENEFITS OF EARLY PLANTING

✓ Early planted crops have more water to utilize during their growing period

✓ There is a better soil condition i.e. aeration and temperature

✓ Early planted crops benefit from the nitrogen flush at the beginning of the rains

✓ The crops escape pests and diseases in the field as crops grow fast before the pest population increases

✓ Early planted crops escape weed competition in the field as crops grow fast and smother weeds

✓ Early planted crops are able to utilize better sun radiation

✓ It allows crop harvesting to coincide with the dry season. This reduces crop losses during harvesting due to bad weather

✓ Timely planting enables timely harvesting and marketing of the produce

✓ Early planted crops are able to utilize nutrients from the soil

✓ Early planting enables proper programming of the farm activities

2. Crop spacing

✓ Crop spacing is the distance between crops in the row and those between different rows.

FACTORS INFLUENCING SPACING OF A CROP

✓ Habit of growth; spreading crops need more space than non-spreading crops

✓ Time taken by the crop to mature; perennials need more space than annuals

✓ Size and space needed by the mature crop; close spacing is done if the mature crop require a small space

✓ Percentage germination; where percentage germination is low, close spacing is done

✓ Root growth habits; crops with spreading roots need bigger spacing

✓ Type of pollination; cross pollinated crops require close spacing as compared to self-pollinated crops

✓ Need to control diseases; in ground nuts close spacing controls ground nut rosette

✓ Moisture content of the soil; close spacing is used when the moisture content of the soil is high

✓ Purpose of the crops; crops that are grown to make silage or hay are closely space

ADVANTAGES OF PROPER CROP SPACING

✓ It allows use of machines on the farm to do activities such as planting, weeding and harvesting

✓ It controls pests and diseases of some crops e.g. in ground nuts close spacing controls ground nut rosette

✓ It controls the growth and establishment of weeds in the garden. Weeds are suppressed by crop cover and denied space for growth

✓ It allows ample working space during field practices such as thinning, pruning, fertilizer application and harvesting

✓ It allows optimum crop population in the field for maximum yields

✓ It allows sufficient utilization of soil moisture and nutrients

✓ It reduces competition for light and pollinators

3.**Seed selection and dressing:** Seed selection refers to choosing best quality seed to be planted so that they are able to grow into mature crops and give high yield while seed dressing is the coating / mixing of seeds with suitable strain of chemicals and pesticide to prevent attack and damage by storage pest.

4.**Use of recommended seed rate:** A seed rate refers to the quantity of seeds required per unit area of land. There are basically three type of seed rate on a farm;

- High seed rate

- Low seed rate
- Optimum seed rate

High seed rate: This is when a farmer plant more seed in an area than that which is recommended. It normally leads to;

- ✓ Overcrowding of crop plants
- ✓ Reduced crop yield due to competition
- ✓ Makes management of crop difficult e.g. weeding
- ✓ Reduced income due to poor quality.

Low seed rate: This is a situation where famers plant few seeds in a given areas. It normally results into low crop yield per given area but it increase individual yield of crop plants due to maximum use of nutrients for the crop plants.

Optimum seed rate: This is when a farmer uses the recommended quantity of seeds in a given area. Optimum seed rate promotes;

- ✓ High yields of crops
- ✓ Easy management of crop
- ✓ High income due to high quality yields from crop plant.

Note: A seed rate is mostly determined by the growth habit of the drop plants and the quality of the seeds used.

5. **Gap filling:** This is the filling of empty spaces where seed did not germinate or where seedling dried up after transplanting in the field to ensure optimum plant population. .It's done by replanting fresh seeds / seedling in the gap.

Gap filling has advantages of regulating plant population and filling empty spaces to a void wastage of land.

6.Thinning: This is the removal of excess seedlings usually weak ones from the planting holes some days after germination to leave correct spacing. Examples of plant that can be thinned are maize, cotton etc.

7. Pricking out: This is the removal of excess seedlings from the crowded area in the nursery bed.

8. Pruning: This is the removal of plant's parts which are less productive or unproductive all together e.g. injured or diseased branches of crop plants.

ADVANTAGES OF PRUNING.

- ✓ It facilitates easy management of crop plants e.g. spraying, weeding etc.
- ✓ It gives the plant proper shape and to control its growth.
- ✓ To control pest and disease by interfering with the cool micro climate which favours their survival.

- ✓ It also encourages healthy growth of crop plants by opening space for air circulation and light entry for photosynthesis.
- ✓ It economizes on the use of chemicals by reducing the surface area to be covered with chemicals during spraying.
- ✓ To control over bearing of fruits e.g. in mangoes and tomatoes.
- ✓ It gives a convenient height for workers for easy harvesting.
- ✓ To improve on the longevity of crop's productive life making the plant to produce regularly and yearly. E.g. in coffee.

9. Staking: This refers to the process of supporting weak stemmed plants above the ground to access sun light for growth. E.g. in passion fruit, tomatoes etc.

ADVANTAGES OF STAKING

- ✓ It exposes plants to get enough sun light for maximum yield.
- ✓ It improves on the quality of the fruits by removing them from contact with the ground.
- ✓ It reduces the incidence of pest and disease existing within the soil especially fungal disease.
- ✓ It facilitates easy management of crop plants e.g. weeding, spraying.
- ✓ It also promotes free air circulation between the plants.

- ✓ The quality of fruits is maintained since they are not trampled on by the farmers

10. Earthing up: This is the drawing of enough soil around the base of shallow rooted crops. Earthing up is common in cabbage, egg plants, onion etc. It's a common practice during weeding.

ADVANTAGES OF EARTHING UP.

- ✓ It prevents lodging of crop plants.
- ✓ It facilitates growth of prop roots especially in cereals that support the plants.
- ✓ The soil heaped prevents the roots from being damaged during weeding.
- ✓ It enables the plant to with stand erosion in case of runoff.
- ✓ It also creates suitable condition for bulb formation in onion.

11. Pest and disease control: Pest and disease should be effectively controlled as they lower the qualities of crop in the field.

12. **Application of manure** to enrich on soil nutrients for better yield.

13. **Irrigation:** This is the artificial application of water from are liable source to a dry land. It's done to maintain adequate moisture in the soil for better crop yield.

14. Drainage: This is done to remove excess water from the soil so as to create suitable for crop growth.

15. Mulching: This is the covering of soil surface using mulches to prevent it from excessive evaporation, control weed growth and soil erosion which lowers crop yield.

16. Timely weeding of crop plants to minimize on completion for nutrients with the crop plants.

17. Timely harvesting: Harvesting refers to removal of matured plant's parts from the parent plants. It's the climax of crop's productive life in the field. Crops should be harvested in time to reduce crop losses caused by insect pests, birds, thieves, rodents, shattering and germination of seeds from the garden.

The plant is considered mature when the reproductive parts has accumulated maximum dry matter or change in colour especially for fruits.

Effects of too early harvest.

✓ It leads to inadequate drying of produce due to high moisture content.

- ✓ Seeds harvested prematurely have poor quality i.e the seeds are deformed.
- ✓ It leads to reduced seed viability either due to immature embryo or accumulation of food reserve on the stem.
- ✓ It pre-disposes crop to pest attack due to soft testa.
- ✓ It's difficult to process plant produce especially threshing.

Effects of delayed harvest.

- ✓ Loses of produce due to splitting of pods, rotting of fruits and vegetable.
- ✓ It encourages buildup of pest and diseases.

18. Drying of crops: This practice is carried out especially on grain to obtain the correct moisture content for storage.

REASONS FOR DRYING OF CROP PRODUCE.

- ✓ It prevents produce from rotting and decay caused by fungi.
- ✓ To reduce insect damage.
- ✓ To prevent growth on crop plants.
- ✓ To maintain seed viability and quality.
- ✓ To reduce bulkiness of crops for easy transportation.
- ✓ To prevent germination of seeds in store.
- ✓ To allow easy processing of crop produce into other forms e.g. maize grain to maize flour.

- ✓ To prolong the storage period for crop produce.

19. Proper storage: This prevents spoilage of seeds caused by storage pest and it also make produce available for future use.

CHARACTERISTICS OF A GOOD CROP STORE.

- ✓ The store must be of good construction and rain proof.
- ✓ The store must always be clean, aerated and dry.
- ✓ It should be vermin proof.
- ✓ It should be securely located to prevent thieves.
- ✓ It should be treated against pest and diseases.
- ✓ The store must be raised off above the ground 50cm to prevent dampness caused by capillarity.
- ✓ It should not have any cracks on the surface or from the wall. This attracts pest.
- ✓ It should be thoroughly smeared before new crop produce are brought in.

MEASURES THAT CAN MINIMIZE CROP LOSSES DURING STORAGE.

- ✓ Proper drying of produce to approximate moisture content.
- ✓ Proper ventilation of the store to allow free air circulation and to prevent accumulation of heat.

✓ Carry out seed dressing before or during storage using suitable chemicals to control pests.

✓ Regular checking of stores should be done and avoid mixing old produce with new ones.

✓ Seal off all the cracks with motors / cow dung to destroy breeding ground for pest that destroy crops.

✓ Clean the store properly before introducing new crop produce in.

✓ Raise the store above the ground to avoid dampness.

20**. Processing**: This is the transformation of raw materials into final utilizable products. It includes activities like threshing, winnowing, sorting, grading and packaging the crop products.

REASONS FOR PROCESSING.

✓ To reduce bulkiness and make transportation easier.

✓ To reduce wastage due to spoilage.

✓ It adds values to crop produce by improving its quality.

✓ It converts products into a form that can be used easily e.g. maize flour from maize grain,.

✓ It prolongs the lifespan of crop produce making it available for long time e.g. milk.

HIGH VALUE CROPS:

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High value crops generally refer to non-staple agricultural crops such as vegetables, fruits, flowers, ornamentals, condiments and spices. Most high value agricultural crops are those known to have a higher net return per hectare of land than staples or other widely grown crops.

They therefore generally have a monetary value higher than staple crops in emerging and expanding local, national, regional and global markets. High value crops and products present an ideal opportunity for the poor in many developing countries to increase their income by participation in commodity value chains, provided there is effective vertical coordination to ensure that supply is in relative balance with demand.

ADVANTAGES/BENEFITS OF HIGH VALUE CROPS

- ✓ Used as food with nutrients like proteins, carbohydrates, vitamins, minerals, fat and water e.g cabbage, mashrooms etc
- ✓ Used as spices for spicing food eg, garlic, onions, pepper etc
- ✓ Used as medicine eg, mashrooms to treat diabetes, cancer etc
- ✓ Some provide antibodies like penicillin eg, mashrooms
- ✓ Some used in making dyes
- ✓ Some neutralize acidity in soils
- ✓ Contributes to sustainable agriculture by reusing agricultural wastes

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Assignment: outline the importance of mashroom growing among the farmers in Uganda

High value crops are categorized into;

a) **vegetable and spices** such as okra, garlic, cabbage, onions,Irish potatoes, vanilla and pepper.

Okra growing

Okra can be grown from 3-6ft tall. It's propagated by seeds. Sow the seeds 1cm deep in rows that are 3ft apart. Seed germination is seen in 2-12days. During planting, 2.5-3kg per acre of seeds may be used with a seedrate of 3.5kgs per acre.

Some varieties can reach maturity by 55 to 60 days from sowing when the pods have attained a mean length of 2-3inches. The crop is grown mainly for its green pods that double as seeds which are rich in vitamins A, B6 and C, iron, magnesium, potassium and fibers.

Garlic growing;

It's grown from individual cloves. Each clove will produce one plant with a single bulb. This may inturn contain upto twenty cloves and therefore self-sustaining.

When planting garlic choose a garden site that gets plenty of sun and where the soil is not too damp. The cloves should be planted

individually upright and about an inch under the surface. Plant the cloves about 4inches apart and 18inches rows.

Garlic should be harvested when half to three quarters of the bottom leaves have died or harvest a test bulb or two to determine maturity. While harvesting, loose the soil with ashovel or fork and pullup plants by hand with caution because garlic bruises easily.Garlic is mainly grown for its immune enhancing allium compound that appears to increase the activity of immune cells that fights cancer indirectly.

b) **Fruits**; that includes; pineapple, mangoes and gooseberry.

c) **Medicinal crops** such as moringa, neem, aloe era and Artemisia sp.

Aloe Vera is a succulent, almost sessile perennial plant with radically arranged leaves and many fibrous supporting roots penetrating into the soil.

Aloe Vera barbadensis miller as scientifically known originated in warm, dry climates of Africa.

However, its wide adaptability and importance as a medicinal plant had it distributed to other parts of the world. In Uganda we commonly call it 'Ekigagi'.

d) **Cottage crops** like mushrooms, flowers and upland rice.

MUSHROOM GROWING

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Mushroom cultivation was introduced in Uganda in 1990 at Kawanda agricultural Research Institute (KARI) the simple technology was imported from Egypt and modified to suit Ugandan conditions

Benefits of mushrooms

- ✓ Used as food with nutrients like proteins, carbohydrates, vitamins, minerals, fat and water
- ✓ Used as medicine that reduces diabetes, cancer, heart diseases, infections
- ✓ Provide antibodies like penicillin
- ✓ Used in making dyes
- ✓ Neutralize acidity in soils
- ✓ Contributes to sustainable agriculture by reusing agricultural wastes

Edible mushrooms.

Agricus bisporus

Agricus bitorquis

Agricus blazei

Auricularia polytricha

Coprinus cinereus

Dictyophora indusiata

Flammulina velutipes

Hericium erinaceous

Hirneola auricular – judae

Lepista nuda

Pholiota nameko

Pleurotus abalones

Tuberregium

Cystodiosus

P. pulmonarius

P.Cornucoplae

P. djamor

P. eryngii

Stropharia rugoso – annulata

Tremella fuciformis

Volvariella volvacea

FACTORS AFFECTING MUSHROOM GROWTH

✓ **Temperature;** varies for the different stages. Incubation (20 to 30^0c), Fruiting (15 to 20^0c). water the room and improve ventilation during fruiting to lower temperature)

✓ **Humidity of air;** At incubation should be 60% while at fruiting at least 80%

✓ **Ventilation i.e. Oxygen and carbondioxide content;** Low oxygen and carbondioxide levels slow down the growth rate. High

carbondioxide concentration leads to production of small heads and long stems

✓ **Moisture content of substrate;** Optimum water content in the substrate is preferred as high and too low affect growth.

✓ **pH of substrate; most** cultivated mushrooms prefer a slightly acidic medium of pH 5 to 6 PH may drop during incubation due to carbondioxide production. Liming may be done to raise the pH.

✓ **Illumination;** mushrooms needs light for fruiting. Too little light results into formation of small heads and long stems

✓ **Nutrient status of substrate especially carbon Nitrogen ratio;** good nutrient levels are needed for proper growth of mushrooms

✓ **Quality of spawn;** high yielding spawn is needed for better production

Requirements for mushroom growing

a)Incubation room; a dark room with a humidity of 60%, low ventilation and internal temperature ranging between 20 to 30^0C. The mycelia is facilitated to spread through the substrate in this room by planting it in "gardens" above the floor

b)Cropping room / fructification room; it's where the mushrooms emerge from the "gardens". Humidity is between 80 t0 90%, temperature 20 to 24^0C and good natural light

c)Substrate organic material on which to grow the mushroom /this is a material on which the mycelium grows. A good substrate for mushroom production should have the following qualities.

- Should have the required nutrients for the mushrooms
- Should not be too loose or compact to allow the mycelium easily colonize it.
- Should have enough moisture for proper growth of mycelium
- PH of the medium should be slightly acidic
- Microbial activity should be free from harmful microorganisms.

Common substrate used

Substrate	**Mushroom species**
Wood logs	Auricularia spp Lentinula edodes Pleurotus spp Tremellafuciformis
Horse and chicken manure	Agricus spp Coprinus comatus Lepista ruida

Rice straw	Volvariella volvacaea Pleurotus spp Agaricus spp
Barley and wheat straw	Pleurotus spp Agaricus spp Stropharia rugoso – annulata
Wood chips	Letinular edodes Pholiota nameko Pleurotus spp Stropharia reguso Dictyophora indusiata

Saw dust	Auricularia spp Flammulina velutipes Ganoderma spp Hericium erinaceus Lentinula edodes Pholiota nameko
Coffee pulp	Pleurotus spp
Maize cobs	Lentinula edodes Pholiota nameko Pleurotus spp
Cotton waste	Volvariella volvacaea Pleurotus spp
Distillers grain waste	Hericium erinaceus pleurotus spp

Cotton hulls (seed cake)	Lentinula edodes Hericium erinaceus Pleurotus spp
Banana leaves	Volvariella volvacaea

Other substrates are;

- Crushed bagasse and other wastes from sugar industry
- Water hyacinth
- Cotton straw
- Used paper
- Coconut soil

Substrate preparation techniques

1. Wood logs
2. Fermented and pasteurized substrate
3. Pasteurized or pre heated substrate
4. Sterilized substrate.

The main species cultivated in Uganda, are *Pleurotus spp*, *Agaricus bisporus*, *Flammulina velutipes*, *Volvariella volvacea* and *Lentinus edodes.*

Pleurotus can be cultivated under a wide range of temperatures with simple technology.

d) Supplements

These are additives which increase yields for the growth of the mycelium. Wood log substrates donot need additional nutrients.

Suppliments provide extra nitrogen or easily degradable carbohydrates.

Inorganic sources of nitrogen

Ammonium sulphate

Ammonium nitrate

Urea

- NB Average nitrogen content of proteins is 16%
- Inorganic supplements are mainly used for cultivation of mushrooms on fermented substrates.

Organic nitrogen sources	**% Nitrogen**
- Blood meal	13.5
- Fish meal	10.5
- Wheat bran	9.7
- Cotton seed cake	6.5
- Pea nut meal	6.5

- Chicken manure 3.6
- Brewer Grain waste 3.5
- Malt sprouts 4.0
- Rice bran 2.0
- Maize bran 2.5

e)Mushroom seed / Spawn

Mushroom seed is referred to as spawn. Spawn is a pre grown mycelium (free from any contaminants) of the mushroom mixed with sterile substrate.

Life cycle of mushroom progresses as follows:-

Mother culture – spawn – mycelium – mushroom

The mycelium comes from a spore i.e. when a spore settles in a favourable substrates, it grows to produce a mycelium.

f) Sterilizer; equipment used to sterilize the substrate and make it free from any contaminating organism

g) Fire wood; needed to provide fuel needed in the process of sterilizing the substrate

h)Water; needed to soak the substrate, water "gardens" as well as producing steam needed in sterilizing of substrate

i) Black polyethene bags; used for making "gardens" where the mushrooms grow

GENERAL PROCEDURE OF GROWING MUSHROOMS

Substrate preparation

✓ Reduce the substrate to the optimum particle size of not more than 3 cm

✓ Soak the substrate in water overnight

✓ Add lime to the substrate at a rate of one percent to the substrate to buffer Ph and control fungal contamination

✓ Drain the substrate on a wire – mesh or slated concrete for one day

✓ Check out on the moisture content in the substrate by squeezing it in the palm to see any dripping water or not. Dripping water means that its excess hence needs further draining

✓ Load the moist substrate into the sterilizer and sterilize it for 3 hours

✓ Allow the material to cool within the sterilizer

Spawning

✓ Handle the materials using sterilized or clean hands/gloves

✓ Place 4-5 kg of cooled substrate into sterilized / clean black polyethene bags/ trays /boxes ("garden")

✓ Add spawn to the substrate in bags at a rate of 5% of the weight of substrate (250g) and mix it well into the substrate

✓ Use a sterilized nail or fork or tooth picks to prick holes at the bottom of the "garden" for good aeration

Crop management

✓ Incubate the gardens in the incubation room for 2 – 3 weeks to allow the spawn colonize the substrate. Maintain humidity at about 60% and temperature between 20 to 30^0C

✓ After 2-3 weeks, transfer the gardens to the cropping room maintained at a humidity of 80 to 90% and temperature between 20 to 24^0c.

✓ Hang the gardens on wires for proper aeration and slit the gardens vertically all around using a sterilized blade to expose the mycelia

✓ Water the gardens twice a day (morning and evening) to maintain the humidity

✓ After 3 to 4 weeks the mushrooms start fruiting (mushrooms emerging from substrate) through the slits

✓ Harvest the mushrooms when at the umbrella stage

✓ Clean by cutting off the lower portion of the stalk. Over mature mushrooms contain a lot of spores that reduce quality

✓ Pack the mushrooms loosely in a clean transparent perforated polyethene bags or stylo foam trays and seal it. Keep fresh mushrooms in a fridge or dry it as way of preservation

Casing

Organic soil (Nutrient rich top soil) is applied to fully – grown compost.

Importance of casing soil.

- Provides water for mycelium and fruit body growth
- Buffers climatic conditions in growing room
- Protect compost layer from drying out
- Provide suitable amount for stimulation of fruit bodies.

CHALLENGES TO MUSHROOM PRODUCTION

- ✓ Mushroom production is labour intensive more especially commercial production
- ✓ Contaminating fungi can invade the substrate reducing production
- ✓ It's difficult to identify good source of spawn
- ✓ Limited support by government to mushroom production
- ✓ Mushrooms are highly perishable
- ✓ Weather conditions in Uganda do not favour mushroom production
- ✓ Gate prices for mushrooms are not good

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CROP PROTECTION:

WEED AND WEED CONTROL

A weed is a plant growing where it is not wanted i.e. a plant which is out of place and is in competition with the crop plant e.g. a bean plant growing in a stand of maize is considered as a weed because it was not planted there.

ECONOMIC IMPORTANCE OF WEEDS IN CROP PRODUCTION / EFFECTS OF WEEDS.

The economic effects refer to both positive and negative aspects of weeds in agriculture production.

Positive effects of weeds.

- ✓ They provide organic matter and mineral nutrients to the plant when rotten.
- ✓ They can be used as roofing materials in rural areas e.g. Spear grass and thatch grass.
- ✓ They provide a good surface cover which minimize on the rate of evaporation and control soil erosion.
- ✓ It is a source of food for wild game.
- ✓ Some are used for house hold purpose e.g. for sweeping as brooms.

✓ Some species of weeds are used as herbal medicine e.g. black jack which is used to dress fresh wound.

✓ Some are used as vegetables in different location e.g. pig weeds (Amaranthus ssp)

✓ They also help in nutrient recycling since they are deep rooted.

Negative effects of weeds.

✓ They compete with plants for nutrients, space, light and water.

✓ Some weeds are poisonous to man and livestock e.g. thorn apple and lantana camara

✓ They reduce palatability of pasture for the animals leading to poor quality production by the animals in terms of milk and meat.

✓ They contaminate farm produce reducing their quality e.g. blackjack seeds in cotton lint

✓ They increase cost of production as farmers tries to control them on a farm.

✓ Weeds harbor pest i.e. some weeds act as hiding ground for pest which attacks crops.

✓ Weeds highly affect the formation and distribution of roots of crop plant under heavy infestation.

✓ They reduces crop yield by depriving crop plants of the essential nutrients.

✓ They also reduce the market value of the crop plants due to poor quality.

✓ They increase the frequency of secondary cultivation and weeding which also increases production cost to the farmer e.g. spear grass.

✓ Weeds also affect crop harvest under heavy infestation.

✓ They make cultivation difficult by sticking on the blade of farm implements.

✓ They are allelopathic i.e. they produce poisonous substance which affects germination and growth of crop plants. E.g. striga.

FACTORS / CHARACTERISTICS / ADAPTATIONS OF WEEDS WHICH MAKE THEM MORE SUCCESSFUL THAN CR OP PLANT IN THE FIELD.

✓ Weeds have extensive root system which enables them to draw nutrients from deeper soil layers than crop.

✓ They are tolerant to harsh condition e.g. drought.

✓ Weeds are adapted to grow in all types of soil and can survive easily on few nutrients e.g. spear grass.

✓ Some weed seed can germinate even if they are immature making them out compete crops in numbers.

✓ Weeds are prolific i.e. they produce very many seeds which increase their chances of multiplication.

✓ They have aggressive growth habit i.e. they grow faster than crop plants e.g. black jack, pig weed.

✓ Weeds are less affected by pest and disease than crops.

✓ They have high reproductive capacity e.g. they have many perenating organs for reproduction such as stolon for couch grass, rhizome for spear grass.

✓ They have spreading growth habit i.e. they form many branches which covers the crop plants.

✓ They are unpalatable to the animals making them to continue growing as crop plants are destroyed down by animals.

✓ They have various dispersal mechanisms which increase their chances of colonizing new places in the field.

✓ Some weeds are allolopathic i.e. they produce poisonous substance which makes it hard for the plant growing around them to grow.

✓ Weeds have long dormancy periods i.e. they can remain dormant in the soil for long without dyeing.

✓ Some weeds have protective structures which prevent them from being destroyed by animals e.g. thorn apple, double thorn.

Classification of weeds

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Weeds are mainly classified into 2 ways i.e.

- ✓ According to the lifecycle.
- ✓ According to the morphology

According to the lifecycle; In this classification, weeds are classified according to the length of their lifecycle i.e. the time they take to grow, mature and die. Under this classification, the following groups of weeds exist;

- ✓ **Annualweeds**; These weeds complete their lifecycle within a year or less e.g. black jack, goat weed, pig weed etc.

Characteristics of annual weeds

- ✓ They complete their lifecycle in one year
- ✓ Reproduces only by means of seeds
- ✓ Produces abundant number of seeds
- ✓ They become difficult to remove if left in an area for long
- ✓ **Bi – Annual weeds**; these complete their life cycle in more than one year but not more than 2 years .In the first year, it may exhibit vegetative growth and flowers and produce seeds in the second year.

Characteristics of bi-annual weeds

- ✓ They complete their life cycle in two years' time.
- ✓ They produce vegetative growth in the first year and produce seeds in the second year then die.
- ✓ They reproduce from seeds only.
- ✓ **Perennial weeds**; they complete their life cycle in more than two years. E.g. coach grass, tick berry, oxalis. Perennial weeds are often very difficult to control because they possess perenating organs e.g. rhizomes, bulbs, corns etc. Perennial weeds reproduce from both seeds and vegetative parts.

According to morphology;

Classification under this one is based on the structure of the weed plants. It can be classified as

- ✓ **Sedges**; these are weeds which grows mostly in water logged areas where water stand most of the time, this group has a triangular stem e.g. Cyprusrotundas, nut grass etc.
- ✓ Wood weeds; they have strong woody stems and they are mainly controlled mechanically by uprooting e.g. Sodom apple, Lantana camara etc.

✓ Herbaceous weeds; these are the weeds with thick water filled succulent stem. e.g. water hyacinth, wandering Jew, pig weeds,

✓ Grass weeds e.g. Spear, star, couch grass. They have weak stem and long narrow leaves

According to botanical nature

Group	**Commonname**	**Botanical name**	**Lifespan**	**Propagation mode**
Grass Herbaceous	Wildfinger millet Speargrass Lovegrass Stargrass Couchgrass	Eleusineindica Imperettacylindri Siteriaverticilatta Cynodondactylon Digitariascalarum	Annual Perennial Annual Perennial Perennia	Seed Rhizome Seed Stolon Rhizome

	Nutgrass Pigweed Wandringjew Blackjack Oxalis Goatweed Thornapple Sodomapple Milkweed Doublethorn Macdonald's eye/Gallant soldier	Cyperusrotundus Amaranthus ssp Commelinabengh Bidenpilosa Oxalislatifolia Ageratum conyzoi Datura stramoniu Solanum incanum Euphorbia heteropylla Oxygonumsinuatum Galinsogapaviflora	l Perennial Annual Perennial Annual Perennial Annual Annual Perennial Annual Biannual annual	Seed Seed splits Seed Seed Seed Seed Seed Seed seed

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METHODS OF CONTROLLING WEEDS

There are number of methods used to control weeds by farmers and these include:

- ✓ Cultural method.
- ✓ Mechanical or physical method.
- ✓ Biological method.
- ✓ Chemical method.
- ✓ Legislative method.
- ✓ Integrated weed control.

The use of any of the above methods keeps on varying from one place to another depending on; the type of weed, the type of plant grown, the economic status of the farmer and environmental conditions.

CULTURAL METHODS:

This aims to give the crop the best conditions which will favour its growth so that it can out compete weeds. These include;

✓ Crop rotation: this helps to destroy the life cycle of weeds that tend to follow particular crops e.g. striga spp in cereals.

✓ Proper spacing: Well-spaced plants give a good ground cover quickly with their leaves; this enables the crop to smother the weeds at an early stage when the weeds are still weak and not yet established.

✓ Timely planting: enables the crops to establish and grow early before the weeds reach their competitive stage.

✓ Mulching: this helps to suppress weed growth, deprives weeds off sunlight making them to die

✓ Flooding; this kill non water loving weeds especially making them to die of suffocation. This is used in crops like paddy rice plantation.

✓ Hand pulling: weeds are uprooted together with their roots and are left to die and dry.

✓ Trap cropping: this allows weeds to grow on a host plant which is then ploughed into the soil when the weeds are still green before producing seeds.

✓ Controlled grazing: this reduces overgrazing and ensures that desirable pastures are not out competed by weeds.

✓ Cover cropping: crops with dense foliage are planted to shade the ground and smoother weeds.

✓ Intercropping: This reduces space and light available for the weeds to grow.

Advantages of cultural methods of weed control

- ✓ There is no danger of environmental pollution.
- ✓ There is no danger of poisoning to plants and animals.
- ✓ It requires little or no technical knowledge compared to chemical control.
- ✓ It's cheaper method compared to other methods.

MECHANICAL / PHYSICALMETHOD

This method involves physical destruction of the growing weeds.

It is very effective for controlling annual weeds but for the case of perennial weeds, they must be weeded periodically because they continue to grow new shoots from their perenating organs.

The methods used in mechanical weed control include the following;

- ✓ Hand pulling / uprooting of individual weeds to expose their roots so that they eventually die.
- ✓ Hand hoeing using garden tools like hand hoe, forked hoe.
- ✓ Mechanical cultivation / tillage. Using ox-drawn implements or tractor drawn implements e.g. ox-plough, disc plough etc.

✓ Slashing / mowing: This is done using cut lasses / slashes / mowers to destroy the weeds. It is more effective in controlling tall and soft weeds than creeping weeds.

Advantages of mechanical method

- ✓ It does not pollute the environment
- ✓ Requires little skills
- ✓ Non toxic to crop plants
- ✓ It is cheap in the long run as tools are used for long
- ✓ The method is quick especially when machines are used

Disadvantages of mechanical method

- ✓ It destroys soil structure.
- ✓ It may cause soil erosion
- ✓ It is laborious
- ✓ Crops may be damaged in the process of weeding
- ✓ It is slow especially when hand tool is used.

BIOLOGICAL WEED CONTROL This involves the use of enemies to control weeds. These natural enemies are commonly animals that feed on weeds. Other living organisms also can be used. Examples Use of rabbits to control the Macdonald's eye

in banana plantations, Control of water hyacinth using beetles, control of Lantana camara by Lantana burgs and goats

Advantages of biological weed control

- ✓ Does not pollute the environment
- ✓ Does not affect the soil structure
- ✓ It is cheap once the biological agent has been identified

Disadvantages of biological method

✓The biological agent of weed control may later become a pest especially when the weed is eaten up.

✓It requires a lot of research in establishing the biological agent hence making it tiresome.

✓It does not destroy the underground parts of weed.

✓It takes a long time for the weed to be eaten up from the garden thus becoming expensive.

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CHEMICAL METHOD

✓This method involves the use of poisonous substance to control weeds. The chemical use to control weeds is called **herbicide.**

Classification of herbicide.

There are two ways of classifying herbicide

(a) Classification based on time of application

- ✓ **Pre- planting herbicide / soil sterilant herbicide:** These are herbicide that are applied into a prepared seedbed before planting crops e.g. bromacil
- ✓ **Pre-emergence herbicide:** These are herbicide that are applied after planting of seeds but before germination e.g. simazine, atrazine.
- ✓ **Post-emergence herbicide:** these are herbicide applied after the crop has emerged or germinated. They are largely used to suppress the growth of weeds without killing or affecting the growth of crop plants in the area.

(b)Classification based on the basis of action.

✓ **Contact non selective herbicide:** These are herbicides which kills any crops with which they come in contact with e.g. paraquat (gramaxone), Glyphosphate, diquat

✓ **Translocated / systemic herbicide:** these are herbicide which kill the entire plant even if they come in contact with only the leaves. They are absorbed through the leaves / stem and transported through plant system slowly there by killing and damaging plant cells.eg 2,4-D, 2,4,5-T, Touchdown glyphosphate, Glufosinate.

✓ **Selective herbicide**: These are herbicides that kill a particular plant only e.g. there are those that are meant to kill broad leaved weeds without affecting narrow leaved weeds e.g. simazine, 2,4-D, MCPA, MCPP.

FACTORS THAT INFLUENCE SELECTIVITY OF HERBICIDE

Selectivity is the ability of the herbicide to kill certain plants and leave others unaffected.

✓ The degree of wetting; the leaves of the plant should be thoroughly wetted e.g. broad leaved weeds has large surface to be attracted with chemicals.

✓ Structure of the plant; some plant have natural protection e.g. waxy cuticles and tough scale leaves which prevent penetration of herbicide.

✓ Resistance of the weeds to herbicide: Some weeds have in built physiological resistance and can detoxify the herbicide making it harmless.

✓ Time of application e.g. post emergence herbicide when applied before emergence of the crop selectivity will not be achieved.

ADVANTAGES OF USING CHEMICAL METHOD / HERBICIDE

✓ It can be used in good time before competition set in e.g. pre emergence herbicide.

✓ It lowers the cost of production on the farm since only one person is employed.

✓ The method is fast

✓ It does not destroy soil structure

✓ There is no root damage

✓ Where the crop morphology does not encourage mechanical weeding like in sugarcane, chemical method is used.

✓ Where the topography of the land does not favor mechanical weeding, chemical method is used.

✓ It is used to control perennial weeds which are difficult to control mechanically.

✓ It is used to control weeds on a large scale.

✓ It is cheaper than using hand labor in the long run.

DISADVANTAGES OF CHEMICAL METHOD OF WEED CONTROL.

✓ It is expensive since it involve buying of chemical,

✓ The use of chemical requires specialized skills which most farmers lacks.

✓ It is difficult to get chemical for use.

✓ Chemical is poisonous to human being and farm animals.

✓ If not used carefully, chemical can destroy crops.

✓ It pollutes air, water and soil.

✓ It causes unemployment since less people are employed in the use of herbicide on the farm.

✓ Some herbicide has long residual effects in the soil and may cause to crops grown in the next season.

FACTORS THAT INFLUENCE THE CHOICE OF HERBICIDE.

- ✓ The prevalent weed species.
- ✓ The climate of the area I.e. rain fall condition, wind etc.
- ✓ The soil type i.e. some soil keeps herbicide for long while others does not.
- ✓ The type of crops in which weeds are to be controlled.
- ✓ The stage of weed growth.
- ✓ The stage of crop growth.
- ✓ The cost of the application

FACTORS THAT INFLUENCE EFFECTIVENESS OF HERBICIDE

- ✓ Application of herbicide in wet weather/rainy condition since the herbicide will; be washed away.
- ✓ Late application of herbicide, herbicide should be applied at the correct stage of weed growth. Older weeds tend to resist herbicide and they need high dosage.
- ✓ Poor formulation and mixing of herbicide which alters the concentration of chemicals, this make herbicide less effective.
- ✓ Use of chemical on the crop not intended for.
- ✓ Spraying in windy weather which make chemical to get drifted out of the intended place.

✓ Use of expired herbicide.

SAFETY PRECAUTIONS WHEN HANDLING HERBICIDE / CHEMICALS

✓ The user should follow the manufactures instruction before mixing and spraying the chemical.

✓ The user should not eat/smoke when spraying herbicide.

✓ Avoid in haling (breathing in) the herbicide since it is poisonous to human being.

✓ The operator should wear protective clothes like gumboots, gloves, overall, mask, cape when using chemical

✓ Avoid spraying in windy condition to minimize drift of chemical to unintended places and always spray following wind direction.

✓ Dispose off empty container after use either by burying them underground or by burning.

✓ Wash yourself thoroughly after spraying the chemical.

✓ The operator should thoroughly wash the spraying equipment after spraying, not in or around the compound and water source.

✓ One should not spray when it is about to rain or immediately after the rain to avoid dilution of chemical.

✓ Do not keep the herbicide in unlabeled container to avoid being mistaken for water or other drinks.

✓ Seek medical attention in case you feel unwell after spraying the herbicide.

✓ In case the herbicide enters your eye during spraying, flush it immediately using clean water and soap.

✓ Animal should not be allowed to pass through the sprayed area as they will cause drift of chemical.

✓ All chemicals should be kept in a safe place out of reach of children i.e. in a locked room.

✓ Do not unblock the blocked nozzles using your mouth in case it get blocked.

CROP PEST.

✓ Pests are living organisms that destroys crop in terms of quality and quantity.

Economic importance of pests.

✓ They reduce the market value of crop plants in terms of quality.

✓ It increases cost of production on the farm when pest are being controlled.

✓ Crop pest result into low production which affect National income of the country.

✓ Pest damage may result into food shortage (famine) for both people and animals. This may lead to migration, death and buying of food.

✓ Use of chemicals to control pest interferes with the environment.

✓ Some pests are eaten as food.

EFFECTS/DAMAGES OF PESTS IN AGRICULTURAL PRODUCTION.

✓ Pest sucks plant juice and introduces pathogens like virus.

✓ Pest also lowers the quality of crop produce e.g. maize weevil on maize grain.

✓ Some pests like termite attack plant roots leading to total death of the whole plant.

✓ Storage pest reduces viability of seed e.g. bean bruchids by eating up the embryo.

✓ Some pests feed on the plant leaves reducing on the rate of photosynthesis e.g. army worms and locusts.

✓ Some pest weakens sacs in store resulting into spilling of stored produce e.g. rats

✓ Pest makes tunnels inside the stem which interferes with translocation within the plant.

✓ They eat up flowers which reduce on the rate of reproduction of crop plants.

✓ Pest also create wound on the crop plants which act as an entry point for pathogens.

✓ Pest also feed on the plant sap containing minerals leading to mineral deficiency.

✓ Pests also lower the quality of crop plants directly by defecating on stored produce, laying eggs in produce etc.

✓ Pest also introduces toxic saliva into the plant tissues which interferes with growth e.g. nematodes feed on leave leading to gall formation.

✓ They cause honey dew around the wounded part of crop plant. This attracts flies that bring in pathogens to crop.

✓ They also deplete the leaves of crop plant (defoliation)

✓ Pest also introduce toxin into the crop plants making them inedible e.g. aflatoxin in groundnuts caused by fungus (Aspergillus species).

✓ Insect pest also suck plant juice from the growing point causing wilting of the plants hence death.

✓ Pest also increases costs of production on the farm as farmers tries to control them.

CLASSIFICATION OF PEST.

According to the plant parts they affect

✓ Root pests e.g. termites, rodents, nematodes Leaf eaters e.g. Locusts, grasshoppers, caterpillars.

✓ Stem borer e.g. Maize stalk borer and sugar cane stalk borer

According to where they attack crops

✓ Field pests: Attack plants when they are still in the field/garden e.g. rats, birds, termites, monkeys, coffee leaf miners.

✓ Storage pests: Attack the produce in stores e.g. Maize weevil, bean bruchid, red flour beetle.

According to the number of plant species they attack (host)

✓ Monophagous pests: These feed on only one crop e.g. banana weevil.

✓ Oliphagous pests: Feeds on few species of plants that are normally of the same family e.g. stalk bores that feed on cereal, boll worms which feed on vegetables.

✓ Polyphagouspests:Thesefeedsonmanyspeciesofplantsandareverydifficultto controle.g.Americanbollwormswhichattackmaize,cotton,bean,tomatoes,sorghum etc

According to stage of crop attacked;

✓ Seedling pests e.g. cut worms which attacks all cereals at young stage. Target pests: These attack crops at all stages of growth e.g. maize stalk borer and sugarcane stalk borer.

According levels of pest damage;

✓ Major pests which cause significant damage e.g. locusts

✓ Minor pests which cause little damages which are not always recognized e.g. butterflies.

According to the mode of feeding (mouthpart);

✓ Biting and chewing pests: These are pests with strong mandibles for biting and chewing of plant parts. They mostly eat the leaves, roots and fruits.

✓ Examples of biting and chewing pests are monkey, termites, rodents, larva stage of butterfly (caterpillars

Damages caused by biting and chewing pest.

✓ They cause physical injury to the stem, roots and leaves of crop plants.

✓ They expose plant cells which make pathogens to enter into the plant tissues.

✓ They eat leaves of plants reducing on the rate of photosynthesis.

✓ They cause rotting to stem and tubers after creating wound.

✓ They reduces crop yield.

✓ Piercing and sucking pests:These are pests with sharp stylets / proboscis that they use to pierce plant tissues and suck plant sap. Examples include the following; Cotton stainer, aphids, butter flies, mealy bugs, cotton leaf hoppers, thrips etc

Damages caused by sucking and piercing pests.

✓ They are vector for disease causing organism e.g. virus.

✓ They introduce toxic saliva into the plant tissues which interfere with plant growth e.g. abnormal swelling (gall) in coffee leaves caused by antestia bug.

Reasons why insects are the major successful pests / Reasons why most pest are insects.

✓ They have high rate of reproduction to ensure survival.

✓ They have short life cycles and so increase in numbers very fast.

✓ Presence of cuticles that prevents water loss and protect insects against chemical.

✓ They are small in size and therefore not easily detected by predators.

✓ They have defensive mechanisms e.g. stings, spines and they pungent chemicals against predators.

✓ Some insects can camouflage to hide from predators.

✓ They are adversely distributed environment giving them advantage to survive continuously.

✓ They are able to move very fast from predation hence escaping from attack.

✓ Some pests are oviparous i.e. produces their young ones alive e.g. Aphids.

✓ The agro system adopted by farmers increase their chances of survival.

✓ Minimum tillage promotes the buildup of pests on the farm.

✓ They have the ability to transform into dormant stage when there is food shortage, extreme climatic condition etc.

✓ Insects are well adapted since they have stayed on earth for long.

✓ They little food requirements and they feeds on wide range of materials.

✓ They are small in size and can fit precisely in habitat hence escaping predation.

✓ They have an exo-skeleton which protect the inner organs against mechanical damage.

✓ Insects secrete uric acid which requires little water for excretion hence preserving water in their body.

Economic injury level is determined by the following factors.

✓ Type of pest: e.g. one antesiabug can affect the whole plant.

✓ Climatic conditions: during the dry season, the sweet potato butterfly is more damaging than the wet season.

✓ Environmental factors i.e : presence of natural enemies to the pest.

✓ Economic threshold: it is the pest population where control is to be done to reduce losses.

✓ Phytosanitary control: this involves methods of control that ensure use of materials that do not carry pests.

✓ Lethal dosage (LD_{50}): the concentration of the pesticide that kills 50% of the pest population e.g. LD_{50} is the concentration that kills 50% of the referred organisms.

Factors that contribute to the prevalence (increase) of pests in the tropics.

✓ Crop improvement that has made crops of better quality which favors multiplication of pests.

✓ Change in farming systems: the introduction of large supply of food to pests hence favoring their existence.

✓ Decline in species diversity: elimination of species diversity disturbs the ecosystem through bush burning, deforestation hence increasing pressure on available crop plants.

✓ Climatic change that leads to destruction of the ecosystem and the habitats for the organisms.

✓ Introduction of new crops that come along with new crop pests.

✓ Increase in use of pesticides: this leads to increase in pesticide resistance.

✓ Crop storage, this enables pests to hide for long in the stored crops. It also concentrates the food supply in the dry grains and ensures a prolonged period of food availability.

✓ Minimum tillage techniques, insect eggs laid in the soil are not

exposed to desiccation by the sun.

✓ Improved transport has enabled importation of infested crops from elsewhere into formerly clean environment.

✓ Cyclicorperiodic occurrences, cyclic climatic changes such as Elnino droughts are often followed by pest out breaks.

The following factors are considered when assessing pest damage / factors which determine the need for pest control.

✓ Part of the plant attacked. If the plant is attacked on the most vital part, then the pest affects the commercial yield of the plant and control is needed.

✓ Population of the pest: if the pest population is high, then control is needed.

✓ Feeding habits of the pest: biting and chewing pest cause major losses because they destroy important points of the plant while sucking pests cause indirect losses.

✓ Presence or absence of predators: most predators eat their prey or weaken them immediately therefore control may not be needed.

✓ Effect of climate on the pest. Climatic conditions like high humidity favours the multiplication of pests e.g. antensia bugs in coffee.

✓ Stage of development of the pest. Certain insects are destructive at particular stages in the lifecycle e.g. larva stage in butterflies.

✓ Mobility of the pest: mobile pests can cause a lot of damage than less mobile pests therefore control is needed.

✓ Presence of alternate hosts to the pest: alternate host even when the major crop is out of season therefore causing limited damage than less mobile pests therefore causing limited damage to the crop than the alternate pest.

✓ Plant resistance: plants that have resistance to damage by particular pests are affected by the pest.

METHODS OF PEST CONTROL.

✓ Cultural method

✓ Mechanical method

✓ Biological method

✓ Chemical method

✓ Legislative control

✓ Integrated pest management

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1. CULTURAL METHOD.

✓ This is the elimination of pest damage by employing agricultural practices normally used in the growing of crops such that it make environment unsuitable for continuous survival of pests. They include;

✓ Timely planting: This enable the crops to grow vigorously and reach harvesting stage early before pest population build up to the point that cause damage. Crop rotation: Alternation of crops in a planned sequence helps in breaking the lifecycle of pest and starving them to death when the host crop is eliminated.

✓ Tillage: Tillage improves on soil conditions which enable proper growth of crop plants against pest attack as well as exposing the life cycle of pest to harsh environmental conditions.

✓ Use of recommended spacing: This create a micro climate that is discouraging for the survival of pest e.g. close spacing control antestia bug and Aphids in coffee and groundnuts respectively.

✓ Proper spacing also allows plant to have enough growth factors hence proper growth that resist pest attack.

✓ Field hygiene: e.g. Rogueing which is the removal and destruction of affected plant by burning or burying them, burning of crop residues to kill pest hiding in them

✓ Flooding: This is a common practice of controlling pest in rice field, it kill the pest by suffocation.

✓ Use of resistant varieties that can withstand attack by pest e.g. hairy structure in cotton and then built physiological resistance in some crops.

✓ Use of trap crops: A trap crop is used to attract the pest from reaching the main garden where the desired crop is growing. Palatable crop is planted around the main garden to trap the pest and it's later destroyed before the pest completes its life cycle.

✓ Close/dead season: This is a period during which a susceptible crop to certain pest is not planted. It controls the pest by denying them food hence starving to death.

✓ Destruction of alternate host plant: Some weeds act as alternate hosts of some pest and therefore proper weeding is effective in the control of pest since they provide alternative hiding places for pest which affect crop plants.

✓ Use of clean planting materials free from pest to avoid introduction of pest in the field e.g. banana weevils, sweet potato weevils etc.

✓ Proper pruning: This removes infected part of plant to avoid secondary infection; it also destroys hiding ground for pest hence discouraging their survival.

✓ Timely harvesting to avoid contamination of crops by the pest while still in the field

Advantages of cultural pest control.

✓ The method is cheap to manage

✓ It has no side effects on the environment

✓ It can be integrated with other method at the same time

✓ It's effective in controlling pest before the population buildup.

Disadvantage of cultural pest control.

✓ It only reduces pest population but does not kill all.

✓ There is need to use the method repeatedly which discourage farmers

2. MECHANICAL METHOD.

✓ This involve the use of specific physical / mechanical measures to control pest damage, it include the following;

- ✓ Handpicking and destruction of pest
- ✓ Use of sound to scare away pests.
- ✓ Use of traps to kill pests.
- ✓ Use of male sterilization technique

3. BIOLOGICAL METHOD.

✓ This involves the use of natural enemies of pest to reduce pest damage. The enemies can be predators, parasite etc e.g. Use of cats to control rats, Use of lady birds to control Aphids, wasps to control caterpillars etc

Advantages of biological pest control.

- ✓ It does not affect the environment
- ✓ No pest resistant to the pest control methods.

Disadvantage of biological pest control.

- ✓ The method is slow
- ✓ It is difficult to completely eradicate pests.
- ✓ A lot of research is required to identify biological agent for a particular pest.
- ✓ The biological agent may turn to be a pest to the crop if not studied properly.

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CHARACTERISTICS OF A GOOD BIOLOGICAL AGENT

- ✓ It must be host specific
- ✓ It must have a high searching ability
- ✓ It must be able to multiply faster to check on pest population.
- ✓ It must be adapted to the environment
- ✓ It should attack the pest at the most damaging stage
- ✓ The biological agent should be selective in nature.

4. CHEMICAL METHOD.

- ✓ This is the reduction / prevention of pest damage by use of chemical compound to kill pest. The chemical use to control pest are called pesticides.

Classification of pesticide

- ✓ According to mode of action Stomach poisons: This target the digestive system and it enters after being eaten by the pest e.g. Dieldrin and lindane.
- ✓ Contact poisons: This go through the skin after dissolving the cuticles e.g. Marathion, and DDT
- ✓ Fumigants: These are carried by air current and they enter through skin pores on the body of the pests
- ✓ According to the organism killed by the pesticide

- ✓ Insecticides; kill insects
- ✓ Acaricides; kill ticks
- ✓ Rodenticide; kill rodents
- ✓ Antibiotic; kill bacteria
- ✓ Fungicide; kill fungi

Terms used in chemical pest control.

- ✓ Persistence: This refers to the length of time that the pesticides remain in the environment (including within the organism) without being broken down.
- ✓ Specificity: This refers to the range of organisms that the pesticide can affect e.g. DDT is a broad spectrum pesticide.
- ✓ Narrow spectrum pesticide only affects restricted range of organisms.
- ✓ Broad spectrum pesticide can lead to pest resurgence.
- ✓ Pest resurgence is condition where by the population of pest increase after treatment to more than before the treatment because the pesticide would have killed even the natural enemies of pests.
- ✓ Tolerance limit: This refers to the quantity of chemical residues that tend to remain in the product that is to be used as food.

✓ Pre- harvest period: This is the period that must elapse after applying a chemical before harvesting to allow the plant break down the chemical to a level below the tolerance limit.

✓ Lethal time (LT): This refers to the length of time that is needed to kill a given number of pest e.g. LT50 refers to the time needed to kill 50% of the total pest population.

✓ Lethal dosage(LD50): This is the concentration of pesticide that kills 50% of the pest population e.g. LD50 is the concentration that kill 50% of the referred organism. LT figure determines the strength of the chemicals.

FACTORS THAT AFFECT EFFICIENCY OF PESTICIDE.

✓ Concentration of pesticide: Pesticide should be of right concentration to give the right strength in killing the target pest.

✓ Time of application: It should be applied at the time of developmental stage when the pest is more vulnerable.

✓ Weather condition at application time: there should be no rain at the time of applying pesticide otherwise its action will be rendered harmless since rain will dilute and alter the concentration of chemical.

✓ Persistence: The pesticide should be persistent enough in order to be effective and to achieve desired effects.

ADVANTAGES OF CHEMICAL PEST CONTROL.

✓ It is very effective in controlling pests.

✓ The concentration of chemical can be controlled to control pest population.

✓ Some chemicals are broad spectrum and therefore kills variety of pests hence be coming cheap

✓ Individual action can easily be taken by farmers to control pests.

✓ It can be used in time when pests are most destructive.

DISADVANTAGES OF CHEMICAL PEST CONTROL.

✓ The chemicals may kill predators and other useful organisms.

✓ The chemicals are poisonous to human being and animal.

✓ Most chemicals pollute the environment.

✓ The chemical may enter the food chain hence affecting many organisms.

✓ Some pest may develop resistance to chemicals if used repeatedly.

✓ The chemicals are relatively expensive to the local farmers.

Characteristics of good pesticide.

✓ It must be toxic to the pest.

✓ It must not be toxic to non-biological agents.

✓ It should be harmless to human and other mammals.

✓ It must be persistence

✓ It should be easy to apply.

✓ It should be affordable to farmers.

5. LEGISLATIVE CONTROL METHOD (QUARANTINE)

✓ This is a lawful regulation of areas to prevent pest damage. Quarantine is done to;

✓ Reduce population of already established pests

✓ Prevent introduction of spread of pests in areas where they have not reached.

6. INTEGRATEED PEST MANAGEMENT (IPM)

✓ This is the use of many pest control methods to bring down the population of pest to a level which is not harmful.

Advantages of IPM.

✓ It provides permanent solution to pest problem since one method reinforce the other.

✓ It is environmentally friendly since the use of chemical is put last.

Disadvantages of IPM.

✓ Farmers are not well equipped with the knowledge of carrying out IPM.

✓ The method rarely kills all pests but only reduces their numbers.

✓ It takes a lot of time.

CROP DISEASES AND THEIR CONTROL

DISEASE:

It is a condition that interferes, impairs or disturbs the normal performance of an organism.

A disease is a deviation from good health.

Harmful Effects of Crop Diseases

✓ Lowers crop yield.

✓ Poor quality products hence reduced market value.

✓ They cause food poisoning by producing toxic substances such as *Aspergillus flavus* in maize produces *Afflatoxin*; *Ergot* in wheat and barley causes nerve endings.

✓ Increase the cost of production.

CLASSIFICATION OF PLANT DISEASES

a) FUNGAL DISEASES

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

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

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

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

Examples of Fungal Diseases

1. Late Blight

✓ Caused by *Phytophthorainfestans* .the disease affects most members of the *solanaceae* family such as Irish potatoes and tomatoes.

✓ The fungi are parasitic and feeds by sending short *hyphae* called *haustoria* into the cells of the host.

✓ Haustoria absorb plant nutrients (manufactured food) from the plant cells resulting in the death of the cell.

✓ The fungi reproduce by spore formation, which are dispersed by wind and raindrops.

✓ It spreads very quickly during warm moist conditions.

Symptoms

✓ Rapid drying of the leaves forming dry patches (necrotic lesions) on leaves and fruits.

✓ Affected fruits appear rotten and fall off prematurely.

Control

✓ Spraying with Bordeaux mixture and other copper based fungicides.

2. Rusts

✓ Cause – Puccinia spp.

✓ They attack the leaves and stems of most cereal crops.

- P. Sorghi - sorghum
- P. graminis. Maize

Symptoms

✓ Infected leaves have red to brown pustules hence reduced photosynthetic are and low yields.

✓ Crops appear rusty.

Control

✓ Spraying with Bordeaux mixture and other copper based fungicides

3. **Smuts**

✓ Cause – Ustillago spp.

- U. scitiminea – sugar cane
- U. nuda - wheat
- U. maidis - Maize.

✓ This produces large number of black spores, which forms black masses on maize tassels and maize cob.

Control

✓ Hot water treatment of the seeds.

✓ Use of certified seeds

✓ Crop rotation.

✓ Field hygiene e.g. rogueing and proper disposal of previous crop residue.

4. Coffee Berry Disease (CBD)

✓ Cause – *Colletotricumcoffeanum*.

✓ It attacks the flowers, leaves and berries.

✓ Flowers and leaves have dark brown spots.

✓ Spots on leaves develop along the margin and later spread to the rest of the leaf causing defoliation.

✓ The disease attacks both green and ripe berries.

✓ Attacked green berries fail to form beans and are hollow.

✓ Attacked ripe berries have sunken wounds and are difficult to pulp/process.

Control

✓ Spraying with appropriate copper based fungicides.

✓ Open pruning.

✓ Resistant varieties e.g. Ruiru 11.

Other Fungal Diseases

✓ Damping off. *Pythium spp.*

✓ Powdery mildew.

✓ Root rots – *Armillaria spp*.

✓ Downey mildew – *Peranospara spp*.

✓ Early blight – *Alternaria spp*.

✓ Anthracnose – ***Colletotricumlindemuthianum***

b)VIRAL DISEASES

✓ All viruses are parasitic and very small.

✓ They are only able to reproduce and multiply in living tissues.

✓ When outside living tissues, they form spores in cysts, which remain inactive until they get into a living tissue.

✓ They are therefore obligate parasites. Viral infections interfere with important life processes of plant such as photosynthesis, respiration, transpiration, and nitrogen utilisation.

Symptoms of Viral infections

✓ Leaf chlorosis – loss of chlorophyll.

✓ Leaf curling.

✓ Mosaics – production of light green patches on leaves.

✓ Malformations (distortions) of plant parts e.g. galls (swellings), small leaves etc.

✓ Rosetting –production of abnormally short nodes hence stunting.

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

Examples of Viral diseases

✓ Maize streak. – Formation of white/yellow stripes on leaves parallel to midrib.

✓ Greening disease – attacks leaves of citrus.

✓ Tristeza – attacks citrus trees. The leaves fall off and there is dying of twigs.

✓ Cassava mosaic -

✓ Brown streak of cassava

✓ Potato leaf roll

✓ Tobacco

✓ Groundnut rosette.

Viral diseases are controlled by controlling the vectors.

c)BACTERIAL DISEASES

✓ Bacteria are facultative parasites. They are single celled and microscopic. Not all bacteria are harmful.

✓ Some are beneficial to man e.g. *Rhizobium spp* which is a nitrogen fixing bacteria.

✓ They may be transmitted through insects, wind, raindrop splashes, manures, seeds, irrigation water, cultivation implements and pruning knives.

✓ They enter plants through openings such as stomata, lenticels and wounds.

Symptoms of Bacterial Diseases

✓ Wilting even when water is in adequate amount due to blockage of xylems.

✓ Cankers – results into the death of plant tissues.

✓ Gall formation in the infected tissues.

i) Bacterial Blight of Coffee (BBC)

Cause – *Pseudomonas syringe.*

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

Symptoms

✓ Dark necrotic lesions with water soaked margins on affected parts.

✓ Shoot die back.

✓ Cankers on mature bark and wood killing the whole plant.

Control

✓ Spraying chemical e.g. Supanil, before, during and after the flowering periods especially during the wet weather.

ii) Bacterial wilt (*Pseudomonas solanacearum*)

✓ Attack potatoes, tomatoes and other *solanaceae* plants

✓ Affected plants wilt even when the soil is moist.

✓ Leaves droop and plants eventually die

✓ High temperature accompanied by wet conditions favour the disease.

iii) Black arm of cotton

iv) Black rot of cabbage

v) Halo blight of beans

d) Nutritional disorders

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

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

e) OTHER CAUSES

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

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

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

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

CONTROL OF CROP DISEASES

a) Cultural methods

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

- ✓ Planting resistant crop varieties that can withstand the effect of certain diseases without lowering the yields e.g. line1- IV are coffee varieties resistant to CBD.
- ✓ Practicing proper spacing of crop. Overcrowding results to quick spread of diseases.
- ✓ Use of health planting materials. Some diseases are seed borne and can effectively be controlled by use of artificial seeds for planting.
- ✓ Practicing field hygiene e.g. burning of crop residue destroying infected plants etc.
- ✓ Drying of cereals and pulses to a moisture content of 12 – 13% before storage. This discourages attack by moulds (fungi)
- ✓ Heat treatments of some planting materials e.g. treating sugar cane cutting with water at 50^0c for 30 minutes control ratoon stunting disease effectively.
- ✓ Proper pruning of crop destroys the micro- climate that may have encouraged buildup of diseases causing organisms.

b) Chemical control

Chemical control should be practiced only when all other methods have proved to be ineffective and when it'seconomical.Chemical control measures include:

- ✓ Seed dressing

This is the application of fungicides before planting seeds.

The fungicides prevent attack on the planted seeds.

- ✓ Spraying

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

- ✓ Soil fumigation.

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

Advantage of chemicals

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

Disadvantages of chemicals

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

c). Legislative method

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

PASTURES/ GRASSLAND MANAGEMENT

TERMS USED

✓ **Pasture** - This is a fenced area demarcated forage plant usually improved and on which animals are grazed.

✓ **Fodde**r – This is a grass or legume that is cut and carried to the stalk for indoor feeding.

✓ **Forage** – This is a plant grown primarily for feeding livestock.

✓ **Hay** – This is feed produced by hydrating green forage to a moisture content of 15% or less.

✓ **Silage** – This is forage preserved in a succulent condition by partial formation.

✓ **Palatability** – This is the relative attractiveness of feed to an animal.

✓ **Herbage** – This refers to leaves, stems and other succulent part of forage plant that animals can feed on.

✓ **Stocking rate** – This is the number of animal grazing in unit area of pasture land irrespective of reliable or available herbage.

✓ **Carrying capacity** – This is the number of animals a given pasture is able to support for a given period of time.

TYPES OF PASTURES

There are two main types of pasture i.e.

Natural and Ley pastures

NATURAL PASTURE

This is open area with a dense cover of native grasses and other plant species.

ADVANTAGES

✓ forage plants found in natural pasture are well adapted to natural condition hence can survive even under poor management,

✓ Natural pasture contains a variety of forage plant needed in the animal diet.

✓ They are found in areas that are difficult to cultivate hence help in the utilization of such idle places.

✓ They can support a large population of local livestock species like goats, sheep, and cattle.

✓ They are cheap to maintain since they do not require a lot of care.

✓ They require fewer inputs during improvement.

DISADVANTAGES

✓ They are less productive in terms of herbage yields and nutritive value.

✓ The grasses mature very fast becoming stemy and coarse hence reducing palatability and nutritive value.

✓ They are usually grazed communally hence high chances of more livestock using it leading to overgrazing.

✓ Due to poor management of natural pasture livestock diseases spread very fast from herd to herd.

LEY PASTURE

These consist of improved grasses and legumes that provide high quality forage. Ley pastures are used for intensive farming and particularly for dairy cattle.

LIMITATIONS

✓ High cost of establishment i.e. money is needed to prepare the land, buy seeds and fertilizers.

✓ Lack of viable seeds – seeds are not readily available on a commercial basis for Ley pastures.

✓ Poor quality animals – Most farmers rear poor quality animals which cannot give profitable returns to cover the cost of leys.

✓ Poor managerial skills – Most farmers lack basic knowledge and skills of managing Ley so that they can be productive for a long period of time.

✓ Poor soil – Most farmers are not willing to surrender their fertile soil for Ley pasture production.

✓ Unreliable rainfall – Ley pasture production requires rainfall which is not less 800mm annually and must be well distributed.

IMPORTANCE OF PASTURES

- ✓ They provide organic matter to the soil after rotting.
- ✓ They provide a wide range of nutrients to grazing animals.
- ✓ They help in utilizing idle land.
- ✓ Deep rooted pasture plants recycle plant nutrients from deeper layer to soil surface for rooters to use.
- ✓ They can break life cycle of pest when planted in a rotation with crops.
- ✓ They can reduce water evaporation from the so acting as a cover.
- ✓ Pastures are the cheapest source of feeds for animals
- ✓ The root of pasture plant will bind soil particles together hence reducing soil erosion.
- ✓ Pasture plant, particularly legumes improves the soil fertility by fixing nitrogen into the soil.

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IMPROVEMENT OF NATURAL PASTURES

- ✓ Fencing - The area should be fenced to exclude wild animals and intruders.
- ✓ Remove bushes and dense tree canopy so that the pasture grasses can receive enough light.
- ✓ Weeds control – Poisonous and notorious weeds should be removed.
- ✓ Provision of water to animals – Watering points should be well distributed to avoid over grazing and trampling on pastures in some places.
- ✓ Erosion control – Stolonferous grass spp should be planted on bear surface or in over grazed area to reduce soil erosion.
- ✓ Over sow – this is the introduction of improved forage spp more especially legumes in natural pasture to improve nutrient content.
- ✓ Control grazing / rotational grazing / strip grazing – This encourages efficient forage utilized and reduces over grazing.
- ✓ Establishing fodder bank that can be fed to animals when fresh herbage is scarce.
- ✓ Distribute salt licks evenly in a pasture to stop animals from creating small path in a pasture as they move to the point with the licks.
- ✓ Practice control burning so that all pasture with parasites are got rid of to give way for the young and nutritious forage.

✓ Draining water logged area so as to encourage proper forage growth and control parasites

FACTORS TO CONSIDER BEFORE ESTABLISHING A PASTURE

✓ Type of soil – A farmer should consider a good soil with a good ability to retain moisture

✓ Topography – pasture land should have a gentle slope which allows easy use of machines during seed bed preparation and planting.

✓ Climate – The area should have adequate rainfall with about 800mm during dry periods.

✓ Planting materials – There should be good quality planting materials that ensure good pasture establishment.

✓ Cost of production – The farmer should make sure that the expense involved in pasture establishment can be met from the income of the animals.

✓ Availability of pasture seeds – The pasture under consideration should have readily available seeds with in the environment.

CHARACTERISTICS OF A GOOD PASTURE SPECIES.

✓ It should be easy to establish hence reducing cost involved in replacing the seeds that failed to establish.

✓ It should be able to provide herbage even in times of scarcity

✓ It should be drought resistant. In order to meet this deep rooted species are always preferred.

✓ It should be easy to manage i.e. easy to plant, weed and harvest.

✓ It should be highly palatable so that the animals can take it.

✓ Should match with the nutrient requirement of animal.

✓ It should show a high resistance to grazing i.e. the species should be able to regenerate after grazing and persist for atleast three years

✓ It should be highly resistant to pest and diseases that can attack the pasture.

✓ Should be able to produce a large quantity of dry matter in a year for the animals to graze on.

✓ It should have a suitable height from the ground to allow easy grazing by the animal.

✓ It must be a pasture that can be easily mixed with other pasture species without having any effect on them or being affected

✓ It should have readily available seeds that can be used for propagation.

TYPES OF PASTURES

Pasture is divided into two broad groups. i.e.

✓ Pasture grasses

✓ Pasture legumes

Examples of pasture grasses

✓ Guinea grass - ***Panicummaximum***

✓ Rhode grass - **Chloris*gayana***

✓ Congo Signal grass - ***Brachiariaruziziensis***

✓ Elephant grass - ***Pennisetumpurpureum***

✓ Kikuyu grass - ***Pennisetumclandestinum***

✓ Nandi grass - ***Setariaanceps***

✓ Thatch grass - ***Hyparrheniarufa***

✓ Star grass - ***Cynodondactylon***

Examples of common pasture legumes

✓ Green leaf Desmodium - ***Desmodium*intortum**

✓ Silver leaf Desmodium - ***Desmodiumuncinatum***

✓ Stylo - ***Stylosanthesgracilis***

✓ Glycine - ***Glycinewightii***

✓ Centro - ***Centrosemapubescens***

✓ Lucerne - ***Medicagosativa***

✓ Clovers- ***Trifoliumspp***

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ADVANTAGES OF INCLUDING LEGUMES IN A PASTURE

- ✓ They fix nitrogen into the soil hence improving soil fertility for other plant species.
- ✓ They show a high resistance to drought hence can be relied on during the dry season.
- ✓ They increase the palatability of the pasture since they are highly palatable.
- ✓ Since they are deep rooted, they help in recycling plant nutrients for use by other plant species.
- ✓ They reduce cases of bloat in animals since they are not very succulent.
- ✓ A good number of them have broad leaves hence have the ability to control soil erosion.
- ✓ The legumes supply protein to the animals which supplement the grass.
- ✓ They give longer grazing period since they mature at different times.
- ✓ They produce better quality and quantity of foliage for the animals.

ADAPATATION OF FORAGE PLANTS TO THE ENVIRONMENT

✓ They produce very many feeds which increases their chances of survival

✓ Their seeds are light hence can be easily dispersed by wind.

✓ they can withstand defoliation and regenerate quickly

✓ They have short life cycle hence able to utilize the shortest period of good conditions

✓ some have thorns and hair which discourage animals from eating them

✓ Some species produce chemicals which keep off animals

✓ Some have underground stem (rhizomes) which will sprout when the leaves and stems are destroyed.

✓ Some grass seeds possess hard seed coat that cannot be destroyed by the animal digestive system.

CONSERVATION OF HERBAGE.

Herbage can be conserved into two major ways i.e.

✓ Hay

✓ Silage

Reasons for conserving forage.

✓ To distribute available forage for animals throughout the year.

✓ To provide feed for the dry season.

✓ To ensure better and full utilization of available land.

✓ On a large scale, conserved forage can be sold as hay etc

HAY

This refers to dried forage mainly pasture grasses and legumes e.g. desmodium and Rhodes grass.

CHARACTERISTICS OF A GOOD HAY

✓ Good hay should be leafy since leaves are richer in food value compared to other parts of the plant.

✓ Should be prepared out of herbage cut at the stage near flowering when the plant is highly nutritious.

✓ It should be green in color since the green Colour signifies the presence of Vit .A

✓ It should be free from dust and moulds which reduce palatability

✓ It should be soft and pliable for easy consumption by the animals.

✓ It should be free from weeds and poisonous plants

✓ It should have a smell which is a characteristic of the plant from which it is made.

✓ The moisture content of hay should not exceed 15% since high moisture may cause rotting.

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FACTORS AFFECTING THE QUALITY OF HAY

- ✓ The species of grass – some grass species produce high quality hay since they can be easily turned and have nutrient content.
- ✓ Storage – Proper storage of hay by protecting it from rain and sunlight preserve the quality.
- ✓ Stage of cutting the grass – Grass cut before flowering produces high quality hay than that cut after flowering.
- ✓ Level of drying – Poorly dried hay becomes moldy and over dried hay lacks Vit. A

PROCEDURE OF MAKING HAY

- ✓ Select a suitable plant species with high nutrient to be used in the making of hay.
- ✓ Cultivate the plant species on a good soil where it can obtain the required nutrients.
- ✓ Harvest the plant species just before flowering when it contains a lot of nutrients.
- ✓ Dry the hay to a moisture content of about 15%
- ✓ Tie the hay in bales and prepare it for storage
- ✓ The hay should be stored in a place well protected from rain and sunlight to preserve the quality.

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SILAGE

This is the herbage cut before flowering and converted into succulent feed through the process of fermentation. It can be made from any succulent green material such as sweet potatoes vines, young maize, sunflower sorghum, young Guatemala grass and elephant grass.

N.B. High protein foliage mixed with starchy foliage in ratio 3:1 give well balanced silage.

THE PROCESS OF ENSILING (MAKING SILAGE)

- ✓ Cut the grass when it is about to flower and incase of legumes when they have formed pods.
- ✓ Chop the grass into small pieces of about 4cm long that can be easily packed.

- ✓ Park the material in the air tight chamber (silo) and compress it to exclude air.
- ✓ Add fermentable water soluble carbohydrates like **molasses** which provide energy to the microbe during fermentation process.
- ✓ Add **urea** at a rate of 5Kg per ton so as to increase nitrogen content of the silage.
- ✓ When the silage chamber is full, seal it off from the atmosphere to exclude air and water.
- ✓ Allow the materials to ferment for At least three weeks
- ✓ Monitor the temperatures in the silo to ensure proper fermentation. When temperatures drop, molasses should be added to provide energy to the microbes carrying out fermentation.

FERMANTATION PROCESS

- ✓ The material is under fermentation through the action of lactobacillus bacteria.
- ✓ Organic acids are produced and the major one being lactic acid
- ✓ Lactic acid gives silage a good flavor, kills off the harmful microbes and acts as the preservative for silage.
- ✓ The PH has to be low between 3.8 -4.3 and the temperature must rise to about 37.8^0C to encourage fermentation by lactobacillus.
- ✓ If the temperatures are low, add more **molasses** into the silage.
- ✓ Add water to lower temperature incase they are high.

N.B. Low temperature can be avoided by:

✓ Partial drying of the material before ensiling to reduce moisture in the silage.

✓ Filling the silage chamber rapidly but compressing the material lightly.

✓ Sealing the silo immediately after the final packing to exclude air as much as possible.

N.B. Forage crops contain other species of bacteria such as *clostridium ssp* which convert sugars and lactic acid to butyric acid.

Butyric acid gives silage a foul smell and makes it less palatable.

FACTORS AFFECTING THE QUALITY OF SILAGE.

✓ The type of grass and legume species ensiled

✓ The stage of growth of the species ensiled

✓ The speed of ensiling

✓ The type and amount of additive used.

✓ Consolidation to exclude air from ensilage.

✓ The moisture content of the material ensiled

✓ The degree to which the temperature rises during ensiling.

REASONS FOR MAKING SILAGE

- ✓ For getting money
- ✓ Increase total amount of herbage produced per unit area
- ✓ Get feeds for use during periods of forage scarcity
- ✓ Conserve forage in succulent form
- ✓ Avoid forage wastage in periods of planting and abundance
- ✓ Increase number of livestock that can be kept per unit area
- ✓ Enables animals eat plant materials that they would not eat when fresh.

ADVANTAGES OF SILAGE.

- ✓ In increases the animal's appetite since it is very palatable and so increases an animal's intake of a feed.
- ✓ It is easier to store than the same quantity of hay since it requires less space per unit weight to store.
- ✓ The losses incurred during ensiling are less than those incurred in making hay.
- ✓ Many species that the animal cannot eat in fresh form can be eaten when ensiled.
- ✓ Under proper storage, silage can stay for several years without losing quality.
- ✓ Because the materials retain succulence, fire outbreaks during storage are avoided unlike in the storage of hay.

✓ There is increased efficiency of feed use since the animal rejects very little of the feed.

PROBLEMS OF USING SILAGE.

✓ Some nutrients are lost due to seepage in the process of silage.

✓ It's more laborious

✓ The plant materials are difficult to compact effectively and some rotting is inevitable.

✓ It is expensive in terms of preservatives used.

✓ It requires large quantities of materials for it to be economical

✓ Poorly fermented silage has a bad smell that it may be introduced into the animal products.

HOW TO REDUCE LOSSES DURING SILAGE MAKING.

✓ Careful harvesting of the material to reduce losses of leaves and contamination by soil.

✓ Proper sealing of the silos to prevent re-entry of air into the silo.

✓ Proper fermentation of the material to exclude oxygen and acid fermentation.

✓ Proper chopping of the material to ensure proper fermentation.

✓ Wilting of the material before ensiling to reduce the moisture content and reduce the possibility of rotting.

- ✓ Addition of additives to increase the energy supply for the bacteria and preservatives.
- ✓ Quick use of the material once the silo has been opened to reduce the chances of spoilage due to exposure to the environment.

STANDING FORAGE

This is the cheapest, easiest and most commonly used method of fodder conservation. This implies deferring cutting of the forage for the dry season feed. It however produces herbage of low quality but it can be supplemented by addition of additives.

FORAGE UTILIZATION METHOD

a. CONTINUOUS GRAZING

This is an extensive system of grazing in which livestock remain on the same pasture for prolonged period.

ADVANTAGES OF THE SYSTEM

- ✓ Fencing costs are reduced or avoided completely.
- ✓ It allows animals to have free access to any part of the pasture
- ✓ No costs are involved in improving pastures.

DISADVANTAGES

- ✓ It allows selective grazing which can lead to pasture wastage
- ✓ It encourages the buildup of ticks and internal parasites within the grazing place.
- ✓ It may result into under stocking or over stocking as plant growth and seasonal conditions change.
- ✓ It's difficult to control / diseases amongst animals since the system encourages communal grazing
- ✓ Pasture improvement is extremely difficult as more people are involved in using the pasture.
- ✓ May easily result into overgrazing and destruction of pastures

b. ROTATIONAL GRAZING

This is where pastures is divided into paddocks and animals are allowed to graze in one paddock at a time until the herbage is uniformly grazed to a given height then moved to another paddock. High producers like lactating animals are allowed first into paddocks for it to graze the more nutritious herbage.

ADVANTAGES OF ROTATIONAL GRAZING:

✓ Provides a uniform developed pasture due to uniform grazing

✓ It allows maximum utilization of herbage by avoiding selective / spot grazing.

✓ Forage yield is potentially higher since pastures are allowed to regenerate than in other systems.

✓ Intervals between grazing allow for remediable practices like fertilizer application, weeding etc.

✓ It's a good method used in the control of parasites like ticks, roundworms, and liver fluke.

✓ It reduces instances of over grazing and under grazing hence controlling destruction of pastures

✓ It makes management practices easy as animals are confined in one place.

✓ It allows flexibility in the use of pasture land since crops can be planted in the idle paddocks.

✓ It can allow higher stocking rate of animals.

✓ Controlled breeding is easy to practice since animals can be grouped according to sex

DISADVANTAGES

✓ It requires a high initial cost of establishing fences on pasture land.

✓ Requires a high level of managerial skills in terms of repairing the fences, improving the pastures etc

✓ Fences can easily injure animals.

✓ Over trampling on pastures by animals leads to wastage

✓ May require a lot of Labour for repairing farm structures and managing animals

c. ZERO GRAZING

This is where animals are confined in structures / stalls where they are fed on fresh forages cut on a daily basis.

ADVANTAGES:

✓ Animals are protected from adverse Climatically conditions

✓ Feed taken in by each animal is easily known hence easy to keep feeding records.

✓ It's easy to identify sick animals since they are in close observation

✓ It's easy to collect manure from the animals since they are confined in one place.

✓ Disease spread is reduced since animals are not in contact with others from another herd.

✓ There is high production since animals do not spend a lot of energy looking for pasture and water

✓ Selective grazing and trampling on pastures is effectively controlled since animals are fed on pastures cut from the field.

✓ It's easy to carryout management practices on animals under this system as animals are under confinement.

✓ The system permits high stocking rate since a large number of animals can be kept on a small piece of land

DISADVANTAGES:

✓ The method is capital intensive i.e. requires a lot of capital for constructing animal structures and feeding

✓ It requires a lot of Labour which can be used in collecting fodder, cleaning the stalls etc.

✓ It cannot support a large number of animals

✓ The system is applicable economically in places where market for milk is readily available to cover the costs involved easily.

✓ It may lead to loss of soil fertility if manure is not taken back to the fodder garden.

✓ The animals lack exercise which can affect their health.

d. DEFERRED GRAZING

This is where a certain paddock is set aside to allow the accumulation of standing hay which can be grazed on during periods of pasture scarcity

✓ Pasture seeds are dispersed for pasture stand improvement

✓ It provides herbage during periods of scarcity.

✓ It allows pastures to develop greater root and crown which is important for subsequent re-growth.

✓ The pasture can be used in the control of soil erosion

✓ It allows for natural establishment of pastures

DISADVANTAGES

✓ The pasture is not as nutritious as the fresh pasture hence a need to supplement it.

✓ Requires a large piece of land for practicing deferred grazing

✓ Does not permit high stocking rates

b) STRIP GRAZING

This is where strips of fresh pastures are made available each day to animals by moving an electric fence forward.

The grazed area is sealed off for regrowth and excess pastures conserved.

ADVANTAGES

- ✓ The animals enjoy fresh grasses each day
- ✓ The grass is eaten at its highest nutritive value
- ✓ Allows intensive grazing hence utilizing pastures efficiently
- ✓ It is highly flexible since it may allow more than one activity on the land

DISADVANTAGES

- ✓ Requires more Labour
- ✓ Requires more skills in using an electric fence
- ✓ Pastures may be destroyed as a result of overgrazing.
- ✓ Ground where animals pass is destroyed and lost since pastures may fail to grow there

c) TETHERING.

This involves tying the animal to a post with a rope such that it feeds within a restricted area. The rope may also have a metal ring that slides along a strong wire supported by strong poles.

ESTABLISHING A PASTURE

✓ Clear the land to remove trees and bushes that may interfere with pasture growth

✓ Prepare a firm (for moisture conservation), fine (to bring small seeds in contact with soil) and weed free (reduce competition for nutrients) seedbed by burning, ploughing, and harrowing

✓ Apply fertilizers to the seed bed to improve soil fertility more especially phosphatic fertilizers for proper pasture establishment

✓ Select good quality seed for planting depending on the animal's needs and environment

✓ Treat the seeds to ensure uniform and proper germination by scarification, inoculation and pelleting

✓ Sow the seeds shortly after the rains so as to take advantage of soil nitrogen made available by mineralization. Methods of sowing are drilling, broadcasting and row planting

✓ Apply pesticides and fungicides to control pests and diseases in pastures

CARRYING CAPACITY AND STOCKING RATE

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

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

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

Example

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

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

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

✓ A Guernsey weighing 450kg would consume

2.5 X 450/100 X 365/1000=4.1 tons DM

✓ Likewise, an Ayrshire weighing 500kg live weight would consume,

1.5 X 500/100 X 365/1000=4.65 tons DM.

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

Some Recommended Stocking Rates on Different Pastures

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

Effects of overstocking

✓ Insufficient regrowth period for the forage hence effects similar to those of very early defoliation.

✓ Overgrazing and loss of soil cover leading to soil erosion.

✓ Invasion of undesirable plant species especially weeds and shrubs.

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CROP BREEDING / IMPROVEMENT

This is a process of changing crops genetically to suit man's needs of food, easy harvesting etc.

Or

It's a directed adjustment of crop plants to fit specific environment and production practices.

METHODS OF CROP BREEDING

1. MASS SELECTION

Here in breeding plants are selected basing on the individual character and these are used in the breeding programme.

2. BULK BREEDING

Products of F1 are grown in bulk before making a single plant selection depending on their performance.

3. PEDIGREE BREEDING

This is the most used method and it's based on the performance of the ancestor and close relatives.

4. SINGLE DESCENT

Here one seed from F2 or F3 is used as a parent for the next generation.

5. RECURENT SELECTION

This is whereby the best individual resulting from a first selection cycle are crossed to generate the materials for the next selection cycles.

AIMS OF CROP BREEDING / IMPROVEMENT.

✓ To increase crop yields so as to save the problem of hunger and food shortage.

✓ To increase the nutrient content of the crop product to solve nutrient deficiency in consumers.

✓ Produce better size and color of fruits / seeds that can attract consumers.

✓ To reduce the gestation period of a crop so as to solve food shortage.

✓ Conferring disease and pest resistance in crop.

✓ Production of crops that can tolerate adverse environmental conditions like drought, low soil fertility, high temperature.

✓ To change growth characteristics of a plant in order to suit harvesting spraying and weeding.

✓ To improve on the short life of the sowed crop production

✓ To improve on seed viability character in plants so that there is no wastage of seeds during planting.

✓ Improving the taste and flavor of certain crop products.

✓ To produce crop products that is easy to prepare as food for consumers.

AGRO FORESTRY.

This is the system of farming in which farmers deliberately/intentionally plant trees that have multiple uses together with crops and/or pastures for animals on the same farm land.

IMPORTANCE OF AGRO FORESTRY.

- ✓ Trees provide shade for animals.
- ✓ Legumes planted fix nitrogen in the soil.
- ✓ Trees are a source of fodder to livestock.
- ✓ Trees support crops with weak stems.
- ✓ Some trees provide fruits which are eaten by man.
- ✓ Trees shade off leaves that decompose to form humus in the soil.
- ✓ Trees are a source of firewood.
- ✓ Trees provide materials for construction of animal shelters,
- ✓ Dry leaves are used as mulching materials.
- ✓ Trees help in rainfall formation.
- ✓ Trees add on the biodiversity.
- ✓ Trees act as Windbreaks & control erosion.
- ✓ Trees act as live fences.

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DISADVANTAGES OF AGRO FORESTRY

✓ Tree- crop damage by animals where livestock are competitors.

✓ Competition for space, light, nutrients, moisture between trees and crops.

✓ Toxification by toxic compounds produced by some tree species. This inhibits seed germination and plant growth.

✓ Trees may be a habitat to a wide range of crop pests especially where we have cereals.

Mechanization is difficult under agroforestry.

✓ During harvesting of trees, there is damage to unintended crops and this causes losses.

REASONS WHY THERE IS LIMITED ADAPTATION OF AGRO FORESTRY BY FARMERS IN UGANDA

✓ Trees, animals and crops compete for growth factors at the interface. This makes it hard for the three components to be integrated sustainably.

✓ Inadequate training and expertise in agro forestry. The farmers have limited knowledge yet there are few extension officers to train them in profitable agroforestry.

✓ Poor land tenure system and land fragmentation that limits the size of available land for integrating trees, crops and livestock.

✓ Inadequate supply of viable seeds and seedling for tree species that can be
profitably integrated in the different agro forestry systems.

✓ Limited demonstration sites for testing tree species for the different agro ecological Zones beforerecommendation for planting by these farmers.

✓ Farmers in Uganda are no aware of many successful agro forestry farmers.The science of Agro forestry has remained less popular and most rural farmers don't have modal successful farmers.

✓ Agro forestry is a form of mixed farming that requires diverse skills and expertise to handle and manage all the enterprises. This expertise is lacking to most farmers.

✓ Inadequate infrastructure like buildings, equipment and tools for use in agro forestry by most farmers in Uganda. This makes post-harvest handling of agro forestry products difficult.

CHARACTERISTICS OF A GOOD AGROFORESTRY TREE SPECIES

✓ It should be able to fix nitrogen into the soil (leguminous).

✓ It should have a deep rooting system to absorb water and nutrients from deeper layers.

✓ It should have few extensive lateral roots on the top soil to reduce competition with associated crops.

✓ It should have a less dense canopy to reduce shading of companion crops.

✓ It should be adapted to a wide range of environmental conditions.

✓ It should be easy to establish and get rid of when desired.

✓ It should withstand repeated pruning.

✓ It should be nutritious and palatable to livestock.

✓ It should be multi-purpose to produce various products e.g. firewood, poles, green
manure.

Note that all trees and shrubs can meet all the requirements thus selection depends on the major intended use in an agroforestry system.

AGRO-FORESTRY SYSTEMS

Agroforestry systems are classified either according to their function or the land use
technology. The main agroforestry systems according to components include the following;

✓ **Silvo-pastoral systems**: the integration of trees with pastures or livestock on the same management unit. For example, growing fruit trees like pears, mangos, oranges and shrubs in widely spaced tree rows.

✓ **Agro-Silvo-pastoral systems:** this is the integration of trees, crops, pastures and livestock on the same management system. It is mod at producing fodder wood and animal products. Species planted include calliandra, acacia, and pine. This system can be practiced on the " farm under the following practices:

✓ **Aquaculture;** this is the keeping of aquatic organisms like fish in pondssurrounded by shrubs, trees and grass lawns.

✓ **Entomoforestry:** this refers to the rearing of useful insects in association with trees. E.g. apiculture (bee keeping) and sericulture(silkworm rearing)

✓ **Apiculture;** the keeping of bees for honey, propolis, bee venom and other bee products in association with trees, crops and fodder.

✓ **Protein banks**; these are leguminous shrubs and fodder planted along edges of the grazing
areas to supply proteins to livestock.

✓ **Agro forests;** the planting of trees together with fodder and short term crops on the same land.

✓ **Agro-silvo-cultural systems:** major components are trees/shrubs and crops. The system is common where fodder, wood and crops are produced together.

This system can be practiced on the farm under the following practices

✓ **Home gardening**: the planting of multipurpose trees, crops and livestock around homesteads.

✓ **Taungya;** the growing of short term crops in young tree plantations during their early years of establishment. This helps to control weeds, control erosion, and protect the young trees against wind.

Factors to consider while selecting tree species for agro forestry

✓ Suitability of tree species to the farmer's preferences and needs.

✓ Adoptability of the species to the environmental conditions.

✓ Complementality of the growth habitats to those of crops. Trees e.g. that shed off leaves allow light penetration.

✓ Suitability of the species to a specific technology; system to be designed should reflect the purpose to which the trees are needed.

(c) Important trees, shrubs and their purpose

✓ **Calliandra**; for fuel, poles, fodder, mulching.

✓ Cajanus Cajan (pigeon pea) feed, fodder, wind brakes.

✓ Acacia alliola; fodder, wood, fuel.

✓ Sesbania sesban; fodder, fuel, poles.

✓ Erythriyia abyssinica; fuel, wood, mulch, live fence.

Tree harvesting methods

✓ **Coppicing**; this involves the cutting of young vigorous trees to a stump or stool of 30cm high. A clean cut should be done at a slanting angle to avoid holding water and facilitate regeneration. The young shoots should be thinned to 2-3 of the largest.

Advantages of coppicing

✓ Helps to reduce competition for growth factors with associated crops.

✓ Saves the costs and times of replanting new trees. In the field.

✓ Increases productivity since more than one tree may be produced on one stump.

✓ Can be used in repair or replacement of aged stems or branches.

Disadvantages of coppicing

✓ Not all trees have coppicing ability

✓ The practice requires a lot of labour.

✓ The practice requires a lot of skills.

Pollarding; this is the cutting of all branches including the top part of treesat least 2m above the ground.

Reasons for pollarding

✓ To regenerate the crown (new branches).

✓ To reduce shading of nearby plants.

✓ Promotes early harvesting of wood, timber, and other products.

✓ To promote vigorous growth ofmultiple stems for fodder, firewood orfuel.

✓ To avoid livestock from reaching thecrownif it is at 2m and below.

✓ For easy harvesting.

✓ Can be used to repair damaged tree branches.

Looping; this is the cutting ofbranches anywhere from the tree ina haphazard manner (in a random way). This is done in order to obtain good green fodder for livestock.

Pruning: involves removal of branches from the lower part of the tree crow sometimes called side pruning.

The objectives of pruning are;

✓ To reduce shading of associated crops.

✓ To improve quality of the stem (straight & knot free for timber/poles)

✓ To provide early harvest of branch wood for fuel, fodder etc.

✓ To remove the good environment for pests and rodents.

✓ To increase growth of the tree.

Thinning: This is a selective process of removing or killing some trees or extra shoots to improve spacing between trees. It makes early

harvesting of firewood, and poles possible, it promotes straight growth of trees. Thinning provide a chance to selectively remove poorly formed trees and species of low value.

ANIMAL PRODUCTION

LIVESTOCK MANAGEMENT

Livestock includes all animals kept on a farm for economic purposes e.g pigs, cattle, goats, sheep, camel, chicken, ducks; bees, pigeons, turkeys e.t.c.

IMPORTANCE OF LIVESTOCK.

- ✓ It's a source of income more especially when the animals are sold wholly by the farm.
- ✓ The livestock industry provides market to the agro chemical industry through the sale of drugs and feeds.

- ✓ Livestock are a good source of proteins for man in form of eggs, milk, meat e.t.c
- ✓ The livestock industry provides employment both directly to people working in leather turning industries and milk processing plants.
- ✓ Livestock provides manure which is rich in nitrogen and phosphorus to be used in crop gardens.
- ✓ Livestock have found a place in cultural and traditional ceremonies where they are being used as sacrifices.
- ✓ Some animals like the cattle, donkeys and the horses are being used as a source of Labour in transporting farm produce and ploughing.
- ✓ On the national level, livestock products like hides and skins are a good source of foreign exchange for the country which improves the economy.
- ✓ The livestock industry is a source of government revenue when taxes are levied on livestock and their products.

FACTORS DETERMINING THE TYPE AND BREED OF LIVE STOCK TO BE KEPT.

- ✓ **Climate:**

The high temperatures of the day tend to discourage most of the exotic animals of European origin and such animals are limited to particular areas of Uganda with favorable environmental. Conditions

- ✓ **Pests:**

The presence of pests like ticks and tsetse flies has limited the raring of exotic animals since they are more prone to tick borne-diseases like: East Coast fever, Red water, etc.

- ✓ **Availability of Feeds:**

Animals like pigs require high protein feeds which are expensive for most of the farmers. This may discourage the rearing of such animals where feeds are not available.

- ✓ **Diseases:**

Like swine fever in pigs, coccidiosis and new castle in poultry tend to limit the distribution of livestock in many parts of Uganda.

- ✓ **Risk baring capacity of the farmers:**

Most farmers in Uganda are peasants with low income. This means that such farmers cannot easily take high risks of looking after high value exotic animals like Friesian cattle.

- ✓ **A low level of skills and education among farmers:**

Most farmers in Uganda are illiterate and have little knowledge on how to manage livestock to look after. This will affect their choice of livestock and hence distribution.

- ✓ **The expected additional function of the animals:**

Animals that have many functions will always be liked and their distribution in an area is high e.g. Cattle. Cattle can provide meat, milk, manure and Labour which other animals may not

- ✓ **Religion and traditional beliefs:**

Some animals are viewed as unclean by certain religion and traditions e.g. The pigs among the Muslims. This meant that such people can't look after the pigs.

- ✓ **Capital:**

In the presence of enough capital, a farmer can look after the highly productive exotic animals with less problems since he can raise all the necessary infrastructure like dips, perimeter fences, and spray races e.t.c.

- ✓ **Government policy:**

Enabling policy has led to an increase in the distribution of livestock in some places e.g. restocking of cattle some areas in Uganda like Teso with cattle.

- ✓ **Market:**

The availability of market for certain livestock or their product in a particular area will increase their distribution and vice versa.

CHARACTERISTICS OF THE LIVESTOCK INDUSTRY IN UGANDA

- ✓ The number of animals kept is unrestricted with most farmers preferring quantity to quality.
- ✓ There is very little attention given to the improvement of the pastures since they are grazed communally.
- ✓ The grazing time is limited as the animals are taken out to graze during the day and brought in the kraal at night.
- ✓ There is little planned mixed farming i.e. crop and animal units are rarely integrated.
- ✓ Breeding is rarely controlled e.g. animals mate when they are still very young and there is a lot of inbreeding.
- ✓ The watering places are very far away from the grazing places and animals spend a lot of energy walking.

- ✓ Generally the standard of livestock management in Uganda is very poor with no records kept at farms.

PROBLEMS OF THE LIVESTOCK INDUSTRY IN UGANDA.

- ✓ **Pests and diseases:**

The tropical conditions favor the multiplication of the pests like tsetse flies and internal worms. These have caused a lot to farmers.

- ✓ **Lack of enough capital:**

Most farmers in Uganda are poor and therefore can't afford expensive inputs like drugs, animal feeds e.t.c.

- ✓ **Breeding:**

In Uganda most animals are mated when they are still young and there is a lot of inbreeding which will affect the quality and quantity of livestock products.

- ✓ **Poor Housing:**

There is no proper housing for livestock in Uganda and the animals are left to sleep outside where they are exposed to advanced environmental conditions which will affect their products.

- ✓ **Poor Record Keeping:**

Most farms in Uganda lack records of individual animals and the farms in general. This makes selection for breeding and culling difficult (removal of unproductive animals in the farm)

- ✓ **Limited Extension Services:**

Most farmers do not receive enough information on livestock management from extension staff. This is because extension workers are far and are not well facilitated.

- ✓ **Poor Marketing System:**

The markets for livestock and their products are still few and scattered with fluctuating prices which discourage the farmers.

- ✓ **Poor Pastures:**

Most of the pastures graded by the animals are of poor quality which lowers animal production

- ✓ **Insecurity and cattle rustling;**

Some places in Uganda are politically insecure which leads to loss of life and property hence discouraging livestock production.

- ✓ **Harsh Climatical conditions**

Long drought leads to inadequate water and pasture which lower animal production

SOLUTIONS TO THE LIVESTOCK PROBLEMS.

- ✓ Extension workers should be facilitated so that they can give services to the farmers more especially those who are in remote areas.
- ✓ Provision of loans, farmers should be provided with loans more especially soft loans so that they have enough capital to improve on their infrastructures like fences, dips e.t.c.
- ✓ Artificial insemination should be encouraged so that farmers can maintain high quality animals which are more productive through the importation of semen.
- ✓ Marketing of livestock and their products should be organized so that farmers can easily get the information through the internet, newspapers and farmers journals about the markets and the available prices.
- ✓ Settled grazing should be encouraged so that more attention is given to the animals for better production.
- ✓ The land ownership laws should be improved so that farmers can get access to land easily with fewer costs involved. Proper land ownership also encourages the development of that particular land.

- ✓ The paddock system of grazing animals should be introduced so that animals can be controlled to reduce over grazing, encourage mixed farming and improvement of the pastures.
- ✓ Routine vaccination of animals against killer diseases e.g rinder pest, ant swine fever, foot and mouth diseases. N.B: should be done by the Government to reduce the incidence of such diseases.
- ✓ Government should endeavor to subsidize agricultural inputs so that the farmer can enjoy a higher profit margin that can encourage them to develop their farms.
- ✓ Security should be maintained in all

areas so that livestock farmers are encourage by reducing risks of property and life loss

- ✓ Valley dams should be constructed so as to solve the problem of inadequate water during drought

CATTLE.

Classification of cattle

Kingdom; Animalia

Phylum; Chordata

Class; Mammalia

Order; Artiodactyla

Genus; Bos

Species; *indicus* (humped cattle)

taurus (hump less cattle)

The immigrant cattle (long horned and short horned) are considered as ancestors of ***Bostaurus*** (European type of cattle) and the ***Bosindicus*** (zebu) type.

These mixed at different times in different ways to create the sanga cattle which is the predominant type of cattle today.

In East Africa, the sanga have been displaced by the zebu.

INDIGENOUS CATTLE

These are humped cattle of tropical origin. Examples are; Zebu, Brahmin, Sanga, Nkole and Boran

CHARACTERISTICS OF INDIGENOUS CATTLE

- ✓ They are resistant to adverse Climatical conditions like high temperatures and drought
- ✓ They can walk for long distances without losing condition
- ✓ They easily convert poor pastures into milk and meat
- ✓ They are tolerant to tick borne diseases like east coast fever
- ✓ They have few problems of reproduction
- ✓ They are cheap to buy and maintain

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EXOTIC CATTLE

These are hump less cattle that have been imported into east Africa from European countries. They are kept for milk and meat or both. Examples of exotic dairy breeds; Friesian, Jersey, Guernsey and Ayrshire

Examples of exotic Beef breeds; Galloway, Hereford, Charolais, Sussex, Aberdeen Angus, Lincoln Red, e.t.c.

Examples of dual purpose exotic breeds; Red Poll, Dexter, Short horn, South Devon and Welsh Black

CHARACTERISTICS OF EXOTIC CATTLE

- ✓ They have a high growth rate
- ✓ They are not resistant to tick borne diseases
- ✓ They may reproductive problems
- ✓ They cannot tolerate high temperatures and drought
- ✓ They require high quality feeds for high production.
- ✓ They lose condition after walking for long distances
- ✓ They require a high level of management
- ✓ They are highly productive in terms of milk and meat

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***Bos taurus* /Exotic**	***Bos indicus* / Indigenous**
Don't have a prominent hump.	Have a prominent hump.
Rounded ears held at right angles with the head.	Have long dropping pointed ears.
Have a short and wide head.	Have long and comparatively narrow head.
Relatively large with the bull weighing up to 1000kgs	Relatively small with the bull rarely weighing exceeding 700kg.
The dewlap, umbilical cord and the brisket are small or absent.	Dewlap and brisket are extensively developed.
Have thick skin which is relatively tight.	Have a thin and loose skin.
Have large amounts of subcutaneous fat.	Have small amounts of subcutaneous fat.
Hair tends to be relatively long and rough	Hair is relatively short and smooth.
Legs tend to be short and are slow moving.	Legs are long and fast moving.

Mature more easily and reach full maturity at 4 years.	Slow maturity and reach full growth at 5½ years
Back line is straight	Backline is high at the shoulders, low behind the hump and higher over the pin bones.

DIFFERENCES BETWEEN

Bostaurus **AND** ***Bosindicus***

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BEEF PRODUCTION

The main objective of beef production is to produce healthy young stocks, fatten them and sell for slaughter as meat.

Breeds of beef cattle in East Africa

The main indigenous breeds are the boran and small short horned zebus

The exotic breeds are Hereford, Aberdeen Angus, charlolais short horn and Galloway

CHARACTERISTICS OF A GOOD BEEF BREED

- ✓ Should have a high ability to mature early
- ✓ Should have a high ability to grow fast i.e. put on weight quickly
- ✓ Should have thick muscles to increase the quantity of beef produced (have a deep body)
- ✓ It should be able to breed regularly so as to increase the herd
- ✓ Should have a high ability of converting herbage into beef

✓ Should have a high resistance to pests and diseases common in the environment

✓ Should be able to survive long drought periods without losing excessive weight

✓ Should show a high degree of tolerance to heat

FACTORS DETERMINING ANIMAL PRODUCTIVITY

✓ Inheritance

This is the most important factor since as the animal received genes of high productivity, and then it can always have the potential. However, productivity is affected by environmental factors which include:

✓ Management

This involves proper care for the animal and observation of signs of ill health

✓ Feeding

Animals that are underfed will have low production and are more prone to diseases.

✓ Diseases

Irrespective of the animals potential of production diseases will always lower the animal's production.

- ✓ Climate

Under this, the most important factors are temperature rainfall and humidity. High temperatures of the day increase evaporation of water from the animals' body which reduces milk production in lactating animals.

- ✓ Humidity

High humidity reduces evaporation of water from the animal's body hence conserving it for other productive purposes like milk secretion.

- ✓ Parasites

A part from transmitting pathogens, animal parasites can extract a lot of nutrients that are supposed to be used by the animals' body.

FACTORS TO CONSIDER BEFORE ESTABLISHING A BEEF HERD

Beef cattle may be raised under the farm herd system similar to having a dairy farm, or under the range / ranch cattle system. Under any of these

systems, when establishing a beef herd there are a number of factors a farmer may need to consider.

- ✓ Type of stock
- ✓ Uniformity
- ✓ Size of the herd
- ✓ Health
- ✓ Condition
- ✓ Age and longevity
- ✓ Reproductivity / fertility
- ✓ Size of cattle
- ✓ Adaptability

SYSTEMS OF BEEF PRODUCTION

There are a number of systems for beef production requiring different levels of skill and management and some of the systems serve different purposes

- ✓ **Breeding pure bred animals**

This is a specialized undertaking and requires great skill and experience in breeding and selection of animals. The purpose is to provide pure breed bulls / replacement stock to other breeders.

- ✓ **Cow and calf systems**

Calves are left with their dams until weaning and the cows are not milked. It requires plentiful pasture and little supplementary feeding except in severe dry seasons.

- ✓ **Growing Stockers**

Stockers are mainly steers and heifers or thin animals. They are only kept for one year and are fed on pasture. Progressive farmers and ranchers can adequately manage the undertaking. The purposes are to recondition steers and prepare them for fattening and heifers are conditioned for breeding.

- ✓ **Baby Beef Production**

This is the production of tender meat from young stock. It involves breeding, rearing and fattening all done on the same farm.

At 4 – 6 months, all the calves are fed on concentrates.

The cows need full feeding in order to produce good calves.

The purpose is to finish the baby beef animals when they are 12 – 18 months old.

- ✓ **Fattening or growing**

This involves the fattening of bought in animals after being fed on high energy feeds before selling

AIMS OF RANCH MANAGEMENT

- ✓ To decrease the animal fluctuations in stocking numbers
- ✓ To reduce the seasonal fluctuation in live weight of stock
- ✓ To minimize reproductive performance towards the ideal of one calf per cow per year.
- ✓ To minimize calf mortality and losses due to diseases
- ✓ To maintain and improve breeding efficiency.

FACTORS THAT DETERMINE THE SIZE OF THE HERD

- ✓ The type of pasture species; high nutritive value of pastures therefore high carrying capacity
- ✓ The productivity of the pasture species; high rate of dry matter or forage for grazing means high number of stock
- ✓ The type of stock e.g. hardy types which can survive well in drier conditions and scarce pasture can be kept in large numbers.
- ✓ Availability of reserve feeds which enable a large herd to be carried through dry periods when pasture is scarce.

- ✓ Economic considerations which are usually of a long term nature e.g. Whether the farmer requires cash immediately and the cost of keeping a large number of animals.
- ✓ Topography of the land where over – stocking in hilly areas could result into a serious case of soil erosion.
- ✓ Availability of water , sufficient and available at all times
- ✓ The presence of poisonous plants and trees that should render portions of the ranch useless.

Drugs equipment and material that need to be kept at hand in the ranch dispensary include:

- ✓ Healing oil which can be applied on wounds i.e. after castration and dehorning
- ✓ Cotton wool for dressing wounds
- ✓ Syringes for injecting drug in the bodies of animals
- ✓ Sulphur drugs such as sulphurdimidine which is a general drug for oral treatment or injection
- ✓ Stilboestrol used in injections on cows after calving, if the after birth is retained and has to be removed.
- ✓ Spirit for cleaning wounds and sterilization of instruments
- ✓ Terramycin spray for skin wounds

- ✓ Terramycin injectable solution which has a wide spectrum and can be used as a general drug against bacterial infections
- ✓ Chlorohexidine for disinfecting e.g. cow's udders

BUTCHERY

PROCEDURE OF SLAUHTERING AN ANIMAL

a) **Before Slaughter**

The animals should at all times be handled humanly, rested and starved for 24 hours. This allows emptying of the gut and reduces spoilage and contamination of meat. The resting also conserves stored body glycogen. After slaughter, glycogen is converted into lactic acid which has a preserving effect on the meat.

Inspection of the animal to check for any deformities, injuries, sex etc. is done at this stage.

b) **Stunning**

This renders the animals senseless just before slaughter to reduce pain. Painless killing of animals is human and it is strongly recommended. Stunning can be achievedeither by use of a hammer gun or electric shock.

c)**Slaughter**

The neck of the animal is cut and it's allowed to bleed by hoisting it up. Adequate bleeding is essential to reduce meat spoilage. Skinning is then followed by **devisceration** which is the cutting open of the carcass to remove the internal organs.

d) **Inspection**

This is the postmortem inspection for infection by tuberculosis, cysts etc.

The carcass has to be passed for public consumption. Condemned carcasses are buried / burnt.

e) **Grading**

The products looked for are fat, degree of marbling, texture of meat and colour. A pale colour indicates poor quality

FACTORS LEADING TO POOR QUALITY OF MEAT FROM ANIMALS

- ✓ Poor feeding of animals leading to disease and nutritional deficiencies
- ✓ Poor meat preservation causing putrefaction
- ✓ Diseases in animals that contaminate meat
- ✓ Parasitic infection in animals causing cysts and eggs in meat

- ✓ Age of animals i.e. very young and old animals produce poor quality
- ✓ Poor animal breed that may produce poor quality meat
- ✓ Chemical poisoning of meat by drugs administered shortly before slaughter
- ✓ Harsh treatment of the animal before slaughter through beating

DAIRY CATTLE

These are cattle reared specifically for milk production.

Examples of exotic dairy breeds include; Friesian, Ayrshire, Jersey, Guernsey and Kerry

CHARACTERISTICS OF A GOOD DAIRY BREED

- ✓ Should be a high milk yielder
- ✓ Should be resistant to pests and diseases
- ✓ Should have a high fertility
- ✓ Should be docile hence easy to be milked
- ✓ Should have a large udder
- ✓ Should be able calve easily
- ✓ Should have a big milk vein
- ✓ Should be able calve regularly for a long time

- ✓ Should have a well suspended udder with four functional teats
- ✓ Should have a long lactation which ensures continuous milk production
- ✓ Should have strong hind legs for supporting a big udder

FACTORS TO CONSIDER BEFORE ESTABLISHING A DAIRY HERD

- ✓ **Capital**

This is needed in the construction of farm structures, purchase of land and the animals.

- ✓ **Land**

There should be enough land to accommodate farm buildings and paddocks where animals can graze from

- ✓ **Labour**

Both skilled and unskilled Labour is required for performing specialized work and manual Labour respectively.

- ✓ **Reliable source of water:**

Water is needed by the animals for drinking and also in other farm operations like cleaning and mixing of drugs.

- ✓ **Ready market**

There should be a ready market for milk and milk products which is easily accessible to reduce the costs incurred in looking for market.

- ✓ **Pastures**:

The place in consideration should have good pastures since the production of the animals is greatly affected by the quality of what they eat.

- ✓ **Transport and communication**

There must be reliable transport so that the farmer can easily move farm products to the market and bring back inputs.

- ✓ **The breed of the animal**

The breed selected should fit the market demand and the Climatical conditions of the place in consideration.

- ✓ **Security**

It's a very important factor for any business since insecurity results into loss of property and life

- ✓ **Government policy in place**

Should be encouraging dairy farming through the provision of good breeds of cattle

- ✓ **Climate in the area**

Should be good for dairy farming

STRENGTH OF THE DAIRY INDUSTRY IN UGANDA

- ✓ High demand for dairy products in Uganda
- ✓ Integrated farming practices can accommodate dairying
- ✓ Suitable climate in most areas of Uganda that favours animal production
- ✓ Availability of quality fresh pastures throughout the year
- ✓ Improved infrastructure that make transportation of milk to the market easy
- ✓ Increased research and development in dairy farming
- ✓ Improved extension services in dairy farming

- ✓ Historical factors like a long history of cattle keeping among tribes in Uganda

INTRODUCING EXOTIC DAIRY CATTLE IN AN AREA

- ✓ Fence off the whole grazing area to keep out intruders and pests
- ✓ Partition the grazing land into paddocks for easy pasture management
- ✓ Remove all weeds and injurious objects from the grazing land
- ✓ Install water points in all paddocks for the animals
- ✓ Introduce bait animals to the paddock to control ticks 3-6 months before bringing in the exotic animals
- ✓ Spay or dip the bait animals regularly over the whole period
- ✓ Remove the bait animals after a specified period and introduce the exotic animals
- ✓ Regularly spray or dip the exotic animals to control external parasites

MANAGEMENT OF DAIRY CATTLE

- ✓ **Regularity of care:** The operations done on these animals should be performed regularly without abrupt interruptions as those may affect the production of animals.

✓ **Kindness to animals**: Rough handling of animals like beating reduces the productivity and can even cause injuries that may be expensive to treat.

✓ **Exercise:** Animals need light exercise for good health but long distances of movement should be avoided as these require a lot of energy lowering animal production.

✓ **Grooming :** Keeping hind quarters of animals off dung, loose hair and any dirt by brushing and dipping leads to production of high quality milk.

✓ **Hoof trimming:** Overgrown hoofs should be trimmed to avoid difficulty in movement and lameness

✓ **Dehorning:** Apart from introducing uniformity in the herd, handling of dehorned animals is easy and less risky

✓ **Identification:** For record purposes, dairy animals should be identified by ear tagging notching, branding and tattooing.

✓ Provision of adequate water; Animals need enough water since the biggest percentage of their body is water. Excessive loss of water from the body reduces milk produced.

✓ **Breeding:** A farmer should aim at breeding of his herd to increase animal number and productivity by incorporating good breeds in the breeding programme.

✓ **Proper feeding**; dairy animals should be given enough and highly nutritious feeds to improve and maintain a high level of production

ANIMAL NUTRITION

Animals are fed for the purpose of production and body maintenance. The edible material given to animals is called food. It is digested, absorbed and~ utilized in the body.

Nutrients are organic and inorganic substances contained in the food materials that supports life.

The purpose of feeding farm animals include;

- ✓ For energy production to maintain the animals life
- ✓ For body growth and development
- ✓ For building resistance against disease attack
- ✓ For repair and maintenance of body cells
- ✓ For reproduction
- ✓ For production purposes in terms of milk, meat, eggs and wool.

Components of Food material include; water, protein, carbohydrates, fats and oils, vitamins and mineral salts.

WATER

The liquid part of the food.

Sources

- ✓ Free water (through drinking)
- ✓ Bound water (contained in feeds).
- ✓ Metabolic water (obtained from oxidation of food).

Functions

- ✓ Regulates body temperature.
- ✓ Transport agent in the body.
- ✓ Universal solvent in the body.
- ✓ Gives shape to the cells (turgidity).
- ✓ Acts as a lubricant.
- ✓ Acts as constituent of body fluids.
- ✓ Important in the expulsion of waste

Products through urine, sweat.

- ✓ Important component of animal products such as milk, meat, eggs etc.
- ✓ It's a medium for enzymatic reactions and other biological or metabolic activities in the body.

FACTORS DETERMINING THE REQUIREMENTS OF WATER BY LIVESTOCK

✓ Production level; high milking animals requires much water than dry ones.

✓ Amount of dry matter eaten; the more the dry matter, the higher the water requirement by animal.

✓ Temperature of the surrounding area; high temperatures causes' high water intake by animals than cool temperatures.

✓ Type of animal;Exotic animals generally need a lot of water than indigenous animals.

✓ Type of food eaten; roughage feeds make animals take a lot of water than succulent feeds.

✓ Physiological state of the animal; lactating and late pregnancy requires more water for milk synthesis than dry normal state animals.

PROTEINS

Are complex molecules that are made up of carbon, hydrogen, nitrogen and oxygen but some may contain Sulphur, phosphorus and iron.

Sources:

✓ Groundnut cakes,

✓ cotton seed cakes,

✓ fish meal,

- ✓ Meat meal.

Functions:

- ✓ Growth of new living tissues.
- ✓ Repair of worn out tissues (body building).
- ✓ Synthesis of antibodies.
- ✓ Synthesis of hormones and enzymes.
- ✓ Production of energy during starvation.
- ✓ Used in the formation of animal products such as meat, milk, eggs.

DIGESTION OF PROTEINS

In non-ruminants, protein digestion takes placed in the stomach.

Food is subjected to mechanical breakdown through chewing into small particles.
Protein is acted on by enzymes to turn into amino acid which is assimilated into the bloodstream.

In ruminants, protein digestion initially takes place in the rumen.

Food is acted on by micro-organisms into microbial protein.
Later, enzymatic action takes place in the "true stomach" or abomasum where proteins are broken down into amino acids which are then assimilated into the bloodstream.

In farm animals, excess proteins are not stored but are eliminated from the body through the following ways;

- ✓ As urea in ureotelic animals
- ✓ As ammonia in creatinine animals like fish
- ✓ As uric acid in birds

CARBOHYDRATES

Are organic feeds made up of carbon, hydrogen and oxygen in the ratio of 1:2:1 and consists of crude fibres and starch and sugars.

Crude fibre is the insoluble part of the foodstuff which usually consists of lignin and cellulose that makes digestibility difficult.

Carbohydrates exists in three major groups' i.e.

✓Monosaccharides; made up of one unit of simple sugars e.g. glucose, galactose and fructose

✓Disaccharides; made up of two units of simple sugars e.g. sucrose and lactose

✓Polysaccharides; made up of several units of simple sugars e.g. cellulose, starch etc.

Sources:

- ✓ Cereals,
- ✓ tubers
- ✓ Commercially mixed feeds.

Functions:

✓Major source of energy and heat to the body.

$C_6H_{12}O_6 + O_2 \rightarrow 6CO_2 + 6H_2O + 2843KJ$

Glucose Energy

✓Excess is stored in form of fat for insulation of the body.

✓Major component of body structures such as cartilage and connective tissue

✓Have aspiring effect on proteins.

DIGESTION OF CARBOHYDRATES

In non-ruminants; carbohydrate feeds are broken down by chewing into small particles.

Then enzymatic action further breaks down carbohydrates into glucose, fructose and galactose which are then assimilated into the bloodstream.

In ruminants; mechanical breakdown of carbohydrate feeds is followed by microbial activities which break down cellulose into volatile fatty acids. These are absorbed through the rumen walls.

Some carbohydrates are broken down by enzymatic action in the "true stomach" or abomasum.

FATS AND OILS

Are chemical substances which are insoluble in water but soluble in organic solvents such as alcohol and they contain carbon, hydrogen, oxygen with some containing nitrogen and phosphorus.

Sources include; Cotton seeds, soya beans, Groundnuts.

Functions:

- ✓Supply energy and heat to the body.
- ✓Excess is stored as fat adipose tissues.
- ✓ Source of metabolic water in the body.
- ✓ Required for the development of neural system.
- ✓ Insulator in the body.

DIGESTION OF LIPIDS IN RUMINANTS

Fats are hydrolyzed in the rumen into fatty acids and glycerol.

Others are fermented into propionic acid,

The shorter chains are passed to the true stomach where enzymatic action takes place.

VITAMINS

Sources includes; Green materials, dried grass, fish liveroil.

Functions:

- ✓ Protects the body against diseases.
- ✓ Regulate the functions of all parts of the body.
- ✓ It acts as a co-enzyme in the body.

Examples: Vitamin A, B2, C, E, K.

MINERALS

Sources includes; Salt licks, Bone meal, legumes, and cereals.

Functions:

- ✓ They are responsible for tissue irritability e.g. calcium and magnesium.

- ✓ Some are important for the physical and chemical reactions in the body e.g magnesium that activates enzymes.
- ✓ They are important in the clotting of blood e.g. calcium.
- ✓ They play a structural role more especially in the skeleton e.g. calcium and phosphorous.
- ✓ They maintain the osmotic pressure of blood and lymph fluid at the cell membrane e.g. potassium.
- ✓ Some are important in the reproductive system e.g. Manganese which increases sex libido.
- ✓ Some are important in the capture and harvesting of energy in the body e.g. phosphorous which is used in the combustion of Adenine diphosphate (ADP)

Iron

This is responsible for the synthesis of haemoglobin and the red blood cells.

It's also a co-enzyme in the cytochrome system. Iron is stored in the liver and spleen of animals.

Deficiency symptoms

It leads to anaemia, however anaemia may be hereditary and also lack of Cu, Co, and proteins can cause anaemia.

Iron deficiency mainly occurs in young mammals because milk is a poor source of iron and also animals kept on concrete since they have no access to soil which a good source.

Copper

This is essential in the synthesis of haemoglobin and also as an enzyme activator. It occurs in pigments of hair and its deficiency leads to **anaemia** and **depigementation** of hair.

Iodine.

This is a constituent of thyroxin responsible for regulation of metabolism in the body. Its deficiency leads to **Goiter** or enlargement of the thyroid gland. In pigs iodine deficiency causes giving birth to piglets without hair.

N.B

Cabbage and Soya beans contain substances which prevent the secretion of thyroxin.

Manganese

This is an activator of most enzymes and its deficiency leads to reduced reproductive processes like spermatogenesis, reduced sex libido, and **star gazing** in chicks i.e. (chicks die with their heads facing upwards)

Calcium

Strengthens bones, helps in blood clotting and important in nerve transmission

Deficiency

- ✓ Weakened bones
- ✓ Low milk production in lactating animals
- ✓ Milk fever in lactating animals
- ✓ Slow growth Lameness

Phosphorous

Strengthens bones, improves growth and improves fertility

Deficiency

- ✓ Leads to esteomalacia and pica
- ✓ Poor milk yields
- ✓ Low fertility

Potassium

Maintains concentration of body fluids

Helps in nerve transmission

Deficiency

- ✓ Slow growth
- ✓ General weakness
- ✓ Nervous disorders

Salt (Sodium chloride) Na^+ and Cl^-

Used in nerve transmission

Deficiency

- ✓ Reduced appetite
- ✓ Loss of weight
- ✓ Reduced milk yield
- ✓ Death after prolonged deficiency

TYPES OF FEED STUFFS

A feed is any organic substance of plant or animal origin that can be eaten by animals to provide the required nutrients such as carbohydrates, proteins, vitamins, minerals etc.

Feeding is considered as an art that requires skills and experience of observing how animals are performing when given a particular type of food.

At the same time it's also a science in that it requires knowledge of the bio chemistry and metabolism of the feeds.

The feed or food eaten by animal is required to meet three important body processes;

✓**Physiological process**; these are inevitable processes which must go on as long as life continues and therefore must be made first in the supply of energy from the food eaten.

✓**Synthetic process**; this process constitutes the production phase of animal which the farmer is most interested such as reproduction, milk production, egg production, wool production, meat production, wool production and work production in draught animals.

✓**The live weight change/ fattening**; this is the last process to be meet by the animal were energy from the feed eaten is converted into fats and other body tissues. This stage involves three major stages i.e. Rapid increase in weight until puberty (self-accelerating phase), decelerating rate of food conversion (self-inhibiting phase), and then the fattening phase when surplus food is converted into fats.

CLASSIFICATION OF ANIMAL FEEDS

This is based on nutrient composition; these include; Roughages, Concentrates and Feed additives.

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ROUGHAGES

Are feeds of low available nutrients per unit weight and high fibre content

Examples include; Dry roughages, succulent roughages, residues from agricultural by products and conserved materials.

Characteristics

- ✓Low level of available nutrients.
- ✓Have high level of calcium especially legumes.
- ✓Good source of vitamin A.
- ✓Have high fibre content.

CONCENTRATES

Are feeds of high available nutrients per unit weight.

Examples; Maize germ and bran, milk products, soya beans, oil seed cakes, meat meal, bone meal, bloodmeal.

Characteristics

- ✓ Low fibre content.
- ✓ Feed content is consistently high.
- ✓ High digestibility of the feed.

- ✓ High in nutrient content.

Feed Additives

These are substances added to the feed to increase; palatability, medication or hormones to make animals produce more.

There are two types:

- ✓Nutritive additives, such as mineral licks.
- ✓Non-nutritive additives, such as;medicates (coccidiostats), Stilboestrol (used in beef animals), Oxytocin (to increase milk let down).

Functions

- ✓ Stimulate growth and production.
- ✓ Improve feed efficiency.

Prevent disease causing organisms.

PRINCIPLES OF FEEDING LIVESTOCK

There are three core values of principles that the farmer must consider when feeding livestock;

✓ **Palatability**; this is the measure of taste of food i.e. its ability or tendency of a feed to be liked by the animals and this is measured by the amount of food consumed by the animal per day without restrictions.

✓ **Productivity**; the animals must be given adequate and quality feeds that enable them to maintain their condition and yet produce high quantities of the required quality such as milk, meat, eggs etc.

✓ **Profitability**; animals should be fed well so as to meet their appetite and ensure high productivity all of which must result into profits maximization to the farmer.

Terms related to feeding:

✓ **Ration.**

This is the amount of food needed by an animal in a day sufficient to maintain its life and keep it for production.

✓ **Balanced ration;**

This is a ration that contains nutrients needed for both maintenance and production

✓ **Maintenance ration;**

This is the amount of food required by an animal to keep it healthy and alive in good health without gain or loss of weight.

- ✓ **Production ration;**

This is the food required by an animal over and above maintenance ration for additional output / performance e.g. milk production, egg production, fattening, growth etc.

- ✓ **Digestibility;**

This is the measure of that proportion of food eaten by an animal less that lost through feaces or the proportion of food absorbed in the body less that lost in feaces.

- ✓ **Digestible crude protein**

This is the measure of N_2 in the feed consumed and retained in the body of the animal after subtracting that lost through feaces, urine and gasses.

- ✓ **Starch equivalent.**

This is the amount of pure starch which has the same energy as a 100 kg of a particular feed

- ✓ **Total digestible nutrient.**

This is the sum total of all digestible nutrients in a feed.

- ✓ **Crude protein**

The rough measure of the amounts of protein in a feed expressed as a percentage of dry matter or this is the product obtained between total nitrogen in a feed and a factor of 6.25 i.e. total nitrogen x 6.25

- ✓ **Protein supplements.**

These are feeds with a high protein content of over 30% e.g. fish meal cotton seed cake, Soya beans, etc.

- ✓ **Basal feed.**

These are feed with a high content of carbohydrates that can provide energy e.g. maize bran, rice bran, mainly cereals and wheat bran.

- ✓ **Bulk feeds**.

These are feeds that contain a limited amount of nutrients in a given weight and usually have a high fibre content e.g. forages / roughages.

- ✓ **Biological efficiency**;

It is the measure of the amount of output per feed eaten by an animal. In lactating animals it can be amount of milk give per kg dairy meal consumed

- ✓ **Economic efficiency**;

It is the measure of the cost of animal products to that of inputs like feeds e.g.

Output X price

Feeds taken X price

- ✓ **Gross energy efficiency**; energy output of an animal per energy intake i.e.

Energy output in products

Energy taken in feeds

- ✓ **Net energy efficiency;**

The measure of real energy output in products from feeds eaten

i.e. **Energy output in product**

Energy taken in – maintenance energy cost

Determining feed digestibility

In practice, digestibility is determined for dry matter, proteins, fats and crude fibre. Digestibility is just a proportional of food absorbed in the body less feacal nutrient. Therefore

Digestibility = Nutrient intake (NI) -Nutrient in feaces (NF) x 100%

Nutrient Intake (NI)

= **NI – NF x 100%**

NI

Example

A fattening animal was given a feed containing 500g of proteins and later 150g of the same protein was found in the feaces.

Calculate the digestibility of such a feed.

Digestibility = NI – NF x 100

NI

= 500 – 150 x 100

500

= 350 70

5 1

= 70%

FACTORS AFFECTING FEED DIGESTIBILITY

- ✓ **Difference between species.**

Ruminants are more efficient in utilizing feeds than non-ruminants due to their long digestive system hence will digest most of the feed taken.

- ✓ **Age of the animal**

Very old and young animals have insufficient digestive systems hence show low digestibility of feeds.

- ✓ **Individual differences**

Animals of the same species have shown differences in their digestibility of the same kind of feed as much as 25%.

- ✓ **Exercise**

A light exercise improves digestibility of a feed while heavy exercises depress it.

- ✓ **Addition of molasses to animal feeds**

These will improve digestibility of feeds since they contain highly digestible carbohydrates.

- ✓ **Type of feed.**

Proteins and carbohydrates are more digestible as compared to other types of feeds.

- ✓ **Associated effect of other feeds.**

Increased intake of proteins will improve digestibility of fibre.

- ✓ **Time**

The whole process of digestion needs time for it to be complete hence it's important to allow enough time for digestion to take place.

- ✓ **Presence of anti-metabolites.**

Some feeds may contain anti metabolites e.g. trypsin inhibitor in raw Soya beans.

- ✓ **Health of the animal**

Sick animals will have a low digestibility of feeds due to the abnormal physiology.

RATION FORMULATION

In making any ration, the following considerations should be made:-

- ✓ **The cost of the feed**

Expensive feed stuff should always be limited in this ration since they may be uneconomical.

- ✓ **Availability of feeds.**

The feeds that make up the ration should be readily available in the environment to reduce transport costs.

- ✓ **The nutrient requirements of animals in consideration.**

If the animals under consideration need a lot of proteins the ration should answer their nutrient requirements.

- ✓ **The palatability of the feeds used.**

Feeds that are used in ration formulation must be highly palatable for animals to gain from it.

- ✓ **The skills of a farmer.**

The person formulating the ration should be highly skilled to produce what is required by the animal.

- ✓ **The nature of the final product.**

The ration made should be in a state that can be utilized by the animal.

- ✓ **The age of the animals.**

Animals at different ages require rations in different forms in a particular nutrient.

METHODS USED IN RATION FORMULATION

- ✓ Trial and error method
- ✓ Pearson's square method
- ✓ Graphical method
- ✓ Linear programming(use of computers)

Steps in ration formulation

✓Finding out the animal's feed requirement based on body weight.

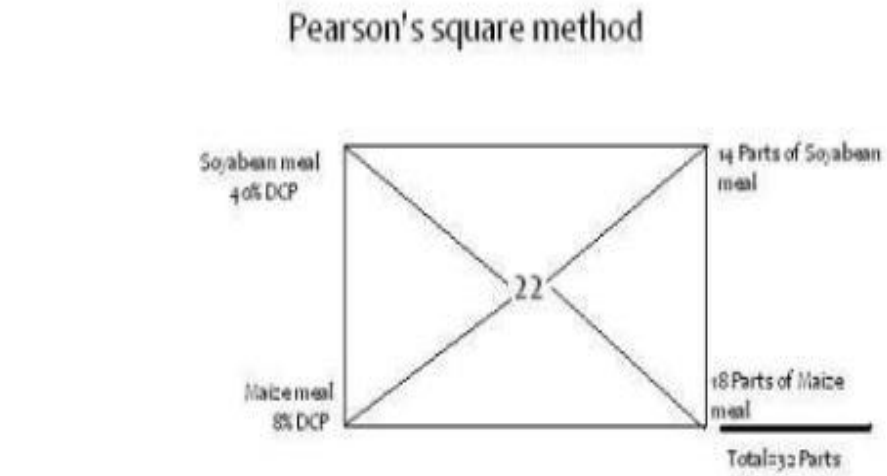
✓List all the available feeds, with theirnutrient composition and their prices.

✓Calculate the amount of ingredients required in the ration to meet the animal's needs.

Examples 1:

Mix a Pigs ration 22% protein using soya bean meal 40% DCP and maize meal containing 8%DCP.

PEARSON'S SQUARE METHOD



Soya bean meal $\frac{14}{32} * 100 = 43.75kg$

Maize meal $\frac{18}{32} * 100 = 56.25kg$

Example 2

A poultry farmer wants to make a ration of 18% crude protein using maize bran which is 15% crude protein, rice bran which is 20% crude protein, cotton seed cake 30% crude protein and ground nut cake 38% to make 500kgs of Feed. Maize bran and rice bran are mixed in a ratio of **2:1** and ground nut cake mixed with cotton seed cake in a ratio of **2:1**

Basal feeds

Maize bran	15% C.P	2	= 30
	x		
Rice bran	20% C.P	1	20
	x	=	
	TOTAL	**3**	**50**

$\frac{50}{3}$ = **16.6%**

Protein supplements

Ground nut. Seed cake 30%			60
2			
Cotton seed cake	1	38%	38
	TOTAL	**3**	**98**

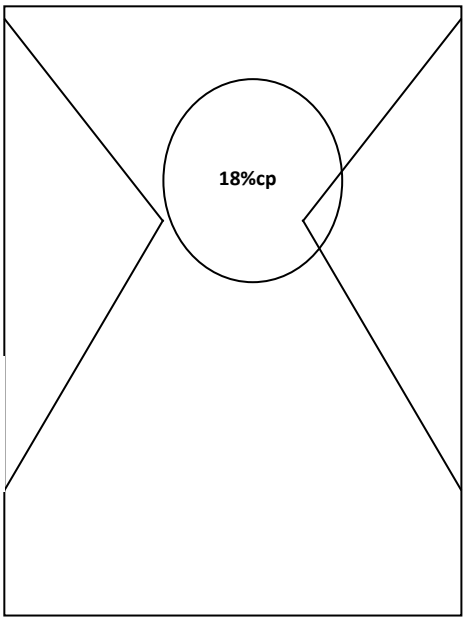
98= **32.6%**

3

3

Basal feeds

16.6%



14.6

Parts of Basal feed

Protein supplement

32.6%

1.4

parts of pp protein Supplement

16.0

parts

Basal feeds needed = 14.6x 500 kg = **456.25kgs**

16

Protein supplement = 1.4 x 500 kg = **43.75kgs**

16

Amount of maize bran needed

2/3 X456.25= 304.2 Kg

Amount of rice bran needed

456.25 – 304.2= 152.05

Amount of G.nut cake needed

2/3 X 43.75= 29.2 Kg

Amount of Cotton seed cake needed

43.75 - 29.2 = 14.55 Kg

Tryout

Given the following

Wheat bran 22%C.P, cotton seed cake 35% C.P, Soya meal 38%C.P, fish meal 40% C.P Make a ration of 18% C.P. giving an allowance of 3% minerals. Mix fish meal, Soya meal and cotton seed cake in a ratio of 3:2:1

DIGESTION IN FARM ANIMALS:

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Digestion is the process by which animals breakdown the complex food materials into simple ones that can be absorbed and utilized by the body.

Farm animals are grouped into ruminants and non-ruminants depending on their digestive system.

The ruminant animals are those that have a complex digestive system consisting of 4 stomach chambers i.e. Rumen, reticulum, omasum and abomasum. These normally chew cuds such as cattle, goats, sheep, buffaloes etc.

Non ruminants are those that only have one stomach chamber and therefore cannot chew curd neither digest food with high cellulose content. They include, pigs, rabbits, man etc.

DIGESTION IN RUMINANTS

- ✓ **Mouth**

Food is gathered here with the help of tongue and teeth, a process referred to as prehesion. There is also chewing of food (mastication) and mixing it with saliva (salivation). Chewing of the curd also takes place here.

N.B. The saliva of ruminant animals does not contain any enzyme, but its work is to lubricate the bolus and facilitate passage through the oesophagus.

- ✓ **Oesophagus**

This is a passage for the bolus from the mouth to the rumen
Rough materials that escaped thorough grinding during preliminary mastication pass back to the mouth through oesophagus.
It allows gases to escape from the rumen to the out in the process of belching.

- ✓ **Rumen / pouch**

It has a surface with projections like a towel it acts as a store for food.
It refines the food particles.
It churns and mixes the food thoroughly with the rumen liquids.
Coarse food particles are directed to the mouth for further chewing.
Provides place for fermentation by microbes like bacteria, fungi and protozoa.

Conditions that favour rumen microbes.

✓ The pH ranging between 6.2 – 6.7 which is maintained by saliva and continuous removal of volatile fatty acids (ethanoic acid (acetic

acid), propionic acid and butyric acid) 2. Low levels of oxygen since most of the microbes can respire anaerobically.

- ✓ The temperature of about 39^0c in the rumen.
- ✓ Enough moisture from water drunk, animal feeds and saliva.
- ✓ Presence of macro minerals and some trace minerals in the rumen needed by microbes.
- ✓ Regular removal of digested material so that fresh materials are in contact with the microbes.
- ✓ Presence of readily fermentable carbohydrates like glucose, sugars and starch in feeds eaten.
- ✓ Adequate supply of energy and nitrogen which enhances microbial activities

Importance of microbes in rumen

- ✓ They enable ruminants to utilize fibrous material by hydrolyzing cellulose into monosaccharide.
- ✓ They build up complete proteins from elementary nitrogen which can be used by the host animal.
- ✓ They can upgrade dietary protein to a standard needed by the host animal.
- ✓ They can synthesize vitamins K, B, C and B complex for the host animal.

- ✓ At death, they provide proteins to the host animal.

- ✓ **Reticulum**

It's known to have a honey comb structure surface

Regulates passage of food from the rumen to the Omasum and from the rumen to aesophogus.

It allows fine food to enter the Omasum

It stores heavy materials like stone, stick, wire swallowed with food that why it's referred to as the hard wave stomach.

- ✓ **Omasum**

It has a surface with flaps that resembles papers of a book.

Most water and organic acids are absorbed here.

Solid particles left in food are further ground by the muscular leaves of the Omasum. The leaves form a pumping action that causes food into the abomasum.

- ✓ **Abomasum (true stomach)**

It has a smooth surface

The walls secrete Hydrochloric acid and gastric juice.

Gastric juice contains enzymes rennin and pepsin which digests proteins. Rennin curdles milk in young mammals.

- ✓ **Small intestines.**

Digestion is completed here by the pancreatic enzymes like lipase, amylase, trypsin, maltase and sucrase.

- ✓ **Large intestines**

It is where the absorption of water takes place.

FACTORS AFFECTING FEED INTAKE BY THE ANIMAL.

- ✓ Environmental temperature; high environmental temperatures reduce feed intake while low environmental temperature stimulate feed intake.
- ✓ Palatability of the feed; feeds that are highly palatable would be consumed in large quantities by the animals as compared with unpalatable feeds.
- ✓ Blood components; a high quantity of glucose and volatile fatty acids in the blood of ruminants will suppress feed intake.
- ✓ High lignin content in feeds will suppress feed intake since it has a low digestibility.

✓ Shift in hormonal balance; during pregnancy, feotal displacements of the rumen and reticulum and changes in hormones will affect food intake.

✓ The volume of the alimentary canal; when the alimentary canal is filled with feeds fast it will cause distention in the reticulo- rumen restricting further feed intake.

✓ Level of animal production; animals that produce a lot of milk will eat more feeds to compensate the loss in milk.

✓ Animal health; sick animals will take less feeds as compared with the health ones

✓ Amount of feed provided; animals will always strive to eat all what is provided hence giving a lot of feeds increases intake

IMPROVING DIGESTIBILITY OF FEEDS.

✓ Selecting animals with high digestibility naturally.

✓ Providing feeds with high nutrients value to animals.

✓ Avoid excessive exposure of feeds to rain and sunshine in order to maintain their quality.

✓ Avoid prolonged exposure of animals to harsh weather conditions by providing a shade.

✓ Provide ample salt and plenty of fresh water for the animals.

✓ Add molasses to feeds to improve digestibility.

✓ chop pasture and crush feeds to increase surface area for enzymatic action

CARBOHYDRATE DIGESTION IN RUMINANTS

✓Ruminants do not have salivary amylase therefore the first enzymes to act on carbohydrates are in the rumen

✓Enzymes in the rumen for carbohydrates are produced by the microbes

✓Microbial amylase and cellulase breaks down starch and cellulose respectively

✓The end products for carbohydrate digestion in the rumen are volatile fatty acids (VFAs-**acetic/ ethanoic acid, propionic acid and butyric acid**), methane and carbon dioxide. Formic and lactic acids are produced in small amounts.

✓The amount of acetic acid produced depends on the amount of fibre and starch in the diet. A diet with high fibre results in production of more acetic acid while consumption of high starch results into production of more propionic and butyric acids.

✓VFAs are absorbed and utilized for energy production rather than glucose used in non-ruminants

✓Acetic acid is the main source of energy in ruminants.

Nitrogen conservation mechanism in ruminants

✓Digestion of coarse fodder in ruminants depends on the activity of microorganisms in the rumen.

✓The microorganisms require supply of energy and nitrogen for their growth and multiplication. In return microorganisms brake down cellulose

✓Nitrogen is very important in ruminant digestion since it can be used by rumen microbes and in the building up of ruminant protein. Therefore, it must be conserved

It is conserved in the following ways;

✓ Ammonia absorbed from the rumen plus that arising from tissue metabolism is converted to urea.

✓ In non-ruminants, urea would be lost in urine but in ruminants, it is recycled back to the rumen through salivary secretion and across the rumen wall.

✓ The recycled urea is utilized by the rumen microbes to build up proteins for the host animal.

✓ The proportion of urea to nitrogen recycled depends on the quantity of nitrogen in the diet

✓ Low dietary nitrogen causes more nitrogen from the liver being returned to the rumen to build protein

✓ The cycle ensures continuous source of nitrogen for rumen digestion.

NUTRITIONAL AND METABOLIC DISORDERS IN LIVESTOCK

Nutrition deficiency disease may be caused by:-

i. Giving the animals too little feeds
ii. Having a diet that is low in one or more nutrients.
iii. Imbalance of nutrients provided to the animals.

i. Milk fever

This is caused due to low level of Ca and phosphorus in the body of the animal especially the high milking dairy animals.

It normally occurs after parturition making the animal to become uncoordinated and paralyzed. The animal suffers muscular spasms, goes into and may die if not immediately treated.

This condition can be controlled by provision of mineral supplements and proteins in diet of the animal in adequate proportions.

ii. Grass tetany

This is also called grass stagers/ hypomagnesaemia. It affects cattle and sheep mainly and it's caused by magnesium deficiency.

Symptoms:

- ✓ Animal becomes nervous
- ✓ There is twitching of the muscles more especially those around the head and the neck.
- ✓ The head of the animal is lifted high
- ✓ There is accelerated respiration
- ✓ There is increase in body temperature and gashing of the teeth.
- ✓ Abundant salivation which is followed by death.
- ✓ It occurs during the 1st week of the pasture season.

Control

Animals should be given mineral lick which contains magnesium sulphates, calcium and phosphorous.

iii. **Bloat**

This is the distention of the rumen which may occur in all ruminants due to excessive gases produced by fermentation of feed stuffs.

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Causes:

- ✓ Feeding of animals on young succulent grass with high protein content.
- ✓ Rumen microbes interfering with normal release of gases
- ✓ Some animals are more susceptible to bloat than others naturally.
- ✓ Some plants contain compounds which tend to form lather (foam) once eaten by animals.
- ✓ Feeding animals on feeds that are known to cause bloat.

Symptoms:

- ✓ Extension of the rumen
- ✓ Difficulty in breathing
- ✓ Loss of appetite / animal stops to eat
- ✓ Death of the animal
- ✓ Animal lies down and sticks its legs out.

Treatment:

- ✓ Affected animal should be treated using a trocar and cannula which is used in piercing the rumen to release the gases.
- ✓ The animal should be given mineral oil orally to open up the system so as to allow gases out.

✓ Use of the broom stick method where a small piece of stick is laid across the mouth of the animal to keep it open and allow gaseous out.

Control / Prevention

✓ Feed animals in good quality forage

✓ Provide anti bloat drugs to animals

iv. **Ketosis** (acetonemia / pregnancy toxemia)

A disorder of animals caused by high production exceeding feeding capacity. Occurs in high milk yielders during the first month of lactation.

Causes

✓ Inadequate feeding for yields

✓ Unsuitable feeds / inadequate roughage

✓ Malfunctioning of the liver leading to increased keto acids in blood.

Symptoms

✓ Low blood glucose levels (hypoglycemia)

✓ Rapid loss of body weight / emaciation

- ✓ Nervousness may develop in the animal
- ✓ Drop in milk yield for lactating animals
- ✓ Apparent blindness
- ✓ Walking in circles.

Preventions

- ✓ Adequate and proper feeding of lactating animals
- ✓ Animals should have enough green pastures.
- ✓ Animal should be exercised
- ✓ For treatment, call a vet.

v. Common scours

This is a feeding disorder which normally affects young animals such as calves resulting from excessive feeding on milk or milk that is contaminated with organisms. This situation can be arrested through;

- ✓ Use of clean feeding utensils such as buckets
- ✓ Always feed the calves with clean fresh milk
- ✓ Feed the calves with the right amount of milk to avoid over feeding
- ✓ Ensuring proper ventilation in the calf pen

DIGESTION IN NON RUMINANTS:

Non ruminant animals unlike the ruminants have only one simple stomach compartment and digestion proceeds as follow;

Digestive system of a bird.

- ✓ **Beak**

It's composed of two horny parts i.e. the upper and lower beak. It picks food and passes it to the crop via the gullet.

- ✓ **Gullet**

These acts as a passage for food from the mouth to the crop.

- ✓ **Crop**

Stores food before proceeding to the glandular stomach. It also softens the food.

- ✓ **Glandular stomach.**

This is an enlarged part just before the gizzard. Its wall contains many glands that secrete hydrochloric acid. It's also referred to as the first stomach.

- ✓ **Gizzard / muscular stomach**

This is the real stomach of the chicken with very muscular walls. It grinds down the feeds to increase action by gastric juice enzyme. It contains grease which is taken up with food.

- ✓ **Small intestines**.

The 1st part forms the duodenal loop where most of the digestion takes place. It's about 1.5 long in an adult chicken.

Digestion of fats, proteins and carbohydrates takes place here.

- ✓ **Cloaca**

This lies between the small and large intestines and it's also called the blind gut. Digestion of crude fibre takes place here due to the presence of bacteria.

- ✓ **Large intestines / colon.**

It's relatively short of [about 1cm] and it's were absorption of moisture takes place.

- ✓ **Vent / cloaca /Common sewer**

The digestive, urinary, and productive trait empty here their products.

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