

O'LEVEL PRINCIPLES AND PRACTICES OF AGRICULTURE:

Definition of Agriculture:

It's an Art or science of growing crops and rearing of animals to produce materials needed by human consumption.

Agriculture is a science because it involves knowledge of other subjects like; Biology, Geography, physics, Chemistry and Mathematics.

Agriculture is an Art because it involves operations, use of farm tools and their maintenance.

The Branches of Agriculture

Agriculture has 5 major branches/ sections which include;

a) Soil science / Pedology:

Deals with the origin of soil, properties fertility, conservation and/also how soil interacts with crops to animals, and how its productivity can be sustained.

b) Crop science/Crop Husbandry

Deals with practices carried out to produce a particular crop.

This involves land preparation, and all Agronomic practices involved when growing crops like; Mulching, fertilizer application, Rouging, Manuring, Early planting, pruning, staking, threshing, Gapping, thinning, etc.

Crop farming can be grouped into:

- (i) Growing of field crops such as coffee, Tea, cotton, Bananas with annual crops like; Maize, Beans, Soya beans e.t.c.
- (ii) **Horticulture**: This is the growing of flowers on a large scale.
- (iii) **Olericulture**:- This is the growing of vegetables on large scale e.g. Tomatoes, Egg plants, Pepper, Cabbages.
- (iv) **Pomology**:-growing of fruits such as Mangoes, Ovacadoes, Apples, etc on a large scale

c) **Animal Science / Animal husbandry**

This deals with animal feeding / Nutrition, housing, Reproduction and health.

Live stock farming can be grouped into;

(i) Pastoralism

A system of livestock farming where farmers look after livestock as their main occupation.

They keep large herds of cattle, land for grazing them is for the community as a whole.

(ii) **Nomadism**: - is a type of livestock farming where the farmers keep moving from place to place with their cattle searching for water and pastures e.g. Turkana, Boran, and Somali.

(iii) **Sedentary Pastoralists**:- These pastoralists settle in one area and establish permanent homesteads e.g. – Bahima of Western Uganda.

(iv) **Transhumance Pastoralism** is where Pastoralists move their animals looking for water and pasture when their areas are hit by

drought but later go back and settle in their homesteads when conditions are favourable e.g. Karamojong.

(v) **Aquaculture**;- involves rearing of fish in ponds as a source of food and income.

vi) Apiculture; involves keeping of bees for honey, wax also source of income

(vi) **Poultry farming**; involves keeping of domestic birds for production of eggs, meat, and income generation.

d) Agricultural Economics

This deals with economic principles of profit maximization, and output from the available resources of production.

Agricultural Engineering

This deals with production and use of tools, machines, farm structures and their maintenance in Agriculture.

Assignment (a)

- ✓ Give 5 problems faced by pastoralists in doing Pastoralism as a system of farming.

IMPORTANCE OF AGRICULTURE TO MAN AND ECONOMY OF UGANDA:

Source of food:

It provides food and beverages consumed by people of Uganda. Examples; Fish, Meat, Milk, pineapples, maize, Beans.

Source of employment:

It provides employment to most Ugandans i.e. about 80% of Ugandan population relies on Agriculture as jobs either directly as farmers or indirectly in the marketing of Agricultural produce. Others serve as professionals e.g.–Veterinary doctors, Teachers, Researchers, Extension workers, etc.

Source of foreign Exchange: It provides foreign exchange through exporting Agricultural produce to other countries e.g. exports coffee, Tea, flowers, hides, etc hence earning money.

Source of raw materials for industries : It provides raw materials to the agro-based industries like Leather tanning industries, Textile industries, sugar processing e.g. Kakira, Dairy processing industries e.g.–Fresh dairy.

Provision of market for industrial goods: It provides market to industrial products e.g Animal feeds for Poultry, Agrochemicals like fertilizers, pesticides, etc, farm tools and equipment like ploughs, hoes, etc.

Source of Income: It generates income to the people through the sale of Agricultural produce which makes them to improve on their standards of living

Source of Medicinal products: Bee keeping sector produces honey which produces **Propolis** as a bi-product, this helps to treat cough, Neem tree, Aloevera, etc

Source of Revenue: Government earns revenue from Agriculture by levying taxes on Agriculture imports and exports.

Recreation: This involves activities like Goat racing; Bull and Cock fights, etc are forms of recreation in some parts of the country.

Assignment 1:

- a) Explain any other **3** significances of Agriculture to the economic development of your country. (Apart from the above).
- b) In what ways is Agriculture important to
 - (i) The farmer (ii) The nation
- c) Give **5** examples of Agro- based industries found in your country

PROBLEMS AFFECTING AGRICULTURE SECTOR AND THEIR SOLUTIONS

1. Poor crop and animal husbandry practices:

Due to illiteracy and conservatism, farmers do not follow correct/ appropriate production procedures, e.g. they do not use improved crop varieties, they do not control weeds and this has affected yields and their products are of poor quality.

Solution:

This can be solved through research, as improved crops and animals are being produced which should be made available to farmers.

Can also be solved through provision of education to farmers about better farming methods.

2. Lack of enough capital:

Majority of farmers in Uganda cannot afford to purchase inputs e.g. – Seeds, fertilizers, machines, Pesticides, this keeps level of production low.

Solution:

Government should facilitate farmers so that they can access credit / Loans easily at low interests in order for them to acquire inputs and machinery to increase their production capacity.

3. Lack of enough extension services:

Many farmers in remote areas rarely receive assistance from extension workers and thus they do farming without proper planning and knowledge.

Solution:

Government should ensure that each sub county receive extension workers in both vet and Agriculture to enable farmers access education, demonstrations in order to improve on their skills in land management, production e.t.c

4. Poor Tools and farming methods:

Most farmers use poor and inefficient tools to produce e.g – Hand hoes, Sickles, Hand Sprayers. This leads to late planting, late harvesting, late harvesting leading to reduced yields.

Solution:

Government should avail farmers with simple Tools and Machines for hire e.g Tractors, Motorized sprayers. As they will reduce drudgery and quicken farm work leading to reduced yield.

5. Pests, parasites and diseases:

These lead to higher losses and reduction of quality of products.

Solution:

More research is required on crop and livestock parasites and diseases so as to find ways of controlling them cheaply and effectively. E.g. developing crop varieties that are resistant to diseases.

6. Un favourable climatic conditions:

In some areas of Uganda rainfall is unreliable while in others rainfall is heavy but for a short time and the rest of the year is dry. This influences crop and animal productivity.

Solution:

This can be overcome by setting up irrigation schemes, construction of valley dams, Boreholes, growing drought resistant crops, livestock, e.t.c.

7. Land Tenure System:

Land tenure refers to the state of ownership of land and the conditions governing that ownership. This means that farmers have no full rights over land, therefore farmers can not invest in long term farm enterprises like planting perennial crops e.g. coffee since they are to be evicted any time.

OR At the same time, due to high population in some areas, farmers own very small plots of land that cannot be mechanized.

Solution:

Government should set up land consolidation programmes so that farmers who own fragmented plots can exchange these plots among themselves and finally acquire big land.

Some people in densely populated areas should be resettled in sparsely populated areas to hire land for the people.

8. Poor storage facilities:

Poor storage facilities lead to damage, loss of quality leading to low prices.

Solution:

Research is needed to develop more efficient methods of storing farm produce.

9. Price fluctuations:

Prices of Agriculture commodities change from time to time depending on the supply

Solution:

Farmers should diversify farm production (diversification) so that they avoid total loss from one enterprise.

Government should stabilize most prices by buying and storing excess produce,

Farmers should produce on contract because contract production facilitates guaranteed prices

10. Shortage of land:

Most people have limited land and this is not viable for economic production.

Solution:

Government should encourage settlement and Resettlement schemes.

11. Conservativeness of farmers:

Farmers are not willing to accept new innovations especially in rural areas.

E.g. AI has met resistance from rural farmers who consider it as immoral

12. Poor transport and communication:

Accessibility to some productive areas is very difficult because of poor road conditions hence farmer's produce may not reach markets where high prices could be realized.

Assignment b:

(a) Give the possible solutions to the following problems to Agriculture production in Uganda.

(i) Poor transport and communication

- (ii) Conservativeness of farmers
- (iii) Religion

PRINCIPLES OF LAND USE

Land use refers to different ways in which land is put to use by man.

For Agriculture to be carried out successfully, land as a factor of production has to be acquired.

WAYS OF ACQUIRING LAND

- Inheritance from the parents.
- Buying a piece of land with / without a land title.
- Through borrowing from friends who have a plenty of it.
- Through settlement and resettlement schemes e.g. Mobuku settlement scheme.
- Through leasing: An individual applies to the state to lease land for a specified period of time (e.g. 9,99,999yrs)
- Receiving land as a gift from a well wisher or sympathizer.
- Through renting or hiring land for a season or a year from individuals or families who have plenty of it.
- Allocation of land to an individual by parents

Land can be put into different uses by man in the following ways:

1. Agriculture:

Here land is used for growing crops and rearing of animals e.g. – subsistence farming, arable farming, Ranching, e.t.c

2. Wild life conservation:

Several places have been set aside to preserve wild life e.g. National Parks, Game reserves, Sanctuary /wild life.

3. Forestry:

Man has planted trees in different areas as a way of conserving environment, income, time, fire wood and Charcoal

Assignment 3:

Identify the role of forests/vegetation

(i) In Soil and water conservation

(ii) To the farmer

Give examples of tree species planted.

4. Recreation: Places have been set aside where people go for entertainment or relax during leisure time.

These places include; Theatres, Museums, Stadiums, Beaches, Botanical gardens, Hotels, e.t.c

5. Mining and Quarrying:

Minerals have been mined in Uganda while others have been identified in different areas e.g. Petroleum in Hoima, Cobalt-Kilembe, Limestone–Tororo, Kilembe–Copper.

6. Construction of settlements:

The commercial centers both Urban and rural schools, hospitals, Churches, e.t.c are constructed on land.

7. Fisheries:

Fishing is carried out on lakes/rivers e.g. Lake Victoria, Kyoga, Albert, River Nile

While artificial fish ponds have also been made.

8. Industrialization:

Many industries have been set up on land examples:

9. Transport and communication:

Land has been for making Roads, Railways, landing sites to ensure quick delivery of Agricultural inputs to market centers.

Air strips have been made also to ensure efficient air transport systems.

Assignment:

Identify other 3 forms of land use.

LOCAL SYSTEMS OF FARMING

Local farming systems in Uganda are due to climate of an area. Basing on this, they include;

1. Banana coffee system
2. Montane system

3. Teso system
4. Northern system
5. Banana finger millet cotton system
6. Pastoral system
7. West Nile system

a) BANANA – COFFEE SYSTEM:

- It is carried out around the fertile regions of Lake Victoria.
- It is characterized by Bi-modal rainfall distribution
- Major cash crops include;
 - Robusta coffee - Sugar cane
 - Tea - Vanilla
- Major food crops include;
 - Banana - Cassava - Beans
 - Sweet Potato - Maize
- Characterized by subsistence farming though commercial farming is also done on small scale.

b) MONTANE SYSTEM:

It is found around the mountainous areas of Kigezi, Sebei, Mbale and Rwenzori

- Soils in these areas are fertile and deep, while others are volcanic.
- Rainfall received is high and Bi-modal in distribution.
- Temperature are low due to Altitude being high
- Major cash crops – Arabica coffee.
- Food crops include;

Banana, Wheat, Sweet potato, Irish potatoes, Sorghum, Beans

- Contour ploughing and terracing are common methods of soil and water conservation.
- Livestock keeping is also carried out in these areas although it is limited by topography.

c) **TESO SYSTEM:**

- Carried out in Regions of Tororo and Teso districts of Soroti, Kumi, etc.
- Major cash crop is cotton
- Food crop is Millet
- Has flat relief with sandy loam soils
- Large number of cattle are kept
- Ox – plough cultivation is carried out extensively in the region
- Rainfall distribution is monomodal in Nature

d) **THE NORTHERN SYSTEM:**

- It is carried out in Lango region in the districts of Lira, Gulu, and Kitgum
- Major cash crops are cotton and Tobacco
- Major food crops being finger millet
- Rain distribution is Monomodal.
- Communal land tenure is practiced.

e) **BANANA FINGER MILLET – COTTON SYSTEM:**

This is carried out in Tororo, Iganga, Hoima, Masindi and Kamuli districts.

- Rain distribution is Bimodal
- Major food crops – Millet, Bananas
- Major cash crops – Tobacco, Cotton
- People in this region keep large herds of cattle

f) PASTORAL SYSTEM:

It is characterized by pastoral tribes such as Karamojong, and Bahima of Ankole

- Large number of cattle and goats of low quality are kept
- Little farming of crops such as Maize, Millet Sorghum is done
- Due to large herds of cattle, there's overgrazing, bush burning and random mating of livestock
- Occasionally they move with their animal from place to place in search of water and pasture.

g) WEST NILE SYSTEM:

- It is practiced in districts of Arua, Koboko, Adjumani and Nebbi.
- The rainy season in this region is one and long compared to the Northern system which is short.
- Cash crops grown are Arabica Coffee, Cotton, Tobacco, Orange, Mango
- Food crops include Millet, Simsim, Cassava, Sorghum, Cowpeas,

AGRICULTURAL SYSTEMS/CROPPING SYSTEM:

These include;

- Shifting cultivation - Mixed farming
- Pastoralism / Nomadism - Arable farming
- Plantation farming - Crop rotation

(a) SHIFTING CULTIVATION:

This involves farming a piece of land continuously until it is exhausted and once exhausted the farmer abandons it and moves to another fertile ground where he re-establishes the farm.

However, this system of farming is only possible where there's a lot of land.

CHARACTERISTICS OF SHIFTING CULTIVATION:

- i) It is dominated by subsistence farming
- ii) Use of human / manual labour
- iii) Quick maturing crop variety are usually planted
- iv) Annual crops grown in this system
- v) Land preparation is by bush burning

ADVANTAGES OF SHIFTING FARMING:

- Cheap and easy to carry out
- Constant movement of farmers ensures disease control since pathogens do not build up in new location
- Enables other activities e.g.—hunting to be done

- There's rural independence
- It is so traditional
- It maintains soil fertility since soil gets chance to regain its fertility/not over depleted
- Constant movement to new plots controls development of gulley erosion.

DISADVANTAGES OF SHIFTING CULTIVATION:

- It causes loss of nutrients due to burning
- It is tire some and wasteful of labour
- It is limited due to population increase
- Low production due to subsistence farming
- It is time wasting
- Provision of extension services is difficult

Assignment:

Give reasons why the practice of shifting cultivation is declining in Uganda today.

(b) BUSH FALLOWING:

Involves growing crops on a piece of land until it is exhausted; once exhausted it is allowed to go back to the bush for some time before it is used again.

(c) ARABLE FARMING:

Is the type of farming where short term crops are grown?

These include;

Cereals e.g. -Maize, Sorghum, Rice

Legumes e.g.-Gnuts, Beans, Soya beans

Vegetables e.g. Onions, carrots, Tomatoes, e.t.c

Field crops e.g. Sunflower, Tobacco, and cotton

(d) SUBSISTENCE FARMING/PEASANT FARMING:

Is a system of farming that involves growing of crops and rearing of animals to produce food for home consumption while surplus is either stored or sold. The money from surplus is used to meet domestic needs.

CHARACTERISTICS OF SUBSISTENCE FARMING:

- Labour is commonly provided by family members
- Operated on small fields /plots
- Simple tools used in land preparation
- Limited farm inputs e.g. fertilizers used
- Intercropping with animal crops usually dominates this system

ADVANTAGES OF SUBSISTENCE FARMING:

- A variety of crops can be grown at the same time and these provide a balanced diet to the farmer
- There's no need of spending money to transport products to the market since all that is produced is consumed at home
- Farmers do not need a lot of capital to invest in farming

DISADVANTAGES OF SUBSISTENCE FARMING:

- Farmers can not generate money from this system so they tend to remain poor.
- The system does not encourage commercial agriculture.
- In case crops fail to yield anything, farmers face famine because there's no any other alternative source of income.

Assignment

Why is subsistence farming commonly practiced in Uganda?

(e) MIXED FARMING:

Is the practice of growing crops and rearing of animals on the same farm at the same time

ADVANTAGES OF MIXED FARMING

- Farmers earn income from both animals and crops instead of relying on one enterprise.
- Animals and crops complement each other as crops provide food to animals and animals produce manure to improve soil fertility.
- Labour on the farm is well utilized e.g. – when there are no crops to attend to labour, attend to animals.
- The farmer and his family are assured of getting a balanced diet from both crops and animal products

- Draft animals are sources of farm power which is used to cultivate land, transport materials e.t.c

DISADVANTAGES OF MIXED FARMING

- A lot of capital require to set up both crop and livestock enterprises
- Some areas do not farm mixed farming e.g.-Mountainous areas do not favour livestock,swampy areas do not favour crops
- Limited land area for each enterprise especially in highly populated areas.
- A lot of skills and technical knowledge is required to manage both enterprises
- Animals are likely to break the fence and destroy crops.

(f) PASTORALISM AND NOMADISM

Pastoralism is a system of farming where farmers look after large cattle as their main occupation.

NORMADISM

Is a system, of farming where farmers keep moving from place to place with their livestock searching for water and pasture

Topical Exercise

- 1 (a) Distinguish between sedentary and Transhumant Pastoralists
- (b) Give examples of each. 2 examples each.
- (c) What measures can be put in place in order to improve pastoral system.

CHARACTERISTICS OF PASTORALISM AND NOMADISM

- Keeping of large herds
- Movement during dry seasons in search of water and pasture
- Overgrazing /stocking
- Bush burning
- Communal grazing
- Random mating due to communal grazing

(g) INTER CROPPING

Is the type of farming where more than one crop is planted on the same piece of land at the same time

ADVANTAGES OF INTERCROPPING

- Total yields of crops per unit area are higher because the farmer gets a product from each of crop.
- Soil erosion is reduced since there's a good crop cover over soil surface.
- Farmer cannot totally fail to get yield because if one crop fails, a farmer gets yields from another one.
- Crops especially legumes fix nitrogen to the soil which improves soil fertility.
- It enables a farmer to obtain high yields
- Farmer gets a balanced diet from all the crops e.g. carbohydrates, proteins
- Weeds are suppressed since little space is left between various crops

- If one of the crop is shallow rooted and the other is deep rooted, nutrients area well utilized by both crops.

DISADVANTAGES OF INTERCROPPING

- Competition for moisture, light, nutrients and water can occur between crops leading to reduced yields.
- It is difficult to mechanize practices such as weeding, spraying and harvesting intercropped crops
- There's wastage of fertilizers especially when one of the crop is not economically profitable.

(h) PLANTATION FARMING/ estate farming

Is the growing of crops on a large scale for commercial purposes.

Examples of crops grown

- Cotton - Sugar cane - Tobbacco - Rice
- Coffee - Tea - Sisal

CHARACTERISTICS OF PLANTATION FARMING

- One type of crop grown
- Large amounts of capital invested
- Processing of the crop usually done at the farm
- Use of high level technology
- Large acreage under production (large pieces of land
- Employment of many workers

ADVANTAGES OF PLANTATION FARMING

- It creates employment opportunities to the people
- High production leads to generation of foreign exchange
- Processing done on the farm helps to reduce costs of production such as transport
- Plantation owners earn a lot of profits due to economies of scale.
- Waste materials are used as animal feeds e.g. Molasses

DISADVANTAGES OF PLANTATION FARMING

- Involves monoculture which destroy soil structure
- Building up and spread of pests and diseases is high
- Requires large pieces of land
- Requires large amounts of capital to start
- Plantation crops have long gestation period hence farmers can not get return immediately
- Fluctuation prices lead/to result into big losses e.g. prices of sugar
- Most plantation crops are cash crops not food crops which may lead to famine e.g. in Busoga most people have resorted to planting sugar cane and importing all food crops rendering prices of food crops high.

(i) RANCHING

Is the practice of rearing animals on a large scale.

The piece of land on to which ranching is carried out is called A **ranch**

Ranches produce mainly beef animals. The success of ranching depends on the following factors:

- Availability of feeds for animals

- Improved animal/beef breeds
- Efficient transport and marketing infrastructure for transport services to most centers.
- Efficient storage facilities to prevent spoilage of products.
- Availability of well trained personnel to perform technical activities on the ranch e.g treating animals, Ranch management, castrating bull calves, e.t.c

CHARACTERISTICS OF A RANCH

- Well established pasture
- Well fenced farmland
- Skilled and semi - skilled labour
- Well improved breeds of cattle
- Proper management system

(j) DAIRY FARMING

This is the rearing of cattle for production of milk and milk by products

CHARACTERISTICS OF DAIRY FARMING

- Well established pasture
- Well fenced farm land
- Skilled labour
- Well improved breeds
- Management in place in excellent

Assignment

1. (a) Give 5 examples of bi-products of milk and meat

(b) Suggest the benefits of:

(i) Ranching (03 marks)

(ii) Dairy farming (03 marks)

POPULATION AND ITS EFFECTS ON AGRICULTURE

Population density is the number of people living in a given area per square kilometer.

$$\text{Population} = \frac{\text{Number of people}}{\text{Area (size)}}$$

Population pressure is the situation where population density is too high for the resources to support it adequately.

EFFECTS OF HIGH POPULATION DENSITY ON THE LAND/ON AGRICULTURE

- Increased land fragmentation which results into reduced productivity of food
- Overgrazing leading to soil erosion and poor animal productivity
- Soil degradation through continuous cultivation and pollution from use of Agro chemicals, polythen dumping of non biodegradable chemicals and erosion

- Land reclamation such as deforestation and draining of swamps for settlement and burning of charcoal leading to change in rainfall patterns
- Shortage of land as a result of food production reduces leading to famine
- High crime rates due to unemployment
- Shortage of social services such as hospitals, schools
- Rural urban migration which reduces labour efficiency in villages especially due to lack of enough labour to work in agriculture.
- Poor sanitation which leads to easy spread of diseases
- Low standards of living among people.

WAYS OF OVERCOMING HIGH POPULATION DENSITY

- By encouraging family planning methods in order to reduce on birth rates
- Fair distribution of national income to reduce on rural urban migration
- Establishment of settlement schemes to provide land to people and reduce on population pressure
- Encourage land consolidation
- Providing massive education about R.U.M, high crime rates
- Construction of industries to reduce on unemployment rates.

CLIMATE AND ITS EFFECTS ON AGRICULTURE

Climate is the sum total of average daily weather conditions of a place/region observed and recorded for long period of time about 30 – 45 years.

Climate is one of the factors influencing distribution of crops and animals. The major elements of climate that influence crop distribution/animal include;

- Temperature
- Rainfall
- Light
- Wind
- Relative humidity

(a) TEMPERATURE:

Definition:- Ask students, as this is part of their Geography

effects of temperature on agriculture production

- Temperature influence on type of crop to grow in an area e.g. Arabica coffee grows well under low temperatures while Robusta coffee grows well under high temperatures.
- Temperature influence type of animals to keep in area.E.g.Exotic cattle do well in areas with high temperature but poor in low temperature areas.
- Temperature causes evaporation; this is loss of water from the surface of water bodies inform of water vapour. High temperature

causes high evaporation which leads to low water for livestock e.g. Karamoja

- Temperature influence growth and germination of seeds
- Temperature influences flowering and fruiting e.g. Maize can not fruit under low temperature – dry period but rather in wet periods
- Temperature influences availability of livestock feeds and their feeding behavior. E.g. under hot temperature animal do not graze but rather go under sheds/shelters, they graze in the morning and later evenings.

(b) RAINFALL: - how it affects Agriculture production

Ask students types of rainfall.

effects of rainfall on agriculture production

- Rainfall provides a natural precipitation/ water which influences germination of seeds.
- Water in the soil influences mineral uptake
- Water influences photosynthesis because its one of the raw materials of photosynthesis.
- Rainfall/water influences flowering/fruiting
- Rainfall influences growth/ distribution of pastures for feeding animals
- Heavy rain fall influences erosion i.e. Gulley erosion which leads to soil infertility
- Unreliable rainfall patterns may delay the planting/harvesting season.
- Rainfall reliability determines the type of farming practice in an area.

(c) light and its effect on agriculture production

- Light intensity has an influence on photosynthesis (stomata)
- High light intensity reduces on the chlorophyll content in leaves
- High light intensity can lead to wilting of plants
- Light influences germination of seeds

(d) RELATIVE HUMIDITY

Is the amount of moisture/water vapour present in the atmosphere compared with the amount when the air is saturated at a given temperature

effect of humidity on agriculture production

- R.H influences rates of transpiration in plants, yet transpiration cools the plant, facilitates water and solute uptake through out the plant.
- R.H which is high depresses heat leading to an used in heat load of the animals.
- High humidity causes reduction in feed intake in birds leads to reduce animal production.

(e) WIND

Wind is moving air

effects of wind on agriculture production

- Wind influences feeding activities of animals especially birds
- Wind leads to lodging of plants
- Wind influences cross pollination which blows anthers from one flower and fall on stigma of another flower

- Wind influences seed dispersal especially when it carries away seeds from one place to another.
- Wind influences soil erosion i.e. wind blows away fertile top soil and manure that has already been applied to the garden.

WATER CYCLE / HYDROLOGICAL CYCLE

The water cycle describes different ways in which water is lost from the earth's surface and its return to the earth in form of rain.

- The sunrays heat the ground which leads to loss of water from water bodies, soil surfaces, plant through leaves and animal bodies through evaporation and evapotranspiration.
- Water vapour rises to higher levels of atmosphere where it condenses to form clouds.
- Rain bearing clouds will give rain. Rain falls on the ground and then water infiltrates/ percolates into deeper soil layers.
- Some of the water flows on the soil surface as surface runoff to the water bodies
- Infiltrated/ percolated water is absorbed by plants and used in the process of photosynthesis and later lost to the atmosphere through transpiration.

The water cycle diagram here

SOIL AND SOIL FORMATION

Definition of soil

- Soil is a natural material that covers the earth's surface.
- Soil is a product of breakdown of rocks by various weathering processes and decomposition of plants and animal remains.
- Soil is a mixture of weathered rocks, air, water, organic matter and living organisms.
- Soil can also be defined as the part of the earth's surface that supports plant and animals life.

SOIL FORMATION

The process of soil formation is called Weathering. This process produces weathered rock materials called parent material.

Weathering involves the following processes

- Mechanical / physical weathering
- Biological weathering
- Chemical weathering

Weathering: is the break down of rocks into smaller particles which is brought about by

Physical and chemical forces.

Physical forces lead to mechanical or physical weathering, while chemicals bring about Chemical weathering.

(a) MECHANICAL WEATHERING

Is the disintegration /breakdown of rocks into smaller particles without changing their chemical composition.

It involves the following:

- Changes in temperature;

Rocks expand as temperature rise and contract as temperature fall; Eventually rocks break down due to differences in rates of expansion and contraction.

- Man's activities;

During construction of buildings, roads and constant cultivations, rocks are broken down into small particles

- Exfoliation;

Here, the out layer of the rock tends to get heated up easily than the inner one. It expands during the day and contracts during the night when temperature falls.

This process of expansion and contraction causes stress that results into peeling off of the outer layers.

- Frost action: (freezing of water);

Water entering cracks in the rocks get frozen to changes in temperature.

Therefore frozen water exerts forces on the rocks which end up opening up into wider gaps weakening the rock.

- Erosion and deposition:

Surface run off carries obstacles that rule against rocks which in turn break down.

(b) CHEMICAL WEATHERING:

This involves chemical reactions that change the chemical composition of the rock

It involves

- **Oxidation;**

Oxygen freely combines with minerals in rocks to form **oxides**; these weaken the rocks which eventually break to form soil.

- **Carbonation;**

Carbon dioxide from the atmosphere combines with rain water to form carbonic acid which reacts with rocks to form soil

(c) Biological Weathering:

This occurs when:

- Plants such as lichens grow on the rock surface weakening it.

Flowering plants later grow on the weakened rock surfaces, roots expand and breaks the rock further

- Burrowing animals weaken the softer rocks; earth worms create drainage routes in the soil.

- The activities of large animals, their movement and trampling effect cause rocks to break down into smaller particles.

FACTORS AFFECTING SOIL FORMATION

The following factors influence the rate of weathering leading to soil formation.

They include;

- Parent material -time
- Topography/Relief -Climate -Human activities

(a) CLIMATE:

The main climatic factors which influence weathering include;

- Rain fall
- Wind
- Temperature

rainfall influencing weathering in the ff ways

- The impacts of rain drops, as they fall from the sky are capable of removing small rock particles from the rock surface.
- Rain water dissolves CO_2 from the atmosphere to form carbonic acid which dissolves rocks
- As rain water flows/surface run off it peels off rock fragments which knock against each other to form soil.

Temperature influences weathering in ff ways

- Temperature speeds up chemical reactions involved in chemical weathering /rate of decomposition of organic matter
- Temperature causes expansion and contraction of rocks which eventually leads to rock disintegration

- Very cold temperatures cause water trapped in cracks to freeze and consequently expand in the rock.

wind influences weathering in the following ways

- Wind blows soil from one area to another affecting soils formed in that area
- Wind blows sand particles against rocks causing Abrasion of rock surfaces/carries heavy materials which can break the rocks

(b) PARENT MATERIAL;

This refers to the material from which soil originates.

- The type of soil formed in an area depends on the type of origin of parent material.
- Parent materials which are rich in Quartz give rise to Sandy soils while parent material rich in volcanic rocks gives rise to clay soils.

(c) TOPOGRAPHY/RELIEF;

- This refers to the general appearance of the land scape e.g. hilly, flat, steep or gentle slope.

- Soils formed at different levels on the hill are different from those at the top of the

hill, and at the bottom because of erosion,

- Soil at the bottom of the hill are deeper than soils on top of the hill, but are

poorly drained and darker than those up the hill.

- this is because the steeper the slope, the more or the greater the effect of erosion.

(d) TIME:

- Soil formation is a slow process.

The length of time over which the rocks have been exposed to the weathering process, affects the nature of the soil.

Soils which are deep are usually associated with longer periods of soil formation while young soils are associated with limited time of soil formation.

(e) LIVING ORGANISMS

These include; - vegetation cover (flora)

- Living organisms (fauna) like bacteria, fungi, termites and

Earthworms.

living organisms influence weathering in following ways

- Small plants (lichens) colonise bare rocks whose roots penetrate into rocks making cracks into them.
- Vegetation cover breaks down and adds organic matter in the soil.
- Plant roots penetrate the cracks in rocks and as they enlarge, they widen the cracks leading to breakdown of rocks
- Some micro organisms like ***Rhizobia bacteria spp*** fix Nitrogen into the soil which enables plants to grow well.
- The tips of plant roots secrete chemicals which dissolve the mineral components of rocks, as a result rocks are weakened

- Soil living organisms feed on organic matter thereby decomposing it
- Large animals break down rocks as they walk over them
- Organisms like termites and earth worms break down soft rocks and they also help in mixing underground soils with top soil and nutrient recycling
- When living organisms die, they increase organic matter content in the soil.

(f) HUMAN ACTIVITIES

Man's activities such as Digging, Road construction, stone quarrying expose the

rocks to the effects of rain and the sun which change its nature.

Man changes both physical and chemical properties of soil formed through

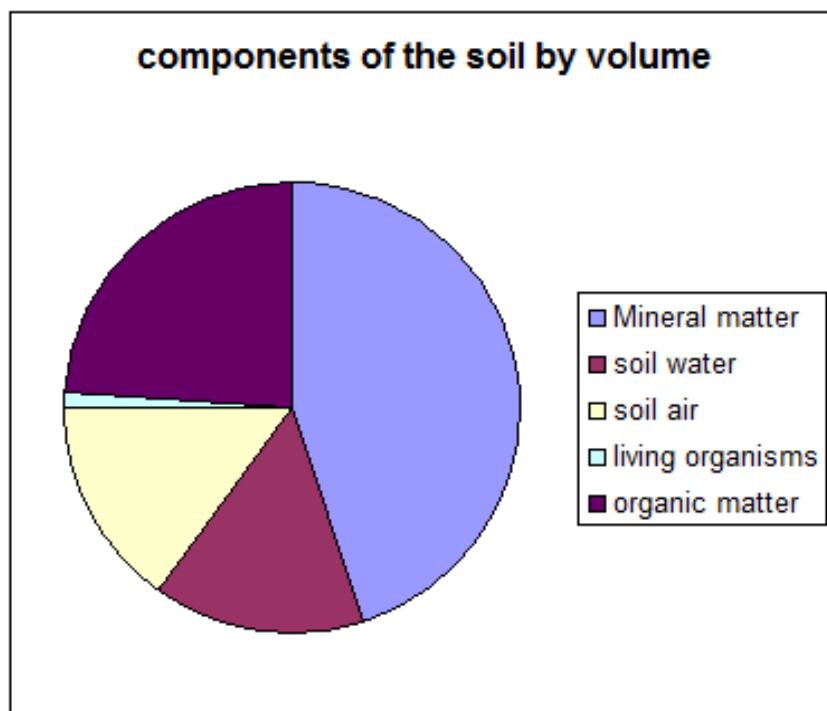
Application of fertilizers, herbicides liming and also deforestation.

SOIL COMPOSITION

Soil is made up of 5 components or determinants. These include;

- Soil water
- Soil air
- Organic matter
- Inorganic matter /mineral matter
- Living organisms

SOIL COMPOSITION BY PERCENTAGE/BY VOLUME



(a) SOIL WATER

This is found in the spaces between soil particles that are not filled with air

It constitutes 25% of soil by volume.

Importance of soil water

- It dissolves mineral nutrients so that roots of plants can take them in
- It keeps soil temperature cool thus enabling living organisms to survive in the soil
- It helps in germination of seeds because its one of the requirements for seed germination
- It softens soil particles thus enabling plant roots to grow between soil particles.
- It cools plants through transpiration
- It maintains the turgidity of leaves and young stems of plants
- It helps to carry away excess salts and chemicals from the soil

Expt to determine Amount of HO_2 in the soil

(b) ORGANIC MATTER

Is that part/fraction of the soil composed of plant and animal remains after various stages of decomposition

It constitutes about 5% of soil by volume

Importance of organic matter/humus

- Increases the water holding capacity of the soil
- Binds soil particles together hence improves soil structure
- Because of its Black colour, it absorbs the heat from the sun thus making the soil warm (improves soil temperature)

- It has a buffering characteristic on soil, which prevents rapid changes in the PH of the soil
- Organic matter provides food and shelter to the living organisms found in the soil.
- Organic matter releases Nutrients such as Nitrogen, carbon, Potassium, e.t.c into the soil which are essential for plant growth
- Holds and retains nutrients that would otherwise be easily lost from the soil by leaching.
- Improves water infiltration by reducing soil surface crusting
- When not fully decomposed, acts as a mulch that prevents soil erosion and weed growth
- Organic matter improves soil erosion

experiment to determine amount of organic matter in the soil (bios)

(c) SOIL AIR

This constitutes 25% of the soil by volume. It occupies the pores between the soil

particles that are not filled with water.

The more the water in the soil, the less the air content and vice versa.

The most important component of air is oxygen which is used for respiration and

Nitrogen that is converted into Nitrates by some bacteria living in the soil.

Importance of air in the soil

- It is needed by soil living organisms and plant roots for respiration
- It oxidizes organic matters forming nitrates that are taken in by plants.
- It is needed for seed germination
- It is used by plants to carry out photosynthesis
- It contains Nitrogen that can be converted into Nitrates for use by plants.
- It expels excess carbon dioxide from the soil

(d) LIVING ORGANISMS

They include earth worms insects such as Ants, Termites, Bacteria, Fungi and Nematodes.

(The importance of living organisms already covered under weathering)

Types of soil living organisms

- *Micro organisms*: these are tiny organisms that can only be seen by a microscope e.g. viruses, fungi, bacteria, protozoan.
- *Macro organisms*: these are bigger in size and can be seen easily with naked eyes. E.g. termites, earthworms, millipedes, centipedes, rodents, etc.

IMPORTANCE OF SOIL LIVING ORGANISMS

- Add humus to the soil when they die
- Help in decomposition of organic matter to release nutrients for plant use.

- Help in fixing nitrogen in the soil e.g. *Rhizobium* in root nodules of legumes.
- Burrowing animals help in mixing various layers of the soil profile with organic matter.
- Burrowing animals and earthworms help in improving soil aeration.
- Burrowing animals and earthworms make tunnels in the soil which help to improve drainage and water infiltration in the soil.
- Some bind soil particles together hence improving soil structure and stability. E.g., earth worms.
- Some produce antibiotics that can be used to control bacteria e.g *Aspergillus* and other penicillin producing fungi.
- Some carry out inorganic transformations of minerals e.g. in well drained soils, Iron and manganese are oxidized to higher oxidations.

NEGATIVE EFFECTS

- Some cause disease to plants.
- Some transmit diseases to plants (vectors)
- Some compete for nutrients with the plants (immobilization)
- Some damage the plants physically
- Denitrifying bacteria cause loss of nitrogen from the soil.

(e) INORGANIC MATTER /MINERAL MATTER

This consists of mineral particles. And constitutes 45% of soil by volume.

Importance of inorganic matter

- Supplies Nutrients to /soil/ plants
- Offers anchorage/support to plants
- Offers a surface onto which water is held

SOIL PROFILE:

Refers to the vertical arrangement of various soil layers/horizons from top to bottom.

A profile where some soil layers are missing is called **truncated** profile due to erosion

The horizons/layers of a profile are made up of small layers called **solumns**

The depth of a soil profile varies from place to place and this is due to the following

- Amount of soil deposited due to weathering
- The effect of soil erosion

Diagram showing a well developed soil profile

characteristics of various horizons/ layers of a soil profile

HORIZON A -TOP SOIL

- There are many living organisms
- It has plenty of organic matter which make it to look
- It has most of plant nutrients
- The soil particles are loosely packed which enable water and air to move freely through it.
- It is called the zone of Eluviation i.e. Minerals are washed away from region A and deposited in region B

HORIZON B -SUB SOIL

- This is some times called zone of Illuviation i.e. is where materials leached from A horizon accumulate or are deposited
- Fewer living organisms exist in this horizon
- It is Reddish/brown in colour due to iron oxide
- It has a tendency of developing hard pan in its region due to ploughing at the same depth seasonally.
- Organic matter content is low or is lacking in some places which makes the soil brown or red.

HORIZON C -Partially weathered rocks

- Made up of coarse, partly weathered rocks
- Soil particles are very tightly packed thus poorly aerated
- This horizon lacks organic matter

HORIZON D - Parent material/ Bedrock

- This is the original parent material which is still intact.
- It has not experienced weathering forces due to protection by the overlying horizons
- It lacks living organisms
- It lacks organic matter

importance of soil profile to crop production

- It can be used to determine the suitability of a soil for agriculture ie. The deeper the profile, especially the top soil layer the better the soil is for crop production.
- Deeper soil profile provides the roots of crops with a bigger volume of soil to exploit
- It helps to determine the type of crop to grow. Shallow rooted crops are grown in shallow profiles and vice versa.

SOIL PROPERTIES

The properties of soil include;

(a) Physical soil properties examples;

- | | |
|------------------|---------------------------------|
| - Soil texture | - Bulky density |
| - Soil colour | - Drainage |
| - Soil temp | - Capillarity |
| - Soil structure | - Soil aeration - Pore space |

(b) Chemical soil properties include:

- | | |
|------------------|-------------------|
| - Soil PH | - Cation exchange |
| - Soil fertility | |

- Soil nutrients

SOIL STRUCTURE

Definition

Is the overall arrangement of soil particles within a given soil

types of soil structure

Soil structure is classified according to size of soil particles, degree of aggregation and shape of soil particles namely;

(a) Plate like structure / Platy structure

In this type, soil particles are arranged in such away that they form thin sheets

lying horizontally on top of the other.

Plate structure is found in top soils

Diagram:

(b) Blocky structure/ Cubical structure

In this type, soil particles are arranged like cubes, Blocks that can fit together.

Some have sharp edges

It is found in the subsoils and Antihills soils **diagram here....**

(c) Prismatic structure

In this type, soil aggregates are vertically arranged and some times in distinct columns. It is found in sub soils **diagram here.....**

(d) Columnar structure

In this type of structure, the soil particles are arranged to form vertical columns but the tops of these columns are round. Also found in the subsoil **diagram here....**

(e) Granular structure; here soil particles are formed together to form small rounded aggregates. It is found in Top soils that contain a lot of organic matter.

- found in surface soils **diagram here....**

(f) Crumb structure

In this type, Aggregates resemble granular type except; that, in this type, the particles/aggregates are bigger, more porous and they readily crumble down shaken to give aggregates with granular structure.

-found in Topsoil **diagram here....**

IMPORTANCE OF SOIL STRUCTURE

- It facilitates aeration/ easy movement of air and water which ensures that there's good balance between water and air in the soil
- It allows adequate retention of water for plant use
- It facilitates good drainage avoiding water logging
- It determines workability/ the ease with which soil can be ploughed
- Controls soil temperature through its control of soil aeration
- It does not allow soil to be easily eroded
- It allow plant roots to grow and spread widely with in the soil

- It prevents build up of CO_2 in the soil to toxic levels through proper aeration

ways of destroying soil structure

- Through cultivation which leads to rapid break down of organic matter.
- Overgrazing which encourages erosion
- Mining which causes deposition of sub soils
- Leaching of nutrients especially from top to subsoil
- soil erosion
- cropping and harvesting practices
- water logging
- Manuring to increase aggregate stability

mentainance of soil structure

- Minimum tillage which allows soil structure to recover and reduces break down of organic matter
- A forestation since roots bind soil particles
- Mulching to conserve soil moisture
- By liming
- By growing cover crops
- By drainage
- Crop rotation and intercropping

SOIL TEXTURE

Is the relative proportion of clay silt and sand in a given sample of soil.

Is the roughness or smoothness of soil when rubbed between fingers.

A soil which is rough when rubbed is said to be **Coarse textured**

A soil which is smooth when rubbed is said to be **fine textured**

Soil can be separated into various particle sizes using **Mechanical analysis**

Mechanical analysis involves separating soil particles according to size using a sieve

Or mixing it with water and allow it to settle (contents).

Table below shows classification of soil particles by size

Name of Particle	Size limit (diameter in mm)
Gravel	20.2 – 2.0
Coarse sand	2.0 – 0.2
Fine sand	0.2 – 0.02
Silt	0.02 – 0.002
Clay	Less than 0.002

Soil textural classes include;

(a) **Sandy soil**

- They are well drained i.e. they have poor water holding capacity
- They have a coarse texture
- They are well aerated

- They have high rate of leaching
- They have a low capillarity
- They have a less stable structure thus can easily be eroded
- They are usually acidic
- They warm up readily during the day and cool down very fast at night.
- They contain 80 -95% sand, 5 – 2% silt and clay 0.1 -1% organic matter
- They are light and easy to work with

Improvement of sandy soil to suit crop production

- Addition of organic matter.
- Addition of artificial fertilizers.
- Irrigation to add water.
- Liming to control soil acidity.
- Addition of organic manures e.g. FYM, compost.
- Mixing with other types e.g. clay.

(b) Loam soils

- They have a well balanced proportion of clay, Silt and Sand particles and are rich in organic matter.
- They have good chemical and physical properties
- They are fairly fine textured
- They are slightly acidic
- They are easy to cultivate

- They have moderate capillarity

(c) Clay soils

- They are fine textured
- They contain a large amount of water, hence poorly drained
- They are very sticky when wet and very hard when dry.
- They are difficult to cultivate, hence referred to as heavy soils
- They do not warm up easily due to large Amounts of water they hold
- They expand when wet and contract when they dry
- They are poorly aerated
- They have high capillarity
- They are slightly Alkaline

Improvement of clay soil for crop production

- By draining i.e. removing excess water
- Adding organic matter
- Adding other types e.g sand to improve on its properties.

EXPERIMENT ON SOIL PROPERTIES (Practicals in Lab)

(1) Experiment to determine texture of a soil using (i) finger feel

(ii) Using mechanical

analysis

(2) Experiment to determine capillarity of different soil samples

(3) Experiment to determine retention of soil samples

(4) Experiment to determine the rate of percolation of samples/Drainage/degree of

Witness/drying

(5) Experiment to determine PH

IMPORTANCE OF SOIL TEXTURE

- It determines the water holding capacity of the soil
- It determines the aeration of the soil
- It determines the ease with which the soil can be ploughed
- It determines the erodibility of the soil i.e. how easy the soil can be crushed away
- It determines the temperature of the soil
- It influences the penetration of roots in the soil.

SOIL FERTILITY

Soil fertility; Is the ability of soil to produce enough Nutrients required to support plant growth.

Soil productivity is the ability of the soil to produce good yields in terms of crops.

FACTORS THAT CONTRIBUTE TOWARDS FERTILITY OF THE SOIL

- Water holding capacity:

A fertile soil should retain just the right amount of water to support crop growth

- Good drainage:

Fertile soils should be able to allow excess H_2O to sink easily. This creates enough space for air and influences having enough temperature for crop growth.

- Soil depth:

Deep soils give plant roots a large area in which to spread and obtain plant nutrients.

- Good organic matter content

The amt of organic matter releases many soil nutrients

- Good soil PH:

- PH also influences availability of plant nutrients
- PH should be favourable for some crops e.g Acidic allows growth of some crops while Alkaline also.

- Good soil structure:

Soil structure influences root penetration into the soil and prevents erosion to occur

- Good aeration:

Soil should have enough air to support respiration of roots and micro organisms

WAYS IN WHICH SOIL LOOSES ITS FERTILITY

- Soil erosion:

Fertile top soil being eroded reduces fertility

- By leaching:

Loss of nutrients to lower layers of soils by dissolving in rain water.

- By volatilization;

Is loss of nutrients to the atmosphere in gaseous form

- By immobilization:

Some microbes use nutrients to survive nutrients like N

- Absorption by plants;

Plants take in Nutrients for growth hence reduce nutrients.

- Excessive drainage

- Excessive irrigation

- Through plant removal:

Is so when crops are harvested, plant remains are not returned to the garden

- Formation of hard pans:

- Is formed below the soil surface due to digging at the same depth seasonally.

- This prevents H_2O movement, root penetration and development.

- Poor farming methods:

- e.g. - overgrazing expose the soil to erosion hence loose fertility.

- Accumulation of salts:

This may be due to use of salty water to irrigate crops.

- Soil capping: ie formation of an impermeable layer of soil on the soil surface. This interferes with water infiltration and air circulation in the soil.

HOW TO IMPROVE / OR MAINTAIN SOIL FERTILITY

- Through fertilizer application and organic manure which add nutrients that have been lost.
- By mulching in order to maintain soil moisture and control erosion
- By improving the drainage
- By liming in order to improve soil PH
- By carrying out irrigation to dilute salts
- Through crop rotation
- Through Bush fallowing
- Through intercropping
- By sub soiling in order to break the soil hard pans and improve root penetration.

SOIL PH

Is the measure of Acidity/Alkalinity of the soil.

It is also the concentration of hydrogen ions in the soil.

A soil is Acidic if it has more Hydrogen ions than Hydroxyl ions.

Alkaline: Soil has more OH⁻ ions than H⁺

Neutral soils have equal amounts of H⁺ and OH⁻ Ions

PH of a soil is measured using the PH scale or meter which runs from 0 – 14.

PH 7 is at Neutral point

The lower the PH the more acidic the soil is while the higher the PH the more Alkaline the soil is

Determination of soil PH

Soil PH can be determined by use of the indicator/dye called – Universal indicator,

- Soil sample
- Distilled water
- Test tubes
- Barium sulphate
- Ph colour chart

Procedure

- Get a small amount of soil and place it in a test tube
- Add Barium sulphate to help in breaking of 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 a PH colour chart on which PH values correspond to different indicator colours are recorded
- The exact PH of the soil under investigation is read off the colour chart

N.B: Red colour indicates strongly Acidic

Blue colour Alkaline

Green Neutral

IMPORTANCE OF SOIL PH

- PH determines what type of crop to grow in a particular soil e.g. – Arabica coffee and Tea do well in Acidic soils, legumes do well in Alkaline.
- PH influences availability of plant Nutrients e.g. – At high PH Potassium becomes unavailable.
- At low PH phosphorus becomes un available
- Some plant diseases are more pronounced in soils with low PH e.g. fungal diseases.
- Nitrogen fixing bacteria prefer a PH of 5.5 – 8 ,Low/high PH will affect the activities of these bacteria

MODIFYING OF SOIL PH

Soil PH can be corrected in the following ways;

- Acidic soils are made Alkaline by addition of lime (Lining)
- Alkaline soils are made Acidic by addition of Acidic fertilizers e.g. – Sulphate of Ammonia
- Addition of organic manure to buffer the soil PH.

SOIL SAMPLING

Is the collection of soil samples from various parts of the field/land and taking them to the lab for analysis.

Objectives / reasons for carrying out soil sampling

- To determine the suitable tillage practices to use
- To determine the type of crops to grow

- To determine the fertility level of the soil and which Nutrients are lacking/to add
- To determine the type and amount of fertilizer to add
- To make crop yield estimates based on fertility of the soil
- To determine the structure of the soil
- To determine the water holding capacity
- To determine organic matter content
- To determine the PH of the soil

equipments for soil sampling

The major equipment used in soil sampling is the Auger but incase it is absent, the following tools can be used.

- Transverse method
- Zig Zag method
- Spot method

(a) Transverse method

In this method, diagonals are drawn across the field/area to be sampled and sites are selected along those diagonals as shown below:

Diagram:

(b) Zig Zag Method

Here, sites are chosen at random in the entire field as shown below without any

formular

(c) Spot Method

In this method, one location is chosen randomly. This is suitable for small pieces of

land of about 0.25 acre.

Diagram:

PROCEDURES OF SOIL SAMPLING

- Obtain clean and complete equipments to use
- Determine the area to be sampled so as to know how many samples to take
i.e. (field should not exceed 5 ha of land).
- Choose the method that will be used to collect samples
- Choose the sites from which the samples will be collected
- Clear all surface vegetation at the selected sites to exclude plant material which is found of decomposing
- Collect the samples from a depth of about 15 cm
- Add all samples from specific depth to make a composite sample
- Thoroughly mix the composite samples by breaking the big clods into small particles.
- Make 2 labels for each representative sample with the following information;
Person taking the sample and Address, Areas sampled, Field Number, Equipment used, Date of sampling, Purpose of sampling, Depth of sampling
- Take the samples to the lab and all dry them
- Carry out the intended analysis and record outcomes.

Areas to avoid while carrying out soil sampling

- Old house sites
- Rubbish pits
- Very wet areas
- Foot paths
- Boundaries
- Anti hills
- Under tree shades
- Kraals

SOIL NUTRIENTS

These are derived from minerals of the soil and are used as plant food.

Soil nutrients are used/required by plants in large quantities or small quantities. They include;

-Macro nutrients

-Micro nutrients

MACRO NUTRIENTS/ Major/Primary Nutrients

These are nutrients /elements which are required by plants in large quantities

They include;

- Nitrogen
- Phosphorous
- Potassium
- Oxygen
- Magnesium
- Carbon
- Sulphur
- Hydrogen
- Calcium

MICRO NUTRIENTS/Trace/ Minor Nutrients

These are nutrients required by plants in small quantities.

They include;

- | | | |
|-------------|------------|----------|
| -Copper | - Cobolt | - Iron |
| -Molybdenum | - Chlorine | - Zinc |
| -Manganese | - Boron | - Iodine |

A)NITROGEN

Roles/uses of nitrogen

- It makes plants succulent with a deep green colour.
- It is useful in the form of chlorophyll, the green colouring matter of leaves.
- It helps in formation of plants proteins.
- It encourages rapid vegetative growth which is important in forage and crops like cabbages etc.
- It controls the availability of phosphorous and potassium.
- In cereals, it makes the size of grains bigger.

Deficiency symptoms of nitrogen

- Plant leaves turn yellowish/brownish in colour.
- Crops produce other pigments instead of chlorophyll.
- Leaves fall off prematurely.
- Fruits ripen prematurely.
- Grains are small in size
- Flowers chop off the plants.

Effects of excess nitrogen in plants

- Stems and leaves are weak.

- Seeds and fruits are poorly developed.
- Leaves become scorched/burning of leaves
- Seeds and fruits are watery
- Plants take longer to mature/delayed maturity
- There's excessive succulence in plants.
- Lodging of stem especially for cereals
- Reduced disease
- Poor grain filling and low quantity grain

Forms in which Nitrogen is available to plants

- Nitrate (NO_3)
- Ammonium ions (NH_4^+)

Sources of Nitrogen

- Through organic matter such farm yard manure and compost manure.
- Fixation by bacteria e.g. Rhizobia and Azotobacter.
- Oxidation of atmospheric nitrogen by lightning.
- Through fertilizers such as S.A, CAN, DAP

The Nitrogen cycle

Is the path taken by Nitrogen as it is transformed from gaseous form to nitrates in the soil.

Diagram here.....

Description

Atmospheric Nitrogen is fixed by symbiotic bacteria such as Rhizobia, clostridium as well as Non symbiotic bacteria (Azotobacter).

During lightning, Nitrogen combines with O^2 to form Nitrogen dioxide which is washed down during thunderstorms as dilute nitric Acid. Once in soil, Nitrates are released for plants use.

- Nitrogen gas is also removed from the atmosphere to manufacture fertilizers.

The fertilizers are then applied to the garden; plants absorb nitrates from the soil.

- Plants are then eaten by animals to form animal proteins.
- Plants and animals die to form organic matter a process called decaying/purification.
- Organic matter is converted to ammonium compounds a process called ammonification/mineralization.
- The nitrifying bacteria (Nitrosomonas and Nitrobacteria convert Ammonium compounds to nitrates then to nitrate respectively.
- The Nitrosomonas bacteria first change ammonium compounds to nitrates then Nitrobacteria converts' nitrates to nitrates.
- Nitrates are lost from the soil through:-
 - Soil erosion
 - Crop removal
 - Dentrification
 - Immobilization
 - Volatilization
- Exposure of soil to sunlight increases soil temperature; this encourages denitrifying bacteria to accelerate volatilization. Once nitrates are not

absorbed by plants; they quickly dissolve in H^O sink deep into the soil a process called leaching.

EXERCISE

a. Define the following:-

i)Mineralization

ii)Absorption

iii)Nitrification

iv)Dentrification

b. In what ways is Nitrogen lost to the soil?

B) CARBON

It is absorbed by leaves of green plants inform of Co_2 during photosynthesis.

Plants also absorb carbon from the soil inform of carbonate ions (Co_3^{2-}) and bicarbonate ions (HCo_3^-).

Uses of carbon

It is used by plants to produce carbohydrates, proteins and oils.

The carbon cycle

Sources of Co_2 to the atmosphere are:-

- Respiration by living organisms
- Burning of fossil fuels i.e. Paraffin, diesel, petrol wood, fuel (charcoal, firewood) etc.
- Decomposition of organic substances
- Volcanic actions, when volcanoes erupt, a lot of Co_2 and other gases are released into the atmosphere.

- Water bodies/oceans, seas, lakes and rivers serve as reservoirs of CO₂ and release it into the atmosphere when atmospheric CO₂ content falls below 0.03%.

Diagram here.....

Process that cause reduction of CO₂ in the atmosphere are: -

dissolution by rain H₂O and photosynthesis.

- When it rains, CO₂ dissolves in rain water to form Carbonic Acid while in soil, thus acid is transformed into carbonates and bicarbonates. These are either absorbed by plants or lost from soil through leaching and erosion.
- Through photosynthesis, CO₂ is transformed in green plants to organic carbon compounds such as carbohydrates, protein and oils.
- When animals eat plant materials, they extract carbon compounds and use them to build their own bodies.
- When plants and animals die, they decay and release the carbon compounds into the soil and air. Then the process above is repeated as shown above.

C) POTASSIUM

It is absorbed as potassium ions (K⁺)

Uses of potassium

- It is used in the synthesis of protein in plants.
- It encourages root development and terminal buds.
- It is important in photosynthesis and respiration.

- It imports resistance of crops against disease
- It is helpful to the formation of both chlorophyll and starch.
- It controls opening and closing of stomata
- It controls growth of buds and roots tips.
- It activates the action of enzymes
- It encourages development of tubers
- It makes grains big and well filled

Deficiency symptoms of potassium

- The margins and tips of leaves dry as the lamina remains green
- It causes loss of green colour in leaves
- The leaves appear curled
- Premature loss of leaves
- Causes lodging of plants
- Leaf mottling (different colours)

D) PHOSPHOROUS (P)

Phosphorous is absorbed in form of phosphate ions.

Uses of phosphorous

- It is important for flowering and fruiting in plants
- It encourages formation of plant roots.
- It is important in Amino acid formation, cell division and photosynthesis.
- It improves the quality of forage and cereal crops.

Deficiency symptoms of phosphorous

- Leaves develop purple green colour and fall off prematurely.
- Cereals crops lodge/fall
- Poor branching in stems and roots
- Axillary buds fail to grow stunted growth.
- Tuber crops like Irish potato are small and few.

FERTILIZERS/MANURES

These are substances which provide nutrients to plants and help to enhance proper growth and development.

There are 2 types of fertilizers namely:-

- Organic fertilizers
- Inorganic fertilizers

A)ORGANIC FERTILIZERS

These are fertilizers produced by plants and animal remains after decomposing.

Forms of organic fertilizers/manures

- Green manure
- Compost manure
- Farm yard manure
- Organic mulches

i) Green manure

This is obtained from crops grown in the garden and ploughed into the soil when they have reached the flowering stage.

Characteristic of crops suitable for green manure production

- They should have a fast growth rate
- They should be able to decompose quickly.
- They should have a high content of nutrients especially Nitrogen
- (should be leguminous).
- They should be free from pests and diseases
- They should be easy to plough into the soil.
- Should be leafy or highly vegetative.
- Should be able to grow on relatively poor soils.

Advantages of green manure

- Green manure crops cover the soil during erosion prone seasons of the year.
- It speeds up biochemical activities in the soil.
- It increases the organic matter content of the soil.

Disadvantages of green manure

- If the material is fibrous, a lot of Nitrogen is used by micro organisms to decompose it. This means that little Nitrogen is left for crops.
- A lot of water is used in the process of decomposition and this leaves little water in the soil for crops.
- Some crops used for making green manure like G.nuts, Beans are food crops add it may be difficult for farmers to sacrifice them for green manure.
- It requires a lot of labour to make

- It may delay the cropping programmes.

ii) Farm yard manure (F.Y.M)

This type of manure is obtained from animal dung, urine and beddings collected from animal houses.

How to make farm yard manure

It can be prepared using the following ways:-

- Beddings can be cut and put in the houses where animals stay.
- Animals urinate and drop dung on the beddings.
- Beddings are left in the houses until they are fully mixed up with urine and dung.
- Beddings are removed and put in the proper areas/under shed in order to reduce nutrients loss through leaching/evaporation/volatilization of nutrients.
- Cover the material to prevent loss of nutrients
- Allow the material to decay for about 1½ months.

Factors affecting the quality of farm yard manure

The type of animal kept:-

- Dung from non ruminants like pigs, birds provides good quality manure than ruminants.
- Type of bedding used; straw/plant bedding absorb more urine than wood shaving.
- Type of feeds given to animals, as concentrates provide excellent firm yard manure than starchy feeds.

- Method of storage:- Manure stored under shelter/shed has more plant nutrients than exposed to rain and sunshine.
- Time; well rotten manure is rich in mineral nutrients than fresh manure
(more time should be taken to enable/allow farm yard manure to rot).

Advantages of farm yard manure

- It usually has a high content of N and phosphorous
- It supplies a high amount of organic matter to the soil.
- It improves on the soil physical properties such as structure.

Disadvantages of farm yard manure

- It is difficult to collect enough animal dropping if the animals are scattered.
- Urine can only be collected when the floor is cemented and only if animals are kept indoors.
- Requires a lot of labour to collect the dung
- Farm yard manure has a bad smell

iii) _____ Compost manure

The term compost means- a collection of items from different sources.

Compost manure is obtained from kitchen wastes and rubbish than can rot easily.

Kitchen wastes include:-

- Left over foods
- Peelings of banana, cassava, potatoes, rice husks

- Rotten foods etc

The materials used to make this type of manure depend on what might be available at home.

When making compost manure, care must be taken to avoid the following:-

- Polythen materials
- Broken glass
- Plastic pieces of materials, this is because materials do not decompose and broken glasses are harmful to the farmer.

Methods of preparing compost manure

There are methods used, namely:-

- The heap method
- The pit method

PIT METHOD

- 5 pits of about 150cm x 150 cm x 60 cm are dug.
- The materials to make the manure are arranged in the 1st pit as follows:-
(i.e. order from bottom to top).
- Dry hedge cuttings/maize stalks to trap nutrients and allow aeration to take place.
- Fresh grass, leaves, kitchen refuse are added

- Some farm yard manure is added to provide food for micro- living organisms that break down the fresh materials.
- Wood ash is added to improve on the nutrient content of manure.
- Top soil is added.

Diagram here.....

- If the pit is not full, the order above is repeated up to when the pit fills.
- When the pit is full, it is covered with dry leaves
- After 3-4 weeks, the materials in the 1st pit are transferred to the 2nd pit and covered with leaves more fresh materials are put in pit 1.
- After 3 – 4 weeks, materials in pit (2) are transferred to pit (3) and covered, material in pit (1) to pit (2).
- After one month, materials in pit (3) are transferred to pit (4) where it stays for another month.
- From pit (4), it is transferred to pit (5) where it stays for another month.

By this the manure is ready for use in the garden.

Diagram here....

Advantages of using compost manure

- It is easy for anyone to get materials to make compost manure.
- It has a long lasting effect in the soil
- It is cheap to prepare

- It adds organic matter to the soil
- It improves soil structure

Disadvantages of using compost manure

- It requires a lot of labour to prepare
- It is expensive to apply since it is bulky
- The quantity of nutrients is always unknown
- May be a source of pests and diseases
- It takes a long time to prepare
- May pose a health risk to the farmer
- It has a bad smell

Group Assignment

- Use the pit method to prepare compost manure and apply it in the school garden.

iv) Organic mulches

- These are materials used to cover the soil surface in a garden. When plant materials are used for mulching, we refer to them as **organic mulches** while
- Materials such as polythene papers when used for mulching are referred to as inorganic mulches.

Advantages of mulching/using organic mulches

- They increase the organic matter content and population of living organisms in the soil.
- The organic matter obtained improves soil aeration, water infiltration and water holding capacity of the soil.
- The mulches supply a variety of nutrients to plants especially N.P and K.
- They improve soil structure
- Mulches prevent soil erosion by improving infiltration of rain water into the soil.
- Mulches conserve moisture in the soil by preventing erosion.
- Mulches moderate soil temperatures by preventing the sun's heat from reaching the soil surface.
- Mulches suppress annual weeds/smooth weeds.

Disadvantages of mulches

- It encourages multiplication of pests since it offers hiding grounds for pests.
- During the rainy seasons, thick mulch contributes to lowering of soil temperature.
- They are expensive to use especially if inorganic mulches are used.
- Mulches can be a fire hazard which may burn crops
- Some mulches especially fresh grass may be a source of weeds.

B) INORGANIC FERTILIZERS

These are manmade chemical substances that are used to supply plants with nutrients.

Inorganic fertilizers can be classified as:-

(i) Straight fertilizers/single

These supply only one nutrient element e.g. SSP, TSP, M.O.P which supply only phosphorous or Nitrogen.

(ii) Compound fertilizers

These supply more than one nutrient element to plants e.g. C.A.N, NPK and DAP, these supply both N and P.

(iii) Complete fertilizers

These fertilizers supply all the three primary nutrients e.g. N.P.K

Advantages of inorganic fertilizers

- The amounts of plant nutrients they contain can easily be estimated.
- When applied they readily release nutrients
- They are easy to handle and store because they come in convenient packages.
- They are specific and so allow application of only the required nutrients.
- They can easily be combined with irrigation water and applied at once.

Disadvantages of inorganic fertilizers

- Some are expensive to buy.

- The nutrients element contained in them can easily be leached.
- They do not improve the physical properties of the soil e.g. structure.
- They can be toxic to plants when used in excess.
- Their effect on soil lasts for a short time hence the need to apply them every season.
- They require skilled labour to apply them
- They can pollute the environment e.g. when eroded by rain water to water bodies.

LABELLING FERTILIZERS

Fertilizers may be labeled as **NPK 5-10-20**. The figure 5, 10 and 20 represent percentages of the available nitrogen, phosphorous and potassium respectively. These may be percentage or ratios.

Example 1

- An artificial fertilizers **NPK** supplies nitrogen, Phosphorous and potassium in the ratios of 5:10:20. Calculate the amount of each nutrient in one tone of the fertilizers.

1 tone = 1000kg

N	P	K
5	10	20

Total ratio = 5+10+20
= **35**

Amount of nitrogen

$\frac{5}{35} \times 1000\text{kg}$

=**142.85kg**

Amount of phosphorous

$\frac{10}{35} \times 1000$

= **285.7kg**

Amount of potassium

$\frac{20}{35} \times 1000$

= **571.4kg**

EXERCISE

QTN

Mr. Kato is a farmer in Mukono district. He is to apply NPK fertilizers on 3ha of land in the ratio of NPK 25÷ 15 – 30.

Calculate:-

- Amount of each nutrient 1 tone
- Amount of each nutrient in 4 tones

- (iii) Amount of each nutrient in 10 tones

QTN

Assignment- **Hand in before next lesson**

1960kg of C.A.N was applied on 4 hectares of land. If the guaranteed analysis of fertilizers was 32:16:8.

Calculate the amount of each element that was applied per hectare.

METHODS OF FERTILIZER APPLICATION

1. Top dressing;

Here the fertilizer is applied on the surface of the soil when crop has already established e.g. NPK fertilizers applied to make crop when it has reached knee height.

2. Band placement;

Here the fertilizer is applied between rows of crops in strips/bands; however, fertilizers should not be put too near or too far away plants.

3. Spot application;

Here particulars spots/places are selected and fertilizers are applied in these places next to a seed/plant.

4. Ring placement;

Here fertilizers are placed in a ring from around the crop. The advantage is that crops are able to absorb the nutrients from all sides.

5. Side dressing

Here fertilizers are placed in a band a few centimeters on the side of the crop, also applied after crop has established.

6. Plough sole;

Here fertilizers are applied at ploughing time and mixed in the soil as ploughing takes place.

7. Fertigation method

Here soluble fertilizers are dissolved in irrigation water and delivered to the soil with the irrigation water.

8. Broadcasting method;

Here fertilizers are uniformly scattered over the soil surface and then ploughing into the soil.

9. Foliar application;

Here fertilizers to be applied are dissolved in water and sprayed onto the leaves of crops.

Factors affecting crop response to fertilizers

- Amount of fertilizers applied;

Correct rate of fertilizers should be applied as too much/too little affects crop growth

- Fertility level of the soil;

If the soil is already fertile, then there's no need to add fertilizers because the crops will not utilize it.

- Moisture content of the soil;

Soil moisture dissolves fertilizer elements which will be taken in by plants in solution form.

- **Soil temperature;**

Some fertilizers especially N fertilizers are affected by high temperatures.

They tend to escape into atmosphere by volatilization.

- **Soil PH;**

This affects the availability of some fertilizers elements in the soil. e.g. Under low PH (acidic) phosphorous becomes unavailable to plants.

- **Type of crop;**

Crops like legumes do not require N fertilizers application because they are able to fix their own N.

- **Method of application;**

Fertilizers should not be placed too close or too far as some may instead burn the crop when in direct contact.

- **Stage of crop growth;**

Fertilizers should be applied at right stage of crop growth e.g. N fertilizers should be top dressed at knee high stage of crop.

- **Nature/form of the fertilizers;**

Some fertilizers are less soluble e.g. SSP, this should be applied early enough to allow it to dissolve and be taken up by plants easily, While others dissolve early e.g. N (urea).

- **Plant population;**

Optimum plant population ensures that plants get adequate N while too high population, there will be competition.

- **Weed infestation;**

Too many weeds compete with crops for nutrients and response is going to be poor. Weed free crops respond well to fertilizer application.

SOIL AND WATER CONSERVATION

Definition:-

These are measures/practices carried out and are aimed at conserving water and

ensure that soil remains in one place.

objectives of soil and water conservation

1. To retain water in the soil so that plant growth is not affected when there's no rain.
2. To maintain soil fertility and productivity, making sure that fertile soil is not lost, because it is the basis for agriculture
3. To make sure that soil is not lost, because it is the basis for
4. To maintain physical properties of the soil favorable for soil growth

SOIL EROSION

This is the washing away of top soil by various agents' e.g. wind, water, Animals

AGENTS OF EROSION

Major agents of erosion include;

(i) Running water:

When it rains heavily, the soil is unable to absorb all the rain H₂O, as a result some of water runs over the soil surface and erodes soil

(ii) Strong winds

Wind must have velocity to be effective in erosion. Velocity is the speed at which wind moves. This is more effective in flat and bare lands.

(iii) Animals e.g. –Cows carry soil particles in their hooves through their pounding

Effect.

Large Number of animals on a small piece of land led to over stocking.

(iv) Human beings

Man carries out cultivation on steep slopes, deforestation, bush burning; all these

Expose soil to erosion agents

FACTORS INFLUENCING SOIL EROSION

1. Land use practices;

Land mostly used for farming, bush burning monocropping exposes it to erosion agents

2. Vegetation cover;

Roots of plants bind soil particles together resisting erosion forces while deforestation exposes to erosion

3. Topography

The steeper the land, the higher the speed of running water, and the greater the erosion

4. Soil type and condition

Soil with loose particles; easily disintegrate when it rains while soils which are tightly packed do not easily disintegrate under impact of rain.

5. Rain fall intensity (Amount of rainfall)

Areas which receive a lot of rain in a short time are more affected by erosion than those where it drizzles for the whole day.

TYPES OF EROSION

There are several types of erosion namely;

(i) Splash erosion/rain drop erosion

Is a type of erosion where rain drops break soil particles which can be easily dislodged from one area to another area.

(ii) Sheet erosion;

Is where running water carries away thin top most fertile layer. It is not easily

noticeable but it is the most serious type because it's the top layer full of organic

matter and nutrients that is being eroded.

(iii) Rill erosion;

Is where small channels are formed by running water. These channels are called

Rills, as the intensity of rainfall and velocity of running water increase the rill deepen

(iv) Gully erosion;

Is where by deep gorges are formed on the soil surfaces due to running water.

Gorges are formed when small rills deepen due to the speed and volume of running

Water

(v) River bank erosion;

This occurs along the banks of rivers when the river water is flowing it carries along

logs, stones, debris and other materials along with it as these materials hit the banks of

rivers they lead to wearing off the banks.

CONTROL OF EROSION

In order to minimize the effects of soil certain measures should be put in place to control

Erosion. These measures are grouped into two i.e.

- Cultural/Biological methods
- Physical/Mechanical methods

(a) CULTURAL METHODS/BIOLOGICAL

This involves use plants as well as carrying out some agronomic practices used to

Improve their growth

These include;

(i) Use of grass ships

Is a narrow band of grass planted along the contour usually ploughed and planted

with grass that can be used for fodder for livestock.

E.g – Elephant grass, signa; grass, Guinea ssp, setaria

(ii) Use of cover crops

For the purpose of controlling erosion, cover crops are planted too close each other

so as to form a dense vegetation cover

E.g of cover crop e.g – potatoes, pumpkins, grasses

(iii) By Mulching;

Mulches help to conserve the water reducing its speed; reducing velocity of

raindrops on to soil

(iv) **By afforestation:**

Plant roots help to bind soil particles together thereby preventing surface runoff.

(v) **Strip cropping:**

Crops grown in strips across the slope to resist/check the speed of runoff which

encourages deposition of soil and infiltration of water.

(vi) **By use of windbreaks;**

Here trees are planted against the direction of wind in order to create a barrier that

reduces speed of wind.

(vii) **Intercropping:**

This increases the population of plants in the field to allow for better use of the land

to protect land from rain drop erosion since the speed of surface runoff is reduced.

(viii) **Crop rotation;**

Different crops planted give a good ground cover with those that give less, reduces

Erosion.

(ix) **Manuring;**

Manures tend to have a binding effect on the soils and so bind soil particles together

which give resistance to raindrops erosion

Assignment

State other cultural methods of controlling soil erosion (Explain)

(b) MECHANICAL /PHYSICAL METHODS OF CONTROLLING SOIL EROSION

(i) Construction of bunds;

These are walls/heaps of soil along the slope so as to act as barrier to the run off.

Bunds help to reduce speed of running water and encourage sedimentation.

(ii) Use of stone lines/Trash lines;

These are rows of heaped trash/stones made across the slope to check the

Speed/reduce speed of running water and trap soil carried by water.

(iii) Use of porous dams/Gabions;

These are made of small stones held together in galvanized wire cages, they

encourage sedimentation of soil leading to filling up of gullies

(iv) Use of Graded banks;

Here the field is divided into smaller portions by construction of banks. These

reduce the length of the slope, which in turn decreases erosion rush.

Excess water from each inter bank area is safely carried away by a bank channel

(v) Use of diversion Channels;

These channels are put on the upper boundary of the field to catch the running

water and carry it away along the sides of the field.

(vi) Construction of Absorption banks;

Constructed at specific locations in the field to catch and store running water, this

water is later used for irrigation.

(vii) Terracing;

Ridge constructed across the slope of the hill to control/regulate the flow of water

down the slope.

Also terraces provide an outlet that can safely dispose of excess water that can not

be absorbed by the field.

(viii) Use of grassed water ways;

Questions:

(a) State any other 3 methods of erosion control by mechanical means

(b) State the dangers that may be caused by soil erosion/effects of erosion.

PRINCIPLES OF CROP PRODUCTION (S.2 WORK)

LAND RECLAMATION

Is the improvement of formerly unusable land to make it suitable for agriculture production.

Land unsuitable for agriculture production include;

- Forest land
- Badly eroded land
- Hilly land
- Water logged land
- Arid/semi arid land
- land infested by pests and disease
- e.g TseTse flies zones

METHODS OF LAND RECLAMATION

- **Deforestation;**

Land under forest or thick vegetation can be cleared to make land suitable for agriculture

- **Afforestation**

Done in a heavily eroded area to control rate of soil erosion

- **Drainage;**

Removal of excess water from the soil/land done by making ditches/channels to carry away excess water

- **Terracing;**

Construction of banks in hilly areas to create level for cultivation

- **Irrigation;**

Artificial supply of water to crops planted in areas where rainfall is unreliable/not enough. E.g a dam can be constructed across a river so that water from river is diverted to the cultivated land.

DRAINAGE

Is the removal of excess water from the soil. Excess water may be as a result of flooding, excess application of irrigation H_2O or even natural precipitation (rain)

BENEFITS OF DRAINAGE/ THE IMPORTANCE OF DRAINAGE

- It improves soil aeration, i.e. uses amount of air in the soil which facilitates good respiration of plant roots
- It raises soil temperatures
- It improves soil structure which facilitates proper root penetration in the soil
- Drainage facilitates growth of certain crops which can not grow in waterlogged areas.
- Drainage enables movement of machines e.g Tractors and other machines on the farm; if soil dries and hardens

- Drainage reduces losses and wastage of crops due to rotting effect
- It reduces on the leaching of Nutrients
- Drainage helps to control parasites e.g snails, mosquitoes which are vectors to the animals and farmer
- Drainage helps to wash away excess salts that may have accumulated in the soil
- Drainage provides firm foundations for farm buildings and structures
- Drainage increases the area available for cultivation
- Drainage allows conducive/suitable conditions for soil organisms to live.
- Drainage allows conducive/suitable conditions for soil organisms to live.
- Drainage helps to allow timely operations to be done on the farm E.g timely seed bed preparation early planting e.t.c

Types of drainage

They include:

- | | |
|----------------------|--------------------------------|
| (i) surface drainage | (ii) Sub surface drainage |
| (iii) Sub soiling | (iv) Use of deep rooted crops. |

SURFACE DRAINAGE

Here water is led away by channels constructed on the soil surface. The water then flows down the slope due to the pull of gravity.

ADVANTAGES OF SURFACE DRAINAGE

- It is cheap to install
- It is relatively easy to maintain
- It is highly effective because of large surface area that they provide for seepage of water into the ground.

DISADVANTAGES OF SURFACE DRAINAGE

- The ditches occupy space that would be used for growing crops.
- Ditches may lead to excessive depressions of HO₂ table which may lead to complete drying of soil.
- Ditches/channels interferes with agriculture operations, Livestock since animals may drop in the ditches.
- Channels are very prone to soil erosion and may develop into gullys.

SUB SURFACE DRAINAGE

Here drainage channels are constructed below the ground surface. Excess water in the

soil moves under the influence of gravity from the soil and enters the drains.

Forms of subsurface drainage;

(i) **Tile and pipe drainage;** here perforated plastic pipes are used, they are buried

50 – 60cm below the ground.

(ii) **Stone drainage/use of Rubbles**

Here channels are constructed on certain areas in the field; filled with stones, followed

by covering soil. Water slowly drains into these channels and then flows away.

ADVANTAGES OF SUB SURFACE DRAINAGE

- The system does not interfere with farm operations
- There's no wastage of land since the drains are below the ground.
- Once installed, there's no maintenance costs incurred
- There's less risk of gully erosion than in the surface drainage
- It removes only excess H_2O but not the water required by plants.

DISADVANTAGES OF SUB SURFACE DRAINAGE

- It is very expensive to install
- Requires skilled labour
- Once it is damaged, it is difficult to maintain, to locate the blocked part of the pipes.

IRRIGATION

Is the artificial supply of water to crops where rain water is unreliable/inadequate.

BENEFITS OF IRRIGATION/THE IMPORTANCE OF IRRIGATION

- It facilitates crop production throughout the year
- It ensures adequate supply of water to crops
- More land can be put under production
- It makes it possible to grow specific crops
e.g. Cabbage, Spinach, Carrots, Rice
- It improves on the quality of crop produce E.g. fruits, vegetables
- It helps to control pests e.g. Aphids most serious in dry season
- It modifies soil physical conditions by making soil softer hence facilitating more tillage operations.
- Irrigation helps to control weeds especially in Rice and other cereals
- It helps to wash down salts accumulated in the root zones/dilution of salts
- It helps to control the planting and harvesting times, so that the farmer is able to target better market prices
- Fertilizers may be applied together with irrigation water

DISADVANTAGES OF IRRIGATION /PROBLEMS ASSOCIATED WITH IRRIGATION

- Irrigation is expensive
- Excessive irrigation leads to leaching of Nutrients
- It can lead to soil salinization especially when sprinkler irrigation is used

- It is limited to areas with enough water sources
- It requires skilled labour
- It can easily cause soil erosion if it is poorly done
- It can lead to salinity of the soil if the water used is salty.

METHODS OF IRRIGATION

There are 3 major irrigation methods i.e

- (a) Surface Irrigation
- (b) Sprinkler/over head
- (c) Drip irrigation

(a) Surface Irrigation

Is the type of irrigation carried out on the soil surface.

It involves 3 other types namely;

- Flood irrigation
- Furrow irrigation
- Basin irrigation

(i) Flood irrigation

In this method, water is just allowed to flood flat low lying areas of the field. Not net

work of canals is used.

ADVANTAGES OF FLOOD IRRIGATION

- It is cheap since farmer does not need to buy any equipment

- Requires less labour
- Weeds can easily rot hence less need of weeding
-

DISADVANTAGES OF FLOOD IRRIGATION

- Can only be applied where there's a lot of water
- Can only be used on flat/leveled land
- Skill is needed to control the distribution of water

(ii) Furrow Irrigation;

Here water is led to the field using furrows or canals. The furrows are constructed on a contour across the slope so that water flows gently under the influence of gravity to avoid erosion.

ADVANTAGES OF FURROW IRRIGATION

- Land does not require leveling
- This method is easy for a farmer to operate
- It is cheap since it involves making furrows only
- Cultivation and irrigation can be done simultaneously

DISADVANTAGES OF FURROW IRRIGATION

- Can not be easily practiced in sandy soils
- Chances of erosion occurring are high

- The furrows can easily be silted up
- It is not suitable for high land areas

(iii) Basin Irrigation

Involves constructing small basins that can hold water directed into them using

canals/furrows.

The water seeps slowly into the soil around the basin.

Advantages of basin irrigation

- Labour costs are low since it is not done daily
- It uses less amounts of water
- Reduces chances of erosion, besides eroded soil is trapped in the basins.

DISADVANTAGES OF BASIN IRRIGATION

- Can not be used in highland/mountainous areas
- Basins occupy land that would otherwise be covered by plants.

(b) Sprinkler/Over head irrigation

-Here water is pumped from the source (River) under pressure and allowed

out of the pipe through small Nozzles such that it falls back to the ground as rain

water.

- Water is pumped into a main line that branches into laterals that have sprinkler heads that end into Nozzles.
- the water is let out of the Nozzles under very high pressure and nozzles then break the water into small droplets/fine sprays.

ADVANTAGES OF SPRINKLER IRRIGATION

- There's no need of leveling the land
- There's no wastage of water since its usage can be controlled
- Soil erosion is minimized since the amount of H_2O applied can be easily controlled
- No wastage of land as no canals are constructed
- Fertilizers/herbicides can be mixed in water and applied to crops
- Can be used on any type of soil even in sandy soils
-

DISADVANTAGES OF OVER HEAD IRRIGATION

- It is quite expensive to buy and maintain the equipment/sprinklers
- Uniforms distribution of water may not be achieved if the weather is windy
- Nozzles can easily be blocked if the water is not clean
- It requires skilled labour to operate
- A lot of labour is required to keep transferring the pipes and sprinklers from one area to another in the field.

- Water infiltration is shallow hence poor root development

(c) Drip/Trickle irrigation

Here water is delivered to the crops using perforated polythene pipes that are laid

along side the rows of crops.

Water drips or prickles slowly through the nozzles on pipes and wets the soil around
plant roots.

ADVANTAGES OF DRIP IRRIGATION

- Water loss through evaporation is minimized
- Method can work well in both hilly/flat areas
- It uses less amount of water than other types
- Fertilization can easily be done
- It is suitable in areas where there's water shortages e.g in dry areas.

DISADVANTAGES OF DRIP IRRIGATION

- It is expensive to install
- Nozzles can easily be blocked if dirty water is used
- May not be effective in areas with steep slopes as water is pumped under low pressure
-

FACTORS CONSIDERED BEFORE CHOOSING A METHOD OF IRRIGATION TO USE

Amount of labour available

Especially to operate sprinkler requires skilled labour, more labour to more pipes from place to place

Water supply;

Both quantity and quality of water should be adequate for the method chosen as drip and

sprinkler irrigation requires clean H_2O

Type of Soil;

Furrow irrigation method may not be ideal in sandy soils that have very high drainage rate.

Relief/Topography;

Flood irrigation is only suitable where land is leveled/flat

Capital;

Some methods require a lot of capital to install them e.g Drip and sprinkler irrigation

Type of crop:

Some crops require more H_2O than others e.g Paddy rice ie flood irrigation only recommended.

Economic viability of the enterprise

The irrigation method that requires a lot of income should be used only if the enterprise yields more profits e.g at Kakira Sugarcane.

LAND PREPARATION

Exercise

Differentiate between

- (a) A seed bed?
- (b) A nursery bed?

OBJECTIVES OF LAND PREPARATION

- To kill weeds
- To bury crop residues of previous season in order to make planting easy
- To add fertilizer materials to the field
- To improve soil aeration
- To destroy/break lifecycle of pests in an area
- To level the soil

operations made in land preparation

They include the following:

- Clearing the land
- Slashing bushes and shrubs
- Cutting of trees
- Removal of tree stumps and obstacles like stones

Methods used in land clearing

- Slashing

- Controlled burning
- Cutting down trees /deforestation
- Digging out tree stumps
- Digging out Anti hills
- Removal of stones

TILLAGE

Refers to preparation of the soil for planting

Can be of 3 types; i.e

- Primary Tillage
- Secondary Tillage
- Minimum/Zero tillage

(a) Primary tillage/cultivation

This refers to the 1st activities done when opening up a piece of land. E.g slashing,

Burning, ploughing.

Tools used in Primary Tillage include;

- Disc ploughs
- Mould board ploughs
- Sub soilers
- Chisel ploughs
- Ox – mould board ploughs

IMPORTANCE /OBJECTIVES OF PRIMARY TILLAGE

- It helps to improve soil structure so as to facilitate water infiltration
- It improves soil aeration

- It enables removing of crop residues which rot and form organic matter
- It controls weed seeds and plants
- It eases secondary tillage practices to be done

(b) Secondary Tillage (24 weeks) after Primary Tillage

Is the second ploughing after primary tillage. It involves turning and breaking of soil

clods to make/obtain a fine tilth

Tools used in secondary tillage include;

- Disc harrows - Rotary cultivators
- Rotavators - Ridgers -Rollers

IMPORTANCE /OBJECTIVES OF SECONDARY TILLAGE

- It turns this rotten organic matter is brought near the soil surface for plant use
- It makes the soil fine for germination of seeds
- It breaks big soil clods to loosen particles which allows easy root penetration
- It ensures a leveled seed bed
- Some times fertilizers are mixed evenly in the seedbed during secondary tillage.

(c) Zero/Minimum Tillage

Is when a seed bed is prepared with little disturbance to the soil surface.

It is recommended that only there to be planted should be disturbed.

Minimum tillage can be done successfully;

- (a) By using herbicides to kill weeds
- (b) By burning/controlled burning

ADVANTAGES OF MINIMUM TILLAGE

- Burning may kill living organisms
- It may lead to compaction of soil since most area is not disturbed
- A lot of chemicals (herbicides) to may be used which are expensive
- Heavy use of herbicides pollutes the environment

PLANTING/ SOWING (PROPAGATION)

Propagation is the using/multiplication of new crops to meet food requirements as well

as satisfactory planting needs for subsequent seasons.

Crops can be propagated using 2 ways/methods i.e

- By means of seeds/sexual method /reproduction
- By vegetative means/ A sexual propagation/reproduction

SEED PROPAGATION

A seed is a fertilized ovule. It consists of an embryo and stores food materials

Surrounded by a seed coat while cereal crops consist of embryos, endosperms and

pericarp. As legumes have no endosperm.

ADVANTAGES OF USING SEEDS FOR PLANTING

- Seeds are cheaper than vegetative organs
- Seeds are easy to handle and transport
- They can be stored for a long period of time
- Seeds are easy to plant
- The control of pests and diseases before storage is easy with seeds.
- Some plants can not be easily propagated vegetatively.
- It controls spread of plant diseases that would be spread through infected vegetative plant parts.

DISADVANTAGES OF USING SEEDS FOR PLANTING

- Seeds take a long time to establish
- Seeds are sometimes delicate i.e. need a nursery bed in order to grow.
- Seeds require proper land preparation
- Seeds often lead to variation in genetic make up i.e. there is no uniformity among offsprings.
- There is high risk of seedling diseases
- Some seeds have a low viability hence cause wastage of time when planted

SEED SELECTION

Is the choosing of good quality seeds/ sorting out of good quality seed for planting.

characteristics/qualities of a good seed for planting

- They should be uniform in shape, colour and size
- They should be from a variety which is resistant to pests and diseases
- Should be from variety resistant to physical damages
- Should be wholesome ie not broken or not having any physical defect
- Should be from variety which is early maturing
- Should be from variety which is high yielding
- Should be from variety that is used to local environment conditions such as temperature, moisture
- Should have long shelf life i.e. longevity
- Should be viable/high viability i.e. ability of a seed to germinate.
- Should be large in size i.e. this means that it has a large embryo to store a lot of food reserves.
- Should be of desirable genetic make up
- Should be pure and clean i.e. without trash, and foreign materials, and not mixed with other varieties.

seed dressing

Refers to treatment of a seed before storage/before planting.

This is achieved by mixing seeds with chemicals such as Lindane dust, Melathion e.t.c

Advantages of seed dressing

It protects seeds from attack by storage pests or soil bone pests like Bean weevils,

Chaffer grabs, grain moths, flour beetles, e.t.c

SEED VIABILITY / GERMINABILITY

Refers to ability of a seed to germinate. It is calculated as the % ge of seeds that germinate out of a seed.

TESTING SEEDS FOR VIABILITY

There are several ways /methods used to test viability namely;

- Germination test
- Lac on test
- Use of potassium permanganate solution
- Indigo carmine method

(i) The germination test method

- Pick a sample of seeds at random and count them
- Select a suitable germination medium e.g wet cotton wool or wet newspapers
- Place the seeds in the medium and water them.
- Provide all necessary conditions for germination such as light, warmth, water

- Continue watering and monitoring the seeds.
- After 5 – 6 days depending on the species in q tin, count the number of seeds that have germinated as a percentage of the total planted as follows:

$$\text{Viability} = \frac{\text{No. of seeds that have germinated} \times 100\%}{\text{No. of seed planted}}$$

If the viability is above 60% then the seeds are good for planting

Assignment (i)

Question

- Group your selves into 10 students per group
- Go the lab, ask the lab technician fot the materials;
e.g - petridish
 - cotton wool
 - Bean seeds 20(picked at random)
 - water
 - Bring the experiment in class
 - keep watering for 6 days

Calculate the %ge viability.

Hand in your books for marking next week

(ii) Lac on technique / test

In this method, the seeds to be tested are soaked into 0.1m tetrazolium salt.
when

viable seeds respire, a colourless tetrazolium salt solution is converted into
a reddish

pinkish dye. All seeds with pinkish dye are considered viable.

Assignment (II)

No. of seeds with Pinck embryos X 100%

No. of seeds soaked

(iii) Use of Potassium Permanganate solution (KMnO₄)

If the viable seeds are heated in potassium permanganate solution, which
is purple in

colour, it turns discoloured.

SEED DORMANCY

Is a condition in which a seed that is capable of germinating fails to
germinate

CAUSES OF SEED DORMANCY

- Hard seed coat

This prevents entry of water into the seed which makes emergency of the
radical difficult

- Presence of incubator substances that prevent germination e.g Absciscic Acid (ABA)
- Immaturity of the embryo e.g seeds undergo further development within themselves before they can germinate.
- High temperature during seed storage of
- Seed coat hairs which interfere with oxygen absorption e.g Oats, Barley seeds.

METHODS OF BREAKING SEED DORMANCY

(i) Using suitable reagents; such as concentrated Sulphuric Acid and Potassium

Nitrates to soften the seed coat.

Seeds are packed into resistant porous bags and soaked into the acid for a few

seconds and then in water quickly and plant them.

(ii) Soaking the seeds in cold water; Over night for one or two days

(iii) Pre-chilling: where seeds are exposed to very low temperature for a short period of

time before planting them in normal conditions.

(iv) Heat treatment

Seeds are soaked in hot water at about 80° sealed for about 40 seconds and or even an hour

(v) **Soaking seeds** in growth stimulating hormones

e.g IAA (Indole Acetic Acid)

NAA (Naphthalene acetic Acid)

(vi) **By Mechanical Scarification**

Here seeds are rubbed with sand paper so as to reduce thickness of the seed coat.

Seed scarifying machines are also used in developed countries.

ADVANTAGES OF SEED DORMANCY

- It enables seeds to wait for favourable conditions before germination
- It prevents death of the entire population in bad times since some seeds will not have germinated yet
- It allows enough time for dispersal of seeds
- It enables colonization of new areas

VEGETATIVE PROPAGATION

Is where new plants are produced with out the use of seeds. Vegetative parts that

contain or that can develop buds are used to give rise to new individuals.

Plants arising from the parents through vegetative propagation are called **clones**

METHODS OF VEGETATIVE PROPAGATION

(a) Use of storage organs such as;

(i) Use of Rhizomes;

These are underground stem that are horizontally in the underground e.g
spear grass,

ginger, couch grass

(ii) Use of runners;

These are stems growing horizontally under ground.

(iii) Use of corms; These are underground stems e.g Coco yams

(iv) Use of stem tubers;

These are swollen underground stems that have buds which develop into
new

Plants e.g sweet potatoes

(v) Use of Bulbs; a plant which stores its food in the leaves e.g Onions

(vi) Use of Bulbils;

These are plants produced from the inflorescences e.g Oxalis

(vii) Use of sucker's e.g. Bananas

(viii) Use of splits e.g. Pyrethrum

(ix) Use of slips e.g that grow from the stem of an old plant

(x) Use of crowns; e.g Pineapples are – vegetative structure found on top
of pineapple

Plants

(b) Use of cuttings;

These are portions of plants that may be cut and used for multiplying other plants.

Cuttings should be taken at the beginning of rains when there is adequate moisture in

the soil and when the plant calls are turgid.

FACTORS THAT AFFECT ROOTING OF CUTTINGS

(i) Temperature;

Cool aerial temperature and warm temperature around the roots promote rooting by

preventing excess transpiration.

(ii) Light intensity;

Lack of light encourages rooting except in herbaceous plant cutting.

(iii) Humidity;

High humidity prevents desiccation by lowering the transpiration rate which

promotes rooting of cutting.

(iv) Leaf area;

Some cuttings require leaves in order to develop roots while others do not

(v) Chemical Treatment;

Rooting hormones can be applied to the basal end of the cutting to quicken the

rooting process e.g **IAA** and **NAA**

(c) Layering;

Involves inducing parts of a stem to produce roots before these stems are cut off, the

parent plant to be planted elsewhere.

The part of the stem is wounded to expose the stem cambium which when buried in a

medium which is favourable for rooting gives rise to roots.

Diagram here.....

N.B: Layering is commonly used when cuttings do not root easily or when large

propagates or planting parts are required.

(d) Grafting

This is the Union between 2 different stems which are compatible. It involves the

joining of a portion taken from one plant on to another plant and allowing them to

grow as one plant.

The upper part of the grafted plant is called Scion while the lower part of the grafted

plant is known as Root stock

In order to ensure the success of grafting the cambium of the scion must be in

contact with the stock cambium.

FACTORS AFFECTING THE SUCCESS OF GRAFTING

(i) Compatibility;

Is the ability of the scion and the stock to form a Union and it only occurs when scion

and stock are from botanically related plants.

(ii) Type of plant;

Some plants are easier to graft than others

(iii) Technique used ie

Quality of cuts, the way the joints are made determines the success of grafting.

(iv) Temperatures and moisture, warm temperature 18 – 27°C favours grafting

(v) Incidences of pests and diseases; after grafting the newly grafted plant is a bit

susceptible and may easily be affected by pests and diseases.

METHODS OF GRAFTING

(i) Notch grafting

Here a slanting cut is made with a sharp knife at the base of the scion and the top of

the stock. The 2 pieces are then fitted and wrapped with grafting tape.

Diagram here.....

(ii) Whip grafting/ Tongue grafting

Here straight slanting cuts are made on both the scion and stock.

Diagram here.....

(iii) Wedge/deft grafting

It is used when the scion is of a smaller diameter than that the root stock.

It is some

times used to graft a new variety into an already established tree.

Diagram here.....

iv) Side grafting

is where the stock has a larger diameter than the scion. The scion is inserted into side of

the stock. A hole which is about 2 ½ cm deep is created at the side of stock.

A scion is inserted into the hole to fit and ensure maximum contact with the cambium.

Diagram here....

(v) Approach grafting

Here two branches from different trees are put together and grafted. They unite and

come together as one tree.

A small wound is made on both branches where they are to be grafted as shown below:

Diagram here.....

(vi) Bud grafting

Here a scion is united with a seed hug tree or mature tree. The scion has only one

Bud and some bark with/without wood. The bud is inserted in a slit made on the

bark of the stock. It is held tightly on the stock by tying with budding tape until it

produces a shoot.

Diagram here.....

ADVANTAGES OF GRAFTING

- Grafting helps in propagating cloves which can not be propagated by other means
- To take advantages of aged root stock i.e. stocks with desirable root characteristics are utilized
- It makes the growing of more than one type of flower/fruit on one tree possible.
- It helps to improve on the variety of plants
- It may be used to repair the damaged trees

- It reduces maturity period of crops
- Grafting allows one to obtain special plant forms e.g Tree Roses.

GENERAL BENEFITS/ADVANTAGES OF VEGETATIVE

PROPAGATION

- The offspring is similar to the parent in all ways
- The offspring grows fast and matures early than seeds
- The offspring is stronger and more hardened than seedling and so can withstand harsh weather conditions
- In some places, it is the only possible way of propagating certain crops.
- It eliminates seed borne diseases than those in seed propagation
- It allows multiplication of plant population very fast
- Land requires little preparation not like in seed preparation

DISADVANTAGES OF VEGETATIVE PROPAGATION

- Vegetative materials are bulky and difficult to transport and store
- Most vegetative parts are perishable can not be stored for so long than seeds
- It requires a lot of skilled labour e.g grafting layering, Budding
- It is generally more expensive than seeds
- Parents can easily spread diseases to offsprings

PLANTING/SOWING

Is the placing of plant materials in the soil for growth.

There are 3 types of planting namely;

- Broad casting method
- Row planting method
- Dibbling method

(a) Broad casting

Is where seeds are scattered all over the seed bed with out any order.

After broadcasting, the soil is stirred so as to mix or cover the seeds with a thin layer of soil.

ADVANTAGES OF BROAD CASTING

- It is faster and quicker than row planting
- It is easy and cheap to carry out by a farmer
- It is most ideal for small cereal crops like wheat, millet, sorghum, e.t.c
- It gives a good plant cover very fast so as to protect the land from erosion
- It gives a higher plant population needed in pastures than row planting
- It does not require any special skill

DISADVANTAGES OF BROAD CASTING

- It wastes seeds
- There is lack of uniformity in depth of planting and germination
- Many seeds may be lost to birds and surface runoff
- It is hard to establish the optimum plant population

- Mechanical operations are not possible since rows have not been established
- There is easy spread of pests and diseases among crops

(b) DIBBLING

Here seeds are planted with a panga or dibbling stick, randomly all over the field.

It is not common in commercial farming due to low production, but is practiced by

small scale farmers especially in the planting of legumes like beans, pigeon peas, and cow peas.

(c) ROW PLANTING

Here the planting materials are planted in rows or lines in the field.

ADVANTAGES OF ROW PLANTING

- Uniform spacing is achieved
- It gives optimum plant population
- There is uniform depth of seed placement and hence good germination
- It enables use of machinery even after planting
- It saves seeds not like Broadcasting
- It controls soil erosion if the seeds are planted on contours or ridges
- It is easy to do some farm activities such as weeding, spraying, e.t.c.

DISADVANTAGES OF ROW PLANTING

- Requires a lot of labour
- It takes a lot of time
- It is not feasible for small seeds
- It can lead to soil erosion due to poor plant cover

AGRONOMIC PRACTICES OF GROWING CROPS

(1) Early Planting/Timely Planting

This is the growing of crops at the beginning of the rainy season.

benefits/advantages of early planting to farmers

- Crops utilize all the seasons rainfall and Nutrients hence high yields obtained
- Crops escape harsh climatic conditions
- Crops grow faster than weeds and therefore escape weed infestation
- It enables plants to benefit from Nitrogen flash. This enables plants to make use of Nitrogen released in the soil in dry seasons before it is leached
- It enables plants to escape fungal diseases that are mostly soil born
- It makes it easy to do other farm operations without congestion
- It is possible to secure higher prices from crops produced when planted early

- It enables a farmer to harvest early, which allows for enough time to prepare for the next planting.

(2) Recommended Spacing

This refers to the distance between plants within and between rows

advantages of planting at a recommended spacing

- Weeds are smothered ie not allowed to grow large enough to cause damage
- Provides optimum plant population per unit area
- Each crop gets adequate nutrients, moisture, e.t.c
- It reduces competition among plants for Nutrients
- Farm operations are made easy e.g weeding, spraying can easily be carried out.
- It reduces incidences of disease attack e.g in ground nuts, close spacing reduces Rosette diseases

FACTORS TO CONSIDER WHEN DETERMINING THE SPACING OF A CROP

- Moisture Availability in the soil

Close spacing is possible in areas with high moisture content and vice versa

- Soil fertility;

Close spacing is possible in more fertile soils and vice versa

- Use of Machinery for Planting;

As Machines require wider spacing to be used in to allow space for weeding, spraying

- Purpose of crop planted;

Crops grown for food production e.g –Maize, Beans are widely spaced than those

intended for green manure, fodder production which are closely spaced

- Growth Pattern/Morphology of a crop;

Crops whose structure is widely spread should be spaced widely than those whose

structure is narrow and upright should be closed spaced

- Method of planting;

As Broadcasted crops are closely spaced than those grown by row planting which are widely spaced.

- Size of the seeds/Planting materials

Small seeded crops require close spacing than those with bigger seeds which require wide spacing

(3) Crop rotation

Is the growing of different crops on the same piece of land season after season.

PRINCIPLES THAT GUIDE CROPROTATION

- (i) Crops with high Nutrients requirement (heavy feeders) should be planted 1st in a newly cultivated land so that they utilize the nutrients before they are lost.
- (ii) Deep rooted crops should be alternated with shallow rooted ones
- (iii) Crops with similar pests and disease should not follow one another
- (iv) Leguminous crops should be included in the rotation so as to improve soil fertility
- (v) A fallow period should be included in the rotation as this destroys disease and pest cycles and also allows soil to recover the nutrients removed by the crops.

benefits/advantages of crop rotation

- Crops utilize optimally the nutrients and moisture since crops grown have different rooting system.
- It breaks the life cycle of pests and diseases since the pathogens are starved when crops that they depend on are not grown that season.
- Soil fertility is improved especially e.g legumes are included in the rotation.
- Protects soil from erosion since land is even covered not bare especially during fallow period.
- It facilitates Nutrient recycling especially when shallow and deep rooted crops are alternated in the rotation

- Farmer spends less on fertilizers since soil is improved by N from legumes.

(4) Depth of planting;

This depends on the following factors;

- **Size of seeds;** As small seeds are planted shallower/shallow depth while Big seeds planted deeper
- **Moisture in the soil:** low moist areas seeds should be planted deeper than areas with high moisture. However, proper depth of planting ensures uniform germination and uniform planting

(5) Weeding

This is removal of un wanted plants in the garden.

This prevents competition for Nutrients, space light and diseases to be spread.

(6) Fertilizers Application/Manuring

Done to improve soil fertility for better crop growth and development

(7) Thinning

Is the removal of weak, excess and damaged plants from the field/Nursery bed and throwing them away.

reasons for thinning

- To prevent spread of diseases from plant to plant
- To avoid competition with plants for Nutrients, light
- Reduce wastage of growth factors

(8) Rogueing

This is the removal of diseased plant parts from a growing plant.

(9) Gapping

This refers to filling of empty spaces/gaps especially where the seedlings did not

Germinate

Reasons for gapping

- It reduces spaces available for weeds
- To ensure optimum plant population
- To reduce chances of soil erosion taking place

(10) Irrigation/Watering:

Is done during dry seasons to supply water to crops for better yields.

(11) Mulching:

Is done during to conserve soil moisture and control wee hence reduce erosion.

(12) Spraying:

Is done to reduce crop losses due to pests and diseases

(13) Earthing up

Is the covering of exposed plants with soil due to the effect of erosion
e.g. Root crops

such as cassava, Irish potatoes

Reasons for earthing up

- Reduce crop damage and pest attack such as squirrels
- To improve on crop yield

(14) **De- Suckering**

Is the removal of excess suckers from the parent plant

Reasons for desuckering

- To reduce competition of nutrients, space, water
- To reduce our crowding
- To increase yields

(15) **Staking**

Is the provision of extra support to plants with weak stems e.g. tomatoes

Methods of staking

(i) **Propping;** this is the provision of extra support to heavy fruiting crops using “Y”

shaped poles e.g Bananas

(ii) **Treilishing;**

Is the support given to plants with tender weak stems e.g Passion fruits

(iii) **Training;**

This is the bending of tender/upper and softer parts of the plant with a tendril

towards a given direction for support e.g beans

Reasons for staking

- To improve on the quality of fruits by reducing rotting
- It makes harvesting and weeding easy because the fruits are exposed
- It reduces damages of crops by strong winds e.g in Bananas
- It helps to improve crop yields
- It prevents attack of soil bone pests on the ground e.g in Tomatoes

(16) Pruning

Is the removal of excess branches, leaves from a plant. This can be done using a pruning knife or pruning saw.

METHODS OF PRUNING CROPS

(i) Formative Pruning:

This is done by cutting off terminal buds of a crop in order to encourage lateral or

horizontal growth so as to achieve normal height of the crop.

(ii) Single stem Pruning:

Is done to the plant in order to achieve only one stem

(iii) Multiple stem Pruning:

Is done on coffee so as to encourage development of many branches and stems

(iv) Agobiada Pruning:

This involves bending of the stem of a plant

REASONS FOR PRUNING CROPS

- It increases crop yields
- It allows air circulation among crops by reducing micro climate for pests and diseases.
- It helps to give a plant a desirable shape to allow weeding, harvesting e.t.c

- It prevents over bearing of fruits and die back in coffee
- It economizes the chemicals used when spraying
- It encourages proper utilization of nutrients within plant when unwanted branches are removed
- It allows light penetration to lower leaves of the crop.
- It encourages uniform production of fruits

(17) Harvesting

This is the removal of mature crop produce from the field.

It should be done at the right time to reduce loss of yields, pest and diseases during

storage and prevent development of volunteer crops.

(18) Drying crop produce

Crop products should be thoroughly dried in order to reduce attack by storage fungi

and insects. T

Therefore grain should be dried to a moisture content of less than 12%

reasons for drying crop produce before storage

- To lower the moisture content of seeds to a level that will enable them to remain viable.
- To reduce incidences of pest and disease damage
- To prevent seeds from rotting when in store
- To reduce chances of seeds germinating while still in store
- To prevent wet heating which can lead to fire outbreaks in the store

Crop storage

To ensure safe crop storage, stores should be leak proof, well ventilated and vamine
Proof.

CROP PROTECTION

This aims at protecting crops from weeds pests and diseases

WEEDS AND THEIR CONTROL

Definition:

A weed is a plant which grow in a place where it is not wanted

It is also unwanted plant in the garden or

It is a plant whose usefulness has not been discovered

Advantages of weeds

- Some weeds are used as vegetables for food in different areas e.g Black night shade, spider weed, Pig weed
- Some weeds are used as medicine e.g Black jack used for dressing fresh wounds
- Weeds are used as feeds for livestock e.g Elephant grass
- Some help in controlling soil erosion by covering the soil surface e.g Couch grass
- Some are used as building materials e.g Thatch grass, spear grass
- Some weeds are leguminous hence fix Nitrogen to the soil e.g silver leaf, desmodium, glycine e.t.c
- They provide local materials for Art and craft industry

- They die and rot to form organic matter which improves soil fertility
- Some act as mulching materials in the garden

Disadvantages of weeds

- They are poisonous to animals and man e.g Sodom apple, tick berry
- They lower the quality of farm produce e.g Black Jack seeds contaminate cotton Lint, Wild onions contaminate milk.
- All terrestrial weeds compete with crops for Nutrients, water, light and space.
- They grow among pastures hence reducing their palatability
- Aquatic weeds block water ways and irrigation channels making irrigation difficult e.g – water hyacinth
- The control of weeds through spraying using herbicides increases the costs of production
- Weeds harbor pests and diseases of crops during the season
- Weeds reduce the value of land e.g – Lantana
- They are parasites to crops e.g – Striga hermontheca SPP in cotton
- Under heavy infestation of crops by weeds, crops have a poor distribution and formation of roots.
- Aquatic weeds reduce the amount of oxygen available for respiration of animals e.g fish, and other aquatic organism.

Reasons why weeds are more successful than field crops

- (i) They produce very many viable seeds that can germinate even when they are immature e.g Black jack, devil's hose whip, Lantana

- (ii) They have a faster growth rate which makes them outgrow crops e.g star grass
- (iii) They are highly resistant to pests and diseases that attack crops e.g most weeds are less palatable to pests
- (iv) They grow in all types of soils and can easily survive on few Nutrients e.g spear grass, Oxalis, Nut grass
- (v) Some weeds are Allelopathic ie they produce substances that make plants difficult to grow around them, a condition called Allelopathy
- (vi) Most weeds have perennating organs which are used to produce new plants e.g Rhizomes for Rhizomes for spear grass, Bulbils for Oxalis
- (vii) They have different dispersal mechanisms which are effective e.g – self explosive mechanisms, hard seed coats, presence of hooks on their seeds.
- (viii) They are resistant to harsh conditions ie Ability to remain dormant in the dry season and sprout out as soon as rain season starts e.g Coach grass and spear grass.

Classification of weeds

Weeds can be classified according to:

(a) Life span

This includes the following groups

(i) Annual weeds;

These take only one season to complete their life cycle e.g Black-jack, Macdonalds weed,

(ii) Biennial weeds;

These take only 2 seasons to complete their life cycle e.g – Double thorn

(iii) Perennial weeds;

These complete their lifecycle in more than 2 seasons or years to reproduce themselves and grow continuously e.g – Couch grass, Lantana

(b) Habitat

This is based on the place where the weeds are found growing ie.

(i) Aquatic weeds;

These weeds grow in water e.g Nile Cabbage, water hyacinth.

(ii) Terrestrial weeds;

These grow on land e.g Couch grass, elephant grass and most weeds fall in this category.

(c) Morphology/Structural appearance

Is done basing on the physical structural appearance of the plant e.g ie

(i) Dicotyledonous weeds

These have seeds with 2 cotyledons e.g legume weeds like centro, Desmodium,

(ii) Monocotyledonous weeds

These have one cotyledon in their seeds e.g grasses of guinea grass.

(d) Botanical classification/ Biological

This is done based on;

(i) Flowering weed plants;

These weeds produce flowers e.g Macdonads

(ii) Non flowering weed plants;

These weeds do not produce flowers and seeds but have vegetative parts e.g wondering Jew

(e) Toxic nature

These include

(i) Poisonous weds;

These include all poisonous weed plants e.g Sodom apple, Thorn apple, Lantana

(ii) Non poisonous weeds;

These include the rest of the weeds that are not poisonous and useful in nature.

TABLE SHOWING COMMON WEEDS OF EAST AFRICA

No.	COMMON ANME	BOTANICAL NAME	LIFE SPAN/LIFE CYCLE	PROPAGATION
1.	Black Jack	Bidens pilosa	Annual	Seeds
2.	Sodom apple	Solanum Incanum	Perennial	Seeds
3.	Couch grass	Digitaria Scalarum	Perennial	Seeds
4.	Guinea grass	Pannicum Maximum	Perennial	Seeds
5.	Pig weed	Amaranthus Spp	Annual	Seeds
6.	Love weed/Bristly Foxtail grass	Setaria verticillata	Annual	Seeds
7.	Goat weed	Agerantum Conyzoides	Annual	Seeds
8.	Spear grass	Imperatta Cylindrica	Perennial	Rhizomes
9.	Lemon grass	Cymbopogon afronardus	Perennial	Splits
10.	Oxalis species	Oxalis Coniculatta	Perennial	Seeds
11.	Thorn apple	Datura Stramonium	Perennial	Seeds
12.	Double Thorn	Oxygonium urinatum	Biannual	Seeds

13.	Wild Finger Millet	Eleusine Indica	Annual	Seeds
14.	Nu grass	Cyperus rotundus	Perennial	Bulbils
15.	Star grass	Cynodon dactylon	Perennial	Seeds / runners
16.	Milk weed	Euphorbia heterophylla	Annual	Seeds
17.	Phytolacca Spp	Phytolacca dodecandra	Perennial	Seeds
18.	Tridax Spp	Tridax Procumbens	Annual	Seeds
19.	Mexican Marigold	Tagetes Minuta	Annual	Seeds
20.	Macdonalds weed	Galinsoga Parviflora	Annual	Seeds
21.	Devil's horse whip	Acheranthus aspera	Annual	Seeds
22.	Wandering Jew	Commelina banghlensis	Perennial	Seeds/Splits/Slips
23.	Nile Cabbage	Pistia stratiotes	Perennial	Runners
24.	Witch Weed/Striga Spp	Striga hermontheca	Perennial	Seeds
25.	Creeping sedges	Kyllinga erecta	Perennial	Seeds/Splits
26.	Thick berry	Lantana Camara	Perennial	Seeds
27.	Water hyacinth	Eichhornia Crassipes	Perennial	Splits/splits
28.	Spider weed	Gynandropsis gynandropsis	Biannual	Seeds
29.	Lions ear	Leolinetus repetifolia	Annual	Seeds
30.	Black night shade	Solanum nigrum	Annual	Seeds
31.	Cats tail grass	Sporobolus Pyramidalis	Perennial	Splits / Seeds

32.	Elephant grass	Pennisetum purpureum	Perennial	Cuttings / Splits
33.	Green leaf desmodium	Desmodium intortum	Annual	Seeds
34.	Silver leaf desmodium	Desmodium uniculatum	Annual	Seeds

WEED CONTROL METHODS

Weed control methods include;

- Cultural control methods
- Mechanical control methods
- Biological control methods
- Chemical control methods
- Legislative/Quarantine
- Integrated weed management

CULTURAL WEED CONTROL METHODS

These aim at giving the crop the best conditions which will favour its growth so that it can out compete weeds. They include;

- i) Early planting;

This enables plants to grow vigorously and establish themselves early enough before weeds become competitive.

- ii) Proper spacing;

Well spaced crops quickly cover up the ground with their leaves and smother weeds then weeds that manage to grow remain visible with yellow leaves.

iii) Crop rotation

This controls parasitic weeds by denying them nutrients and breaking their life cycle

iv) Use of clean planting materials

This prevents introduction of weed seeds into the field

v) Controlled burning

This will kill both weeds and their seeds if the fire is hot enough

vi) Flooding

Weeds are completely submerged and killed by suffocation e.g. weeds in paddy rice

vii) Mulching; Mulches cover the weeds and seeds making them unable to germinate due to lack of light i.e. smother

viii) Use of trap crops

These attract numerous weed plants and then are destroyed with weeds.

ix) Controlled grazing;

If the number of animals grazing on a piece of land is greater than that it can support, the animals graze on species to outcompete the palatable ones

x) Use of Intercropping

This reduces space and light available for the weeds to grow.

MECHANICAL WEED CONTROL METHODS

This involves use of farm tools and implements to control weeds e.g

- Hand hoeing
- Slashing
- Harrowing
- Deep cultivation

Advantages of mechanical weed control

- It does not pollute the environment
- It is toxic to crops like chemicals
- It requires no special skills

Disadvantages of mechanical weed control

- It may destroy soil structure
- It's not easily done to plants with thorns e.g. pineapples, Sisal, e.t.c
- It may cause soil erosion
- It may be laborious

BIOLOGICAL WEED CONTROL

- This involves use of living organisms to control weeds.

Examples of Biological weed control agents

- i) Use of goats to feed on leaves and flowers of weed pastures e.g. Couch grass, star grass, elephant grasses
- ii) Use of weevils e.g. – *Neochetina eichhornae* controls water hyacinths.

NB: The enemy of a weed either kills the weed or suppresses its growth

Advantages of biological weed control

- Method is easy to carry out
- Method is cheap as far as the farmers situation is concerned.
- Method does not pollute the environment.

Disadvantages of Biological weed control

- To find the best /right biological weed control agent, is a long and slow process which ends up being an expensive venture.
- Biological weed control agents may attack crops after eradicating weeds
- The agent may not be in large Number to control weeds effectively or it might take long to bring weeds under control.
- The Biological agents did do not effectively eradicate weeds but maintain a certain population of weeds on which they can survive.
- Once the agent has been released to the garden it might be very difficult to tell whether the agent is working or Not
- It requires a lot of research to come up with suitable biological weed control agent.

CHEMICAL WEED CONTROL

This is the use of chemicals to kill weeds. The chemicals used to kill weeds are called Herbicides. These chemicals may scotch weeds or might interfere with their physiological processes like photosynthesis.

Categories of herbicides

They include;

(a) Contact herbicides/contact non selective herbicides

They are herbicides which kill any plant they come in contact with. They are usually applied on leaves. They kill any plant they come in contact

Examples include;

- Glyphosate (Round up)
- Gramaxone (Paraquat)
- Reglone (Diquat)
- Propanil

(b) Systemic/translocated herbicides

These are herbicides which kill the whole plant even if they got in contact with only the leaves. They are absorbed through the leaves stems, roots and translocated through out the whole plant killing it slowly

Examples include;

- Dalapon
- 2,4 – D
- MCPA
- Dicamba
- Atrazine
- Picloran
- glyphosirate
- Amitrole

(c) Selective herbicide

These are herbicides that kill particular kind of weeds e.g they are meant to kill broad leaved weeds and do not affect those with narrow /small leaves.

Examples of selective herbicides

- Simazine
- MCPA
- Linuron

- MCPP

N.B:

It is possible for herbicides to be both selective and systemic at the same time

Examples

- 2,4 – D
- 2,4,5 – T
- MCPA
- MCPP

Advantages of Chemical weed control

- It is very effective and quick at killing weeds
- It saves time as a large area of land can be effectively covered in a short period of time
- Roots of crops can not be damaged unlike in mechanical method
- Herbicides eliminate drudgery of labour as in hand weeding
- Soil structure is not destroyed when using chemicals as a case in mechanical weed control
- Where relief limits mechanical control, chemical weed control is the best
- It makes harvesting more easier as there's no interference with the weeds
- Where the morphology of a crop limits hand weeding e.g weeding sugarcane, sisal, chemicals can be effectively used
- It is cheaper on a large scale lowering costs of production

Disadvantages of chemical weed control

- It requires skilled labour especially in determining the concentration and mixing ratios
- Chemicals pollute air and water at the farm
- Non selective chemicals may damage crops if used wrongly
- Chemicals are poisonous to both man and live stock
- Chemicals are expensive in terms of costs
- Chemicals can kill useful organisms e.g the pollinators and predators e.t.c

HERBICIDE SELECTIVITY

This is the ability of herbicide to kill certain plants and leave others unaffected
selectivity of herbicides depends on the following factors.

- i) Size of leaves;
The larger the leaf, the more the herbicide will affect the leaf
- ii) Degree of wetting on the leaf;
During spraying, the more the wetting, the more the effect of herbicide
- iii) Resistance to herbicides;
Some weeds have in built physiological resistance and can detoxify the herbicides making them harmless.
- iv) Timing of application
Old weeds are less affected by herbicides than young weeds
Stage of application i.e. Pre emergent, post emergent
- v) Structure of the plant

Some plants have hairy leaves, others produce wax, and all these hinder herbicides from penetrating weeds.

Conditions for maximum effectiveness of herbicides

- Herbicides should be mixed in proper concentration
- Correct herbicide should be used for the intended weed.
- Do not spray when its going to rain
- Do not spray in a windy weather because chemicals will drift from the target weed to other plants
- Ensure that you do not use or spray expired herbicides
- Apply the herbicides at the correct stage of crop growth
- Apply the herbicide at the correct stage of weed growth

SAFETY MEASURES IN THE USE OF CHEMICAL FOR WEED

CONTROL

Safety precautions should be taken when handling herbicides. This is because they are poisonous to both livestock and the farmer. They include;

- The operator should wear protective clothing like gloves, gum boots, eye shields, overalls, Eye goggles, e.t.c before spraying
- When spraying, the operator should not eat, smoke or drink anything.
- When the nozzle of sprayer gets blocked, one should not unlock it by sucking or blowing with the mouth.
- When spraying the operator should face the direction that wind is blowing to but not against wind.

- Empty containers should be buried in a deep pit
- After spraying, the sprayer should be washed thoroughly with Soap and water, rinsed and dried facing upside down.
- After spraying, protective clothing should be carefully removed and washed with soap and water
- In case of accidental contact with the herbicide, the affected area should be washed with a lot of water, and victim should be rushed to medical personnel
- Unused chemicals must be kept in cool, dry place and out of reach of children.

Assignment -field assignment

- Identify an area with weeds
- Obtain a sprayer and the herbicide any category
- Follow precautions given, prepare and mix the herbicide
- Properly apply the herbicide on to the weeds
- Clean the equipment properly after spraying
- Wash /Rinse your hands
- Visit the site sprayed after 5 days
- Make notes /records in your books

CROP PESTS AND CONTROL

Definition

A pest is an organism which destroys crops and competes with man for food and fibre.

ECONOMIC IMPORTANCE OF PESTS

- When pests attack crops directly, they reduce both quality and quantity of farm produce.
- Some pests introduce disease causing organisms that reduce on crop yields.
- Expenditure of the farmer rises as pests are being controlled through purchase of chemicals
- Food shortage for both man and livestock
- They damage leaves and reduce photosynthetic rate

Assignment

- Suggest other 5 economic importances of pests to the farmer.

Categories of Pests

The most important crop pests include;

- Insects
- Mites
- Rodents
- Nematodes
- Birds
- Fungi, Bacteria and Viruses

(i) INSECT PESTS

- They are the largest group of animals and most serious category of pests.
- Some insects are beneficial to the farmer e.g. Bees help in pollination of flowers
- Termites help in soil formation while some of the predatory insects help in controlling destructive insects.

- The type of damage caused by insect pests depends on the type of mouthparts of insects.

There are 2 basic types of mouthparts of insects ie.

- a) Insects with biting a chewing mouth parts
- b) Insects with piercing and sucking mouthparts

Insects with chewing mouthparts include;

- Locusts
- Grass hoppers
- Crickets
- Arm worms
- Termites
- Larvae and Adults of beetles
- Cut worms

Insects with piercing and sucking mouthparts include;

- Aphids
- Scales
- Thrips
- Flies
- Butterflies
- Antesia bugs
- Moths
- Mealy bugs
- Cotton stainers

These pierce plant tissues and suck sap and introduce toxins/disease causing organisms.

REASONS WHY INSECT PESTS ARE SUCCESSFUL THAN OTHER PESTS

- They have a high reproductive rate ie. They lay many eggs
- Insects are resistant to some chemical and other pest control measures

- They have organs which did their rapid movement and escape easily from enemies and predators.
- Some insects have dull colours and others resemble the environment which they live which gives them camouflage (Mimicry) e.g. grass hoppers.
- They produce exo skeleton which makes them survive harsh environment condition.
- Their mouthparts are adopted / modified for attacking specific plants
- They have a variety of crops on which to feed ie they feed on a wide variety of crops.
- They are small in size and therefore cannot be seen from a distance

(ii) **RODENTS**

They include; - Moles, Rats, squirrels

These uproot young germinated cereal seedlings while others eat fruits. They are also storage pests.

CONTROL

By trapping them, poisoning them, use of stores with Rat guards/deflectors.

(iii) **BIRDS**

These are serious pests of grain crops e.g Maize, Sorghum, Millet, as well sun flower.

E.g sudan dioch, weaver birds

Control

Timely harvesting ,use of scaring devices to scare away the birds like scare crows ,and by destroying their breeding grounds

PRINCIPLES AND PRACTICES OF AGRICULTURE

CROP PRODUCTION

REVISED NOTES

FOR

O'LEVEL STUDENTS

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	DESCRIPTION (PARTICULAR)	QUANTITY/UNIT	UNIT COST	AMOUNT
1.	Ammeters (0 – 1.0 A)	20	19,000/=	380,000/=
2.	Ammeters (0 – 5.0 A)	20	19,000/=	380,000/=
3.	Ammeters (0 -1.0A AND 0-5.0A) DUAL	20	19,000/=	380,000/=
4.	Voltmeters (0 -5.0 V)	25	17,000/=	425,000/=
5.	Voltmeters (0 – 3.0V)	25	17,000/=	425,000/=
6.	Voltmeters (0 – 3.0V) and 0 -5.0V DUAL	20	17,000/=	340,000/=
7.	Potentiometers (1 meter long one wire)	10	45,000/=	450,000/=
8.	Metre bridges	10	50,000/=	500,000/=
9.	Galvonometers centre zero 30 - 0 -30	10	19,000/=	190,000/=
10.	Standard resistors (1 Ω)	40	3,500/=	140,000/=
11.	Standard resistors (2 Ω)	40	3,500/=	140,000/=
12.	Standard resistors (3 Ω)	30	3,500/=	105,000/=
13.	Standard resistors (5 Ω)	30	35,00/=	105,000/=

14.	Standard resistors (10 Ω)	30	35,00/=	105,000/=
15.	Bulb holder (single MES)	40	1,000/=	40,000/=
16.	Cell holders (Double)	40	4,000/=	160,000/=
17.	Cell holders (Single)	40	3,500/=	140,000/=
18.	Set of masses (Iron) 100g 4 +1	10	25,000/=	250,000/=
19.	Set of masses (Iron) 50g 4+ 1	10	25,000/=	250,000/=
20.	Set of masses (Iron) 9 + 1 10 GM	10	20,000/=	200,000/=
21.	Pendulum bobs (Iron) 3/4"	40	4,000/=	160,000/=
22.	Stop Clocks	20	30,000/=	600,000/=
23.	Diverging/ Concave lens (focal length 10 cm)	30	3,000/=	90,000/=
24.	Diverging/ Concave lens (focal length 15 cm)	30	3,000/=	90,000/=
25.	Converging/Concave mirrors(focal length 10cm)	30	3,000/=	90,000/=

(C) AGRICULTURE EQUIPMENTS / IMPLEMENTS

No.	DESCRIPTION (PARTICULAR)	QUANTITY/UNIT	UNIT COST	AMOUNT
1.	Shears	2	25,000/=	50,000/=
2.	Sickles	2	8,000/=	12,000/=
3.	Wheel barrow	1	70,000/=	70,000/=
4.	Plane	1	90,000/=	90,000/=
5.	Saw	1	60,000/=	60,000/=
6.	Harmer	1	7,500/=	75,000/=
7.	Mallet	1	50,000/=	50,000/=
8.	Pincher	1	6,000/=	6,000/=
9.	Sprayer	1	55,000/=	55,000/=
10.	Pumps	1	110,000/=	110,000/
11.	Drenching gum	1	65,000/=	65,000/=

12.	Burdizzo	1	46,000/=	46,000/=
13.	Trocar and Cannula	1	18,000/=	18,000/=
14.	Nose Ring	1	10,000/=	10,000/=
15.	Milk Can	1	160,000/=	160,000/=
16.	Mowing Machine Engine	1	295,000/=	295,000/=
17.	Fork Hoe	1	6,000/=	6,000/=
	SUB TOTAL			1,232,000/=

Grand Total ----- 37,361,000/=
