THE HELPING HAND

UACE AGRICULTURE

CLASS NOTES

"making teaching and learning of agriculture simpler and more interesting."

(PRINCIPLES OF CROP PRODUCTION

INCLUDING: 1). URBAN & PERI-URBAN FARMING

2). PRODUCTION OF HIGH VALUE CROPS

3). AGRO-FORESTRY

4). CROP IMPROVEMENT

5). CROP PROTECTION.

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"love it, pass it"

UNIT ONE: URBAN AND PERI-URBAN FARMING.

COURSE OUTLINE: Be sure you have covered the following areas;

Principles and practices invloved in Urban and peri-urban farming.

Problems associated with Urban and peri-urban farming.

Benefits of Urban and Peri-urban farming.

Principles of Organic farming.

Problems asssociated with organic farming.

URBAN AND PERI-URBAN FARMING

This is the production and distribution of food and other produce through intensive systems within and around a city or town boundaries to generate revenue.

It is also termed as market gardening, commercial urban agriculture, and Enterpreneural urban agriculture.

MAJOR PRACTICES OR ACTIVITIES IN MARKKET GARDENING.

- ★ Back yard gardening.
- ★ Container gardening.
- ★ Green belt agriculture.
- ★ Street and road side trees.
- ★ Hedge-rows consisting of edible plants.
- ★ Rooftop gardening.
- ★ School yard gardening.
- ★ Soil filled sacks/bags.
- ★ Soil filled wooden boxes.
- ★ Trellis/fence farms.
- ★ Vegetable gardens.
- ★ Hydroponics.
- ★ Aquaponics.

CHARACTERISTICS OF URBAN FARMING.

- ★ Labour intensive, as small sizes of the gardens do not allow for mechanisation.
- ★ Involves growing of high value crops.
- ★ Involves intensive cultivation of crops for high yields.
- ★ Mainly uses organic inputs though chemicals may be applied.
- ★ Relies on irrigation rather than natural rainfall as production is throughout the year.
- ★ High yields are obtained due to intensive management.

★ Crop produce have ready markets.

BENEFITS OF MARKET GARDENING.

1. Utilisation of vegetative wastes as compost by urban gardens reduces waste volume in cities.
2. Public land dedicated to urban farming is maintained by gardeners, reducing costs of maintenance for the city.
3. Reduces costs of transporting food from the rural areas.
4. Increases local employment opportunities e.g. land scaping, green house construction e.t.c.
5. Ensures utilisation of underused resources e.g. rooftops, roadsides e.t.c.
6. Rooftop gardens increase roof durability and property value.
7. Rooftop gardens also help to control excessive heating of the roof thus, maintaining room temperature.
8. Provides opportunity for treating industrial wastes and waste water through re-use in agriculture.
9. Attracts new businesses e.g. agro-equipment industries, restaurants e.t.c.
10. The area required to provide food is reduced.
11. Rooftop gardens retain precipitations which reduces storm water run off.
12. Rooftop gardens reduce noise and wind effects.
13. Reduces emission of gasses like methane and carbon dioxide from compostable wastes in landfills hence, improved air quality.
14. increases opportunity to access food for city dwellers.
15. Improves health from eating locally produced food stuffs.
16. Increases physical activity and recreational opportunities.
17. Food security in case of natural or economic disasters.
18. Preserves the community's natural heritage.
19. Protects public spaces from un-official use.

CHALLENGES OF URBAN FARMING.

1. High level of pollution from industries in areas outside agriculture land reserves.
2. Limited space in urban areas.
3. Lack of policies and regulations addressing urban farming in statutory plans.
4. High costs of inputs such as irrigation water and labour in towns.
5. An increase in real or perceived risks to health and safety.
6. Lack of licensing specific to the nature and operations of farming businesses.
7. Restrictions on the selling of produce from farm sites.
8. Restrictions on keeping small livestock e.g. bees and chicken.

ENCOURAGING THE ADOPTION OF URBAN FARMING IN UGANDA.

1. Incorporating urban gardening into integrated storm water management plans and liquid waste management plans.
2. providing school-aged children a hands-on farm experience.
3. Supplying compost manure from garbage to urban farmers for free.
4. Supporting commercialisation of food production in cities to enhance self-sufficiency of gardeners.
5. Providing credits and space to urban farmers to support production.
6. Creating permanent sites for farmers' markets throughout the cities.
7. Support public-private partnership between city councils and urban farmers to establish stable agriculture activities in and near cities.
8. Provide incentives to landowner to promote food production e.g. schools.
9. Review city bylaws regarding keeping of livestock.
10. Establish a municipal agricultural land bank to link available land with people wishing to farm.
11. Designate peri-urban agricultural zones in city development plans as part of green belts or green corridors.
12. Providing security to urban farmers.
13. Promoting urban agriculture demonstration gardens and educations.

ORGANIC FARMING

Refers to farming systems that avoid the use of synthetic chemicals such as fertiliser and pesticides while encouraging the use of natural inputs like manures.

It is an integrated production management system which promotes agro-ecosystem health, including biodiversity and biological activities.

Organic agriculture shares many techniques used by other sustainable agriculture approaches.

For example;

- Intercropping
- Crop rotation
- Mulching
- Mixed farming

However, the use of natural inputs, improvement of soil structure and fertility and use of crop rotation plans represent the basic rules that make organic agriculture a unique management system.

EXAMPLES OF ORGANIC FARMING PRACTICES.

1. Use of medicinal herbs instead of chemicals to treat animal diseases.
2. Use of herbal extracts to make pesticides for pests control.
3. Use of organic manures instead of artificial fertilizers to improve soil fertility.
4. Crop rotation to maintain soil fertility.
5. Using biological agents to control pests.
6. Using natural seeds instead of genetically modified seeds.
7. Selection and rearing of disease resistant crops and animals.
8. Using proper hygiene and sanitation measures to control diseases.
9. Recycling nutrients by using crop residues either directly as compost and mulches or indirectly through livestocks as farm yard manure.
10. Using renewable sources of energies e.g. biogas, solar systems.

OBJECTIVES OF ORGANIC FARMING

1. To enhance biological diversity within the whole system.
2. To increase soil biological activities.
3. To maintain long-term soil fertility.
4. To recycle wastes of plants and animal origins in order to return nutrients to the soil.
5. To utilise renewable resources in locally organised agricultural systems.
6. To promote healthy use of soil, water and air and minimise pollution from agricultural practices.
7. To promote careful methods of processing agricultural products to maintain organic integrity and qualities.
8. To produce food of high nutritional quality in sufficient quantity.

PRINCIPLES OF ORGANIC FARMING

The organic farming practices are based on the following principles;

1. Principle of health; the role of organic agriculture whether in farming, processing, distribution or consumption is to sustain and enhance the health of ecosystems and organisms from the smallest to human beings.

In view of this, it should avoid the use of agro-chemicals that may have adverse health effects.

2. Principle of ecology; the reduction of inputs by reuse, recycling and efficient management of materials and energy will contribute to improved environmental quality and conserve resources.

3. Principle of fairness; this emphasizes that, those involved in organic farming should conduct human relationships in a manner that ensures fairness at all levels and to all parties. (i.e. farmers, processors, distributors, traders and consumers).

Fairness requires systems of production, distribution and trade that are open, equitable and account for real environmental and social costs.

4. Principle of care; this states that, precautions and responsibility are the key concerns i management, development and technology choices in organic farming. Science is necessary to ensure the development of organic farming. however, it must consider valid solutions from practical experiences, traditional and indigenous knowledge to

prevent risks by adopting unpredictable technologies (like genetic engineering).

5. Principle of sustainability; Sustainable agriculture refers to successful management of agricultural resources to satisfy human needs without compromising the needs of the future generations.

Sustainability in organic farming must be seen in a holistic sense(in all aspects) including ecological, economic and social aspects.

BENEFITS OF ORGANIC FARMING.

1. Contributes to social well being by reducing the losses of arable soil, water contamination, pesticide poisoning and biodiversity erosion.
2. It is based on traditional knowledge and culture (i.e no special skills needed).
3. Improves economic conditions and development of rural areas as local resources are used.
4. Reduces health hazards to consumers as inorganic inputs are avoided.
5. Encourages diversification and adaptive management to increase food production.
6. Generates employment opportunities to locals.
7. Operating costs are significantly lower.
8. The demand for organic products creates new export opportunities thus, earning foreign exchange.
9. Improves soil structure and fertility through use of crop rotation and manure.
10. Promotes biodiversity through use of biological or natural pests control.
11. Does not pollute the environment.
12. Promotes soil and water conservation measures for improved fertility.

DISADVANTAGES OF COVENTIONAL AGRICULTURE.

Conventional agriculture, refers to the systems of production that employ the use of synthetic agro-inputs to produce in bulk for world market consumption.

The systems have several disadvantages like;

1. Artificial fertilizers are easily washed from soils into lakes and rivers causing eutrophication.
2. Increases health hazards due to the chemical residues in food (i.e.

biomagnification or bioaccumulation).

3. Prolonged use of artificial fertilizers results into soils with low organic matter content which is easily eroded.
4. Leads to rapid soil exhaustion and decline in yields.
5. Loss of biodiversity due to killing of insects ny pesticides and introduction of genetically modified organisms.
6. Increases costs of production e.g. buying of chemicals.
7. Artificial chemicals deestroy soil organisms resulting into poor soil structure and aeration.
8. Leads to pests and disease resurgence, making them more difficult to control.

UNIT TWO: PRODUCTION OF HIGH VALUE CROPS.

COURSE OUTLINE: Be sure you have covered the following areas;

a). Vegetable and species e.g.

i). Okra

ii). Garlic

iii). Irish potatoes

iv). Pepper.

b). Fruit crops e.g.

i). Pineapples

ii). Mangoes

iii). Goose berry

iv). Passion fruits.

c). Medicinal crops e.g.

i). Moringa

ii). Neem

iii). Aloe vera

iv). Artemisia spp.

d). Cottage crops e.g.

i). Mushrooms.

ii). Flowers (Roses)

iii). Upland rice.

PRODUCTION OF HIGH VALUE CROPS

These are crops of high economic value grown mainly for commercial purposes. They provide more profits per unit of land acreage than other crops.

They are classified as follows;

A. vegetables crops and spices e.g. okra, garlic, onions, pepper e.t.c.

B. Fruit crops e.g. pineapples, passion fruits, mangoes, goose berry e.t.c.

C. Medicinal crops e.g. Moringa, Neem, aloe vera, artemisia spp e.t.c.

D. Cottage crops e.g. mushrooms, roses, upland rice e.t.c.

ADVANTAGES OF HIGH VALUE CROPS.

1. Many of them provide food to man and farm animals, increasing food security.
2. They have high productivity pe unit area.
3. They have a wide adaptation to various environment.
4. They are widely demanded (i.e. highly marketable).
5. Require relatively less space as compared to other traditional crops.
6. They are easily processed into other products.
7. They offer a large scope for specialisation.
8. Grow and mature within a short time.
9. They can be easily integrated in home gardening.

DISADVANTAGES OF HIGH VALUE CROPS.

1) Require a lot of labour in production process.
2) Highly affected by pests and diseases requiring constant spraying with chemicals.
3) Most of them require well prepared seed bed which is labour consuming and destroys soil structure.
4) Require a lot of soil management practices e.g. fertiliser application, irrigation, mulching.
5) Highly perishable leading great post harvest losses.

6) Require relatively more skills to cultivate.

CONSTRAINTS IN THE PRODUCTION OF HIGH VALUE CROPS.

1) Limited supply of improved varieties for most high value crops.
2) Limited access to quality seeds for planting.
3) Unpredictable weather changes e.g. sudden drought, floods e.t.c.
4) Pevalence of many pests and diseases of most crops lower yield.
5) Limited supply of quality land for production.
6) Limited labour supply for managing the crops during production.
7) High post harvest losses due to increased perishability and poor handling.
8) Shortage of improved storage facilities in production areas leading to losses.
9) Inadequate market to match the production and supply of high value crops.
10) Limited skills among farmers relevant to production of high value crops.

PRODUCTION OF GARLIC

(Allium sativum)

Garlic is a biennial erect herb that grows to a height of 30-60cm tall, with superficial adventitious roots.

The bulbs consist of disc-like stem, thin dry scales which are the bases of foliage leaves and smaller bulbs or cloves formed from axillary buds of younger foliage.

The cloves are enclosed by the dry outer scales.

USES OF GARLIC.

- Used as a condiment for flavouring other foods.
- It has a medicinal value and is used in treatment of many ailments.
- Allicin produced by garlic can be used in production of antibiotics.

GROWTH REQUIREMENTS.

- Moderate temperatures ranging from 13-24 degree celcious.
- Good supply of water throughout growing season.
- Well drained fertile soils with high organic matter.
- High altitude.
- Long day light

FIELD PRACTICES.

1. Propagation; garlic is propagated vegetatively from cloves.
2. Seed bed preparation; cultivate the soil deeply and carry out secondary tillage to pulverise the soil and remove obstacles.
3. Planting; planting is carried out at the beginning of the rainy season. Cloves are planted 5cm deep at a spacing of about 30 x 15cm.
4. Fertilizer application; garlic gives good response to organic manure thus, compost may be incorporated into the soil before planting to improve soil fertility and structure.
5. Irrigation; garlic requires a good supply of soil moisture therefore, if planting was

done off season or the rainfall is inadequate, irrigation helps to overcome moisture deficit.

6. Weed control; garlic is less competitive and yield is highly reduced by weed infestation. Weed control may be achieved by cultivation, use of recommended herbicides.
7. Pests control; the common pests are cutworms and pink stalk borer. Spray recommended chemicals to control them.
8. Disease control; the major diseases of garlic are fungal which can be controlled by methods like early planting.
9. Mulching; this can increase the yield of garlic significantly as it conserves moisture and controls weeds. Grain straws are not recommended as they host several pests.
10. Topping; involves removal of flower stalks with small aerial bulbs in some types of garlic to enhance crop maturity and yield.
11. Harvesting; this must be done when the garlic is 4-6 months old (after planting) depending on the variety. When mature, the tops drop/fall over and begin to die back. Harvesting is done when 25% of the tops have fallen, by digging out the bulbs using a recommended too e.g.hand hoe.

POST HARVEST HANDLING OF GARLIC.

1. Curing; this can be done by placing the bulbs on open trays in a well ventilated building or indoor using forced air to dry them.

2. Sorting and grading; after curing, the tops and roots are trimmed off, loose outer sheath brushed off and then graded according to size.

3. Packing; garlic is packed in mesh bags or in a well ventilated crate. Avoid packing too many of them together as they release a lot heat causing loss of quality.

4. Storage; adequate air circulation and proper storage containers are important to remove transpired heat and moisture.

5. Transportation; dried bulbs are transported using refrigerated tracks to distant places.

6. Marketing; it is normally sold as fresh products to fresh produce markets and prices are determined by demand.

7. Utilisation/consumption; this depends on the intended use of the quantity bought e.g. as a condiment for flavouring food e.t.c.

PESTS OF GARLIC.

1.Cut worms. these in the soils.

They attack and eat the roots of young plants.

Control:

- Deep ploughing to expose the worms to natural enemies like birds.
- Land must be kept free from weeds for about 6 weeks before planting to starve the worms to death.

2. Pink stalk borers. these are the larvae of Sesamia calamistis moths.

They attack and tunnel through stems causing yellowing of the central tips and leaves die off.

Control:

- Effective weed control.
- Use of natural enemies e.g. parasitic wasps.

DISEASES OF GARLIC.

1. Brown rusts (Puccinia porri). This is seen by the following symptoms;

- Leaves are covered with powdery spores.
- Leaves turn yellow with time.

CONTROL.

- Timely planting.
- Field sanitation.

2. White bulb rot. It is seen by the following symptoms;

- Leaves turn yellow.
- Snow-white mycelia on the bulb surface.
- Root systems are destroyed completely.

CONTROL.

- Crop rotation.
- Destruction of infected residues.

- Soil treatment before planting.
- Sterilization of soil touching tools and equipment before use.

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(Passiflora edulis).

Passion fruits are also called, Granadillas.

It us grown locally for commercial purposes as well as for home use especially the purple granadillas.

COMMON VARIETIES OF GRANADILLAS.

a). Purple Passion fruits (Passiflora edulis sims).

characteristics:

- Leaves, stems, tendrils are clear green (without traces pf reddish or pinkish colour).
- Less vigorous.
- The fruits are round or oval in shape.
- The fruits are deep purple when ripe.

b). Yellow passion fruits (Passiflora edulis flavicarpa).

characteristics:

- They are more vigorous.
- There are reddish, pinkish or purple colour on the stems, leaves and tendrils.
- The average fruit size is slightly larger than that of purple type.

NB: Other commercial varieties though not common are;

1). Kaveri; the hybrid variety of passion fruits which is a graft between purple and yellow varieties.

2). Noel special; Hybrid variety developed to resist Alternaria disease. It is early maturing but self incompatible (i.e. needs a pollinator for fruiting to occur.)

GROWTH REQUIREMENTS OF GRANADAILLAS.

- Moderate temperatures throughout the year as they are sensitive to severe froth.
- High relative humidity.
- Well distributed rainfall of not least than 1200mm/annum.
- Deep fertile and well drained soils.

FIELD PRACTICES OF GRANADILLAS.

1. Propagation; granadillas are mostly grown from seeds. However, one must, be sure to use seeds from ripe fruits selected from healthy plants.

How To Prepare Seeds For Propagation:

Scoop out the content of granadillas that has been cut through.

Wash the content to separate the seeds from the pulp.

Dry the seeds in the shade and sow in the seedling trays or planting bags filled with a well prepared soil mixture.

To enhance germination, the seeds together with the pulp can be placed in a container and allowed to ferment for 1-3 days.

It is then washed thoroughly, dried and sown as soon as possible.

Seeds may be stored in a closed container at 13 degree celcious for 4 months.

2. Soil preparation; deep ploughing is necessary to loosen the soils for proper root growth and development.

3. Nursery bed preparation;

Sterilise the soils to use in the nursery bed to prevent root rot nematodes.

Seeds can be sown i trays or polythene bags.

Where possible, sow 2 seeds per bag and select the stronger one.

Push a thin stake into the soil next to the emerged seedling so that it can be trained up the stake.

Remove the developing side shoots regularly.

4. Transplanting; seedlings are ready for transplanting when they are about 3-6 weeks from the time of sowing. The seedlings to be transplanted should be transferred with a ball of soil around their roots to avoid root damage.

5. Spacing; generally, plant spacing of 1-2meters are used depending on the soil conditions.

6. Trellising/training; a sturdy is constructed to support the trellis to train the passion fruit plants to grow upright.

7. Pruning; is the removal of unwanted shoots and vines to permit growth and improved production.

Only 2 vines of each plant are allowed to grow and run along the trellis wire as main vines. Cut off all laterals at ground level if they start growing along the ground.

8. Fertilizer application; apply recommended phosphate fertilizers e.g. DAP at planting and Nitrogenous fertilizers during the growing season of the passion fruit.

9. Disease control; the commonest diseases of passion fruits are;

i). Dumping off: caused by fungi as a result of poor nursery bed management.

ii). Foot rot: where the base of the stem thickens, causing cracks in the soil surface through which other pathogens enter resulting into rotting of the stem.

10. Pests control; pests which frequently occur to granadillas include sting bugs and tip wilters.

11. Harvesting; Depending on the variety and time of transplanting, the first fruit is usually ready for harvest 4-6 months after planting

The fruit matures in 75 days from flowering and will naturally fall to the ground when fully mature. A mature passion fruit plant normally produces 2-3 harvests annually; one main harvest and several smaller harvests.

POST HARVEST HANDLING OF PASSION FRUITS.

1. Transportation; the harvested fruits should be transported to the packing area during the coolest time of the day in order to minimise heat build up.

2. Cleaning; the initial step in preparing passion fruits for marketing is to clean the surface of the fruits and remove any dirt, surface stains, sooty moulds and leaf tissues.

3. Grading and sorting; pre-sorting of fruits should be done in the field and additional grading at packaging to remove fruits that do not meet market requirements.The main characteristics used in grading are; size, skin colour, shape e.t.c.

4. Waxing; waxing enhances the shine and external appearance of the fruits, reduces post harvest weight loss, minimizes shriveling and extends market life.

5. Packaging; passion fruits should be packed in strong, well ventilated containers capable of being stacked without damaging the fruits.

6. Temperature control; passion fruits stored at temperatures above optimum will ripen more quickly and lose more weight. Below the optimum, fruits will suffer from low temperature chilling injury. The optimum storage temperature for passion fruits ranges from 4-7 degree celcius.

POST HARVEST DISORDERS/DAMAGES.

i). Chilling injury; when kept at temperatures below optimum, the fruits suffer from a physiological disorder known as chilling injury.

It is seen by;

- Pitting and sunken lesions on the fruit surface.
- Uneven skin coloration.
- Internal darkening of the pulp.

ii). Off flavour development and decay; this occurs when chilling injured fruits are transferred to ambient temperatures for marketing.

iii). Post harvest diseases; these are diseases whose infections begin from the fields and disease development is accentuated with tissue injury.

Causes:

Inappropriate harvesting techniques e.g. dropping fruits down.

Over filling containers during transportation.

Allowing fruits to rub against adjacent stems while in the field.

During storage, these damaged areas serve as entry points for fungal infections.

Examples:

a). Brown spots;

It is a fungal disease caused by Alternaria passiflorae.

It appears as tiny spots which enlarge into sunken circular lesions with brownish center.

Eventually, the rind around the diseased area becomes wrinkled and the fruit shrivels.

b). Phytophthora fruit rot;

It is caused by fungus, Phytophthora nicotianae which is soil borne.

It appears as water-soaked, dark green patches that dry out.

c). Septoria spot;

It is caused fungus, Septoria passiflorae.

It is seen by tiny, irregular light brown spots on the fruit surface that develop into blotches filled with minute black fruiting bodies of the fungus.

Uneven ripening and a mottled fruit coloration.

MUSHROOM PRODUCTION.

Mushrooms belong to the kingdom Fungi; a group very distinct from plants, animals and bacteria. They are non-photosynthetic and therefore, depend on other organisms for food by absorbing nutrients from the organic materials in which they live.

Mushrooms though classified as vegetables in the food world, are not technically plants,

though able to provide several important nutrients (which they concentrate in their tissues from organic substrates they grow on).

USES OF MUSHROOMS.

- Provide a delicious food rich in proteins, vitamins and mineral salts.
- They are also rich in fibre which aid in digestion of food.
- Mushroom extracts are used for medicinal purposes.
- Used in making of several cosmetic products.
- Used in brewing of tonic beverages.

NB: The commonly cultivated edible fungi include;

- Button mushrooms
- Oyster mushrooms
- Shiitake
- Lion's mane

FACTORS CONSIDERED WHEN CHOOSING MUSHROOM SPECIES TO GROW.

1. Availability of waste materials to use as growth medium; e.g. rice straws, wheat straws, coffee husks for oyster mushroom while Shiitake grows well on logs.
2. Available environment for growing the mushroom; outdoor production of mushrooms require limited knowledge and monitoring of growth conditions while indoor production requires manipulation of growth conditions.
3. Costs of equipment needed; air cleaning equipment or respirators are necessary in order to safely work in the production facility for Oyster since farmers may be allergic to their spores, mushroom driers and storage equipment.
4. Skills required to manage the life cycle; mushroom production on a sterilized saw dust demands a greater capital investment and more skillful management than log production.
5. Market demand for the species; organically grown Button mushrooms, Oyster mushroom, Shiitake are more marketable than other species.

PRODUCTION OF OYSTER MUSHROOM (Pleurotus spp)

This is the commonest of the known cultivated fungi.

Several varieties of Oyster mushroom exist, among which include;

- Gray oyster (P. sajor caju).
- Cherry oyster (P. cystidiasus).
- King oyster (P. eryngii).
- White oyster (P. florida).
- Yellow oyster (P. citrinopileatus).
- Pink oyster (P. djamor).

ADAVANTAGES/BENEFITS OF CULTIVATING OYSTER MUSHROOM.

1. Require a small space to grow compared to other high value crops.
2. They grow and mature faster i.e in about 15 days.
3. They have a high germination percentage thus, high yields.
4. Do not require a lot of labour to manage.
5. They have a fewer pests and diseases.
6. Can be processed into different products e.g. medicine, beverages and cosmetics.
7. Have a ready market than most traditional crops.
8. If well processed and preserved, they can stay for long without losing quality.

FACTORS NECESSARY FOR OYSTER PRODUCTION.

1. Temperature; the incubation period requires a temperature of 20-30 degrees and 15-25 degrees at fruiting.
2. Humidity; high relative humidity of 80-90% at fruiting to avoid drying of substrate and the mushroom.
3. Ventilation; at fruiting, the carbon-dioxide concentration should be reduced to lower levels (i.e. about 0.05-0.08%) as higher concentrations lead to long, small stems with no caps.
4. Light; exposure to light is important for initiation of fruit bodies.
5. Substrate; fermentation of the substrate makes nutrients available to the oyster. Oysters grow well on a variety of substrates ranging from wheat straws, sugar cane wastes (bagasse and molasses), sunflower wastes, water hyacinth, papers

e.t.c.

6. Spawn; good quality spawn (seeds) from high yielding and clean oysters are required.
7. PH of the substrate; oysters require a medium pH of between 6 and 7 for proper growth and production.

FACTORS CONSIDERED WHEN SITING MUSHROOM GARDENS.

1. Distance to the market; the site should be near market since they are highly perishable and need to be delivered to the market immediately they are harvested.
2. Availability of good quality substrate material; the material should be sterilized and highly nutritious to provide necessary nutrients for spawn growth.
3. Accessibility; should be near road for easy transportation of substrates and mushroom products to the markets.
4. Availability of clean water for wetting the substrate for spawn germination.
5. NB: It is important to eat only organically grown mushrooms because they absorb and concentrate whatever they grown in; (including heavy metals, air and water pollutants).

STEPS FOLLOWED IN RAISING MUSHROOMS.

1. Chop the straws or substrate and soak them in water for 24 hours.
2. Sterilize the substrate against any bacterial infections and pack in air tight polythene papers/casings.
3. Introduce spores/spawn and move the casing to a dark incubation room and keep it covered with white cloth.
4. Keep the temperature of the incubation room at about 20 degrees celcius.
5. Check the casings for contaminations and discard if decomposing.
6. Introduce a little light and keep watering during the growing period.
7. After 3 weeks, grown mushrooms are ready for harvest.

NB. To produce spawns for cultivation, inoculate a pasteurized medium with a sterile culture of a particular mushroom species.

After the culture has grown through out the medium, it is called a spawn.

PRECAUTIONS WHILE RAISING MUSHROOMS.

1. Incubate in a dark room to encourage spawn growth.
2. Do not introduce holes in the polythene papers (casings) before white growth to avoid bacterial and fungal infections.
3. Maintain moisture content of the substrate to avoid desiccation.
4. Moderate temperatures to avoid shrinkage and low quality.
5. Do not water directly but introduce a mist to avoid rotting and fungal infections.
6. Maintain favourable humidity to avoid desiccation.
7. Harvest immediately to avoid rotting and loss of quality.

CHALLENGES OF MUSHROOM PRODUCTION IN UGANDA

1. Perishability of mushroom that calls for cold storage and rapid processing or marketing. This causes greater losses to mushroom farmers.
2. Low quality substrate due to inadequate skills in substrate preparations and preparation of the growing houses.
3. Pests and diseases, that attack the spawn especially those grown outdoor.
4. Inadequate supply of quality spawn (seeds) for raising quality organic mushroom.
5. Low prices for mushrooms, given offered to the farmers by middlemen especially for unprocessed mushrooms.
6. Harsh climatic conditions, characterized by dry and hot weather discourages production of mushrooms.
7. Indoor production of mushrooms require a large supply of highly skilled labour and use of specialized equipment which is expensive.
8. Inadequate research and extension on mushroom growing in Uganda limits production due to limited awareness.

UNIT THREE: AGRO-FORESTY.

COURSE OUTLINE; Be sure you have covered the following areas;

Meaning of Agro-forestry

Methods and procedure for establishing agro-forestry.

Principles and practices of agro-forestry.

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Establishing a nursery bed for agro-forestry trees.

Selection of trees for agro-forestry.

Advantages of agro-forestry.

Challenges of agro-forestry.

Harvesting and processing of trees in agro-forestry.

AGROFORESTRY.

This is a system of farming in which farmers plant trees that have multipurpose uses together with crops, pasture and/or with animals on the same farm land.

OR.

It is a land use system and technology where woody perennials are planted in agricultural crops and animals in some form of arrangement or sequence.

The main components of an agro-forestry system are; trees and shrubs, crops, pasture, and livestock together with the environmental factors of climate, soil and land forms.

Other components include; bees, fish which occur in specialized systems.

The interaction between these components can lead to higher sum total and diversified production which increases production/yield.

IMPORTANCE OF AGROFORESTRY.

1. Increased tree cover; agro-forestry encourages land owners to participate in tree planting and as a result increases tree cover in the environment.
2. Risk management; agroforestry involves a mixture of species maturing at different times and demanding different conditions. These can substitute or supplement each other in case of seasonal climatic failures.
3. Soil structural enhancement; tree roots aid in the physical break up of compacted soils which improves structural properties e.g. aeration, drainage e.t.c.
4. Soil erosion control; agroforestry controls soil erosion through stabilization embankments against run off and wind.
5. Pests and disease control; the species mixture checks the spread of pests and diseases making the system less susceptible to productivity fluctuations.
6. Economic benefits; trees can increase farmers' income through production of marketable products like fruits, wood fuel.
7. Environmental conservation; through provision of alternative sources of wood products, reducing pressure on natural forests/vegetation.
8. Shade provision; to crops and animals thus, preventing excessive evapotranspiration
9. Improving soil fertility and productivity; trees aid in nutrient recycling , bringing within the root zones leached nutrients and also fix nitrogen especially those that are leguminous in nature.
10. Biodiversity conservation; a number oof useful tree species are being lost as they get exploited for fire wood, charcoal, medicine e.t.c. Such loss can be overcome by agroforestry.
11. Trees act as live fences; trees planted along boundaries can act as perimeter fences.
12. Prevent the effect of strong winds; by acting as wind breaks to reduce the damages that would be caused by strong winds on farms.

13. Provide feeds for livestock; some species of trees used can provide browse to goats or some over grown branches cut and fed to farm animals.
14. Provision of medicinal herbs; to the farmer and his livestock.
15. Rainfall formation; trees absorb underground water and transpire the water to the atmosphere thus, helps in saturation of the atmosphere to fom clouds.
16. Trees also provide support to climbing crops such as Passiflora spp.

DISADVANTAGES OF AGROFORESTRY.

1. Trees may provide an alternative hosts to pests and diseases of crops.
2. Tree-crop damage by animals where livestock are a component.
3. Trees compete with crops for growth factors.
4. There is shading of crops from sunshine which is an important factor for photosynthesis by trees.
5. Some tree species produce toxic chemicals which inhibit proper growth and development of crops.
6. Mechanization is difficult under agroforestry.
7. During harvesting of trees, there is damage to unintended/immature crops causing losses.

CHARACTERISTICS OF A GOOD AGROFORESTRY TREE SPECIES.

1. Should be able to fix nitrogen into the soil.
2. Have deep rooting system absorb water and dissolved nutrients from deeper layer.
3. Have a fewer extensive lateral roots on the top soil to reduce competition with crops.
4. Have a less dense canopy to reduce shading of companion crops.
5. Adapted to a wide range of climatic conditions.
6. Easy to establish and get rid off when desired.
7. Withstand repeated pruning.
8. Nutritious and palatable to livestock.
9. Multipurpose to produce various products e.g. firewood, poles, green manure

e.t.c.

10. Should grow in a wide range of soil conditions.
11. Free from pests and diseases.

REASONS FOR THE LIMITED ADOPTION OF AGROFORESTRY IN UGANDA.

- Inadequate training and expertise in agroforestry; Farmers have limited knowledge yet there are few extension officers to tran them in profitable agroforestry.
- Poor land tenure systems; that limit the size of land available for integrating trees, crops and livestock.
- Inadequate supply of viable seeds and seedlings; for desirable tree species for agroforestry.
- Limited demonstration sites; for testing tree species for different agro-ecological zones before recommending them for planting.
- The science of agroforestry has remained less popular and most rural farmers do not have model successful farmers.
- Agroforestry is a form of mixed farming that requires diverse skills and expertise to manage.
- Inadequate infrastructure like processing buildings/units, equipment and tools; for use by farmers in agroforestry makes post harvest handling difficult.

AGROFORESTRY SYSTEMS.

Agroforestry technology (system) is a set of specifications on arrangement and management of agroforestry components resulting from research or long term observation.

Agroforestry systems are classified according to either their function or land use types.

All agroforestry systems are characterized by three (3) basic components namely:

- The woody perennials (trees and shrubs).
- The herbaceous plants (crops and pasture).
- The animals.

The main agroforestry systems, basing on the components composition include;

1. SILVI-PASTORAL SYSTEM.

This is an agroforestry system where pasture or animals nd trees are combined on the same management unit.

2. AGRO-SILVI-PASTORAL SYSTEM.

Thus us an integration of tree, crops, pasture and livestock on the same management unit.

This system can be practised on the farm under the following practices;

a). Apiculture; this is the keeping of bees for honey propolis, bee venom e.t.c. in association with trees, crops and fodder.

Apiculture together with Sericulture makes up Entomoforestry.

Sericulture is the rearing of silk worms.

b). Aquaculture; thi is the keeping of aquatic organisms like fish in ponds, surrounded by shrubs, trees and grass lawns.

c). Protein banks; these are leguminous shrubs and fodder planted to supply proteins to livestock.

d). Agro-forests; th planting of trees together with fodder and short term crops on the same land.

They are woodlots on farms for provision of poles, timber, fuel wood, fodder and fruits.

3. AGRO-SILVI-CULTURAL SYSTEM.

This is an agroforestry system where cultivated crops are mixed/integrated with trees/shrubs for sustained production of crops, fodder and wood. This system can be practised on the farm under the following practices;

a). Home gardening; is the planting of multipurpose trees and shrubs, crops and

rearing of livestock around a homestead.

b). Taungya; is the growing of short term crops (annuals) in young tree plantations.

OR. is the growing of annual crops in forestry trees in the early years of establishment.

COMPONENT INTERACTIONS IN AGROFORESTRY.

The trees, crops and livestock interact with each other at a theoretical site called an interface. The type of interactions between two compound can be described on the basis pf observable net effect of one component on another in the system.

a) In ecological terms, the types of interactions between two species can be described as;

i). Commensalistic; if there is a positive effect on one species nd no observable effect on th other.

ii). Amensalistic; if there is a negative effect on one species and no observable effect on the other.

iii). Monopolistic (Predatory/Parasitic); if there is a positive effect on one species and a negative effect on the other.

iv). Inhibitory; if there is a negative effect observed on both species.

v). Synergistic; if there is a positive effect observed on both species.

Synergism refers to an interaction between two or more substances/species to produce a combined effect greater than the total sum of their separate effects.

b). In agroforestry systems, the interactions can be described as;

i). Complementary; if the components help each other by creating favourable conditions for their growth and development than for sole crops.

ii). Supplementary; if the two components interact in such away that the yield of one exceeds the yield of its sole crop without affecting the yield of the other component i.e. one component is maximising its resource utilisation without limiting it for the other component.

ii). Competitive; if an increase in the yield of one component leads to decrease in the yield of the other component.

MAJOR INTERFACES IN AGROFORESTRY SYSTEMS.

The interfaces for interaction include;

i). Tree-crop interface.

ii). Tree-animal interface.

iii). Crop-animal interface.

TREE-CROP INTERFACE.

This is the interaction between trees and crops on the same agroforestry management system.

The Positive Interactions:

- Trees provide support to creeping crops with weak stems.
- Leaves of trees fall off and decompose to form manure.
- Trees form a canopy that provides shade to crops.
- Tree roots bind soil particles together hence, controlling soil erosion in crop gardens.
- Trees protect crops from strong winds.
- Leguminous trees and crops contain nitrogen fixing bacteria in their root nodules that fix nitrogen into the soil.

The Negative Interactions:

- Trees compete with crops for growth factors like space, light e.t.c.
- Trees harbour crop pests and diseases that destroy the crops.
- Tree branches break off and damage crops.
- Some trees produce toxic substances that inhibit germination of crops e.g.Eucalyptus.

TREE-ANIMAL INTERFACE.

This is the interaction between trees and livestock in the same agroforestry management system.

The Positive Interactions:

- Trees provide shade to the animals.

- Trees provide fodder to animals.
- Trees provide herbal medicine to animals.
- Trees provide nectar to bees.
- Trees provide wood for construction of animals structures.
- Trees provide oxygen to animals for respiration especially during the day.
- Animals provide Carbon dioxide used by trees during photosynthesis.
- Animals provide manure for growth of trees.
- Animals act as agents of dispersal for tree seeds.
- Bees act as agents of pollination to trees.

The Negative Interactions:

- Animals destroy trees by trampling on them or eating their leaves and seeds.
- Some trees are poisonous to animals when eaten.
- Animals are agents of erosion since they destroy vegetation, exposing trees to agents of erosion.
- Trees branches can fall off and injure animals.
- Trees act as habitats for parasites to animals.
- Trees and animals compete for oxygen especially at night.

CROP-ANIMAL INTERFACE.

This is the interaction between crops and animals in the same agroforestry management system.

The Positive Interaction:

- Crops act as fodder for the animals.
- Crops provide oxygen to animals for respiration.

- Crops provide shade to animals.
- Crops are a source of nectar for the bees.
- Crops are a source of herbal medicine to animals.
- Animals provide Carbon dioxide to animals for photosynthesis.
- Animals pollinate crop flowers.

The Negative Interactions;

- Crop branches fall off and injure animals.
- Animals destroy crops by feeding or trampling on them.
- Crops act as habitats for animals parasites.
- Some crops are poisonous when eaten by animals.
- Some crops contain thorns that prick and pierce the animal skins.
- They both compete for oxygen especially at night.

FACTORS AFFECTING INTERACTIONS BETWEEN COMPONENTS IN AN AGROFORESTRY SYSTEM.

1. Species; some crops may perform well when grown with a particular tree component whereas, the yield of other crops may reduce when grown with the same tree because different crops interact differently with the same tree species.
2. Density of trees; canopy cover of trees intercepts light depending on the density of trees and consequently affects the performance of the underground crops. i.e. the yield of under grown crops is decreased with increase in tree density.
3. Stage of growth of th trees; aged trees require more growth resources and pose more competition to young crops.
4. Soil factors; competition between components increase when the supply of growth factors in the soil is limited.
5. Management factors; failure to manage crops to compete favourably with trees for growth factors can result into a reduction in yield.

MANAGING COMPETITION AMONG AGROFORESTRY COMPONENTS.

1. Root pruning; to minimise competition for growth resources by reducing overlapping of tree roots into crop roots.
2. Canopy pruning; to allow more light reach the underlying plants.

3. Mulching; reduces the growth of weeds, slows loss of water from the soil and supplies nutrients up on decomposition.
4. Irrigation; to ensure adequate supply of water for all components.
5. Adequate spacing; to reduce competition and ensure ample growth space for the components.
6. Application of fertilizers; to add the supply of nutrients in the soil needed by the components.
7. Weed control; weeds increase competition for water, nutrients and light which lower production by the major components.
8. Pests and disease control; pests attack to crops reduce their ability to compete favourably with trees for growth factors this, ought to be controlled for efficiency.

SITES FOR PRACTISING AGROFORESTRY ON THE FARM.

- Farm boundaries, along the edge of the farm by planting Pine, Ficus, or Kei apple.
- Along terraces, on steep slope by planting leguminous shrubs like Calliandria.
- Compounds, around homesteads e.g. flowers, hedgers or herbs like Moringa, Neem and aloe-vera.
- Bare areas with rocks that do not support proper growth of crops e.g. nitrogen deficient soils.
- Swampy areas with marshy vegetation, where bees and fish farming can be practised along side shrubs like Calliandria, Sesbania.
- Along slopes of highly eroded areas by planting Ficus, Eucalyptus.
- Along river banks by planting trees e.g. Eucalyptus, Pine, Acacia.

MULTIPURPOSE TREES AND SHRUBS.

These are trees and shrubs which are deliberately retained/grown on farms and managed for more than one use.

They provide multiple products for either home or market use or both and serve ecological functions e.g. soil erosion control.

GENERAL CHARACTERISTICS OF MULTIPURPOSE TREES AND SHRUBS.

1. Easy to establish from seeds or cuttings.

2. Able to grow rapidly.
3. Able to improve soil fertility.
4. Be deep rooter.
5. Good adaptability to different field conditions.
6. Produce less canopy to prevent excessive shading.
7. Produce many important products.
8. Easy to eradicate from the farm in case of need.
9. Should not be an alternative host for pests and diseases.
10. Should not be poisonous to livestock on the farm.
11. Should not produce toxic chemicals in the soil.
12. Able to sprout after harvesting or pruning.

NB. Not all trees and shrubs can meet all the requirements thus, selection depends on their intended used in an agroforestry system.

TREES AND SHRUBS FOR SOIL FERTILITY IMPROVEMENT.

- Should have the ability to fix nitrogen.
- Deep rooting system with fewer lateral roots.
- High biomass production.
- Less canopy to increase light penetration.
- High nutrient concentration in the foliage.
- Low carbon to nitrogen ratio (C:N) for faster decomposition of litter.
- Easy root decay.
- Absence of allelopathic chemicals.

TREES AND SHRUBS FOR RESTORATION OF DEGRADED LAND.

- Should be hardy to survive harsh climatic conditions.
- Ability to adopt to a wider range of soil conditions e.g. pH.
- Easy to establish and eradicate.

- Ability to grow faster with minimum care.
- Deep rooting.

TREES AND SHRUBS FOR FUEL WOOD.

- Easy to harvest.
- easy to establish.
- Rapid growth rate.
- High coppicing ability.
- High adaptability to a wide range of sites.
- High calorific value.
- Acceptability as fuel wood by users.
- Unpleasant to animals.

TREESS AND SHRUBS FOR FODDER PRODUCTION.

- High biomass production.
- High crude protein content in leaves and stems.
- Palatable and digestible foliage.
- Good coppicing ability.
- Ability to produce pods or fruits in dry seasons for propagation.
- Ability to encourage pasture growth beneath them.
- Easy to establish and harvest.
- High resistance to pests and diseases.
- High potential for genetic improvement through grating and breeding.
- Ability to grow faster.

TREES AND SHRUBS FOR HEDGE FORMATION.

- Easy to establish.
- Rapid growth rate.
- High lateral regrowth.

- High adaptability to a wide range of environment.
- Thorny to increase efficiency.
- Resistant to pests and diseases.
- Unpalatable to animals.
- High competitive ability.

MANAGEMENT OF TREES AND SHRUBS IN AGROFORESTRY

(TREE HARVESTING).

Trees growing in the fields must be properly managed to maximise production of desired output.

The management practices which can be applied to the parts of the tree above the ground (crown) include;

Coppicing

Pollarding

Side Pruning

Lopping

Thinning

The practices carried out on the parts below the ground include;

Root pruning.

Trenching.

1. COPPICING.

This involves cutting of a tree down to its stump or stool and allowing it to regrow. The tree/shrub should be cut at a height of about 30cm from the ground and at an angle/slanting.

ADVANTAGES OF COPPICING.

- ✓ Reduces competition for growth factors with associated crops.

- ✓ Saves the time and cost of replanting new trees in the field.
- ✓ Increases productivity since more than one tree may be produced on the stump.
- ✓ Can be used in repair or replacement of aged stems.

DISADVANTAGES.

- ✓ Not all trees have coppicing ability.
- ✓ The practice requires a lot of labour.
- ✓ Requires a lot of skills.

2. POLLARDING.

This involves cutting off of a tree crown (branches and top parts) to encourage regeneration of new branches.

The crown is cut off at a height of at least 2m above the ground.

ADVANTAGES OF POLLARDING.

- ✓ It promotes early harvesting of wood, timber e.t.c.
- ✓ Provides fodder which is out of reach of livestock.
- ✓ Reduces shade near crops.
- ✓ Can be usd to repair damaged tree branches.

3. SIDE PRUNING.

This involves removal of branches from the lower part of the tree crown.

REASONS FOR PRUNING.

- ✓ To reduce shading of associated crops.
- ✓ Improves quality of the stem (i.e. straight and knot fre for timber and poles).
- ✓ Provides early harvest of branch wood for fuel, fodder e.t.c.
- ✓ Removes the micro-climate suitable for pests and fungal diseases.
- ✓ Increases growth rate of the tree.

4. LOPPING.

This involves removal of one or more branches from a tree crown in random manner to obtain fodder.

The main criterion in selecting branches to cut is often good, greenn leafy branches since it is done to obtain fodder for the livestock.

5. THINNING.

Is a selective process of removing some extra shoots to improve spacing between trees.

ADVANTAGES.

- ✓ It makes early harvesting of firewood and poles possible.
- ✓ It promotes straight growth of trees.
- ✓ Provides a chance to selectively remove poorly formed trees or species of low value.

6. ROOT PRUNING.

Lateral roots growing in crop land are cut at 0.3-0.6m from the tree base.

This practice is done when the trees have reached a height of at least 2-3m.

ADAVANTAGES.

- ✓ It reduces competition for water and nutrients between trees and crops.
- ✓ It also prevent root damages to farm structures.

7. TRENCHING.

A trench of about 60cm deep is dug at a distance of about 50cm at the edges of trees bordering cultivated crop fields. All exposed lateral tree roots from the trench line are cut so that they do not overlap to cultivated land.

CONSERVATION AND UTILISATION OF TREES AND FORESTS.

Forest conservation refers to measures taken to utilise forest resources sustainable to serve the needs of the present generation without compromising the needs of the future generations.

DEFORESTATION IN UGANDA.

Is the cuting down of trees for timber, fuel, herbs or other uses in large number without replacing them.

MAJOR CAUSES OF DEFORESTATION IN UGANDA.

1. Construction and expansion of transport routes like road and railways that pass through the forests.
2. Lumbering in most forests for timber and timber products like paper.
3. Urban and industrial development that has led to expansion of settlements and factories in forest resources.
4. Weak and unclear land law and rights that have led to encroachment on forest reserves by the public without prosecution.
5. Uncontrolled bush burning especially during the dry seasons by most subsistence farmers during bush clearing.
6. Mining activities in gazetted forest areas especially oil mining and quarrying.
7. Need for land for settlement schemes for refugees and internally displaced people (IDPs) due to wars and natural disasters.
8. Political instabilities in some parts of Uganda have increased clearance of forests to remove hiding places for rebels.
9. Wild fires especially during the dry season that destroy larger pieces of forested areas.
10. High levels of poverty among most Ugandans has also increased dependence burden on natural resources like forests by most people for wood fuel.

MEASURES TO CONSERVE FORESTS IN UGANDA.

1. Afforestation.
2. Re-afforestation.
3. Sensitization of masses around forest reserves on the importance of forests and dangers of forest destruction.
4. Empowering the local communities to develop alternative sources of income other than relying on forest products.

5. Developing alternative sustainable and green sources of energy loke biogas, and solar to replace wood and charcoal.
6. Controlling pests and diseases that attack trees in forests to encourage regrowth.
7. Establishment of forest reserves to avoid cultivation and exploitation of natural vegetation zones.
8. Improving research on tree species and management to produce fast maturing, environmentally adapted tree varieties.
9. Employing forest rangers to protect and guard forested areas against exploitation.
10. Empowering non-governmental organizations like NEMA and setting up other national environment protection legislations to control degradation.
11. Developing alternative building and construction materials like plastics, stones and metals to reduce over utilisation of trees.
12. Issuing forest lumbering and utilisation certificates to those authorised to utilise forestry resources to control unauthorized entry.
13. Careful harvesting of only mature trees without damaging young trees to encourage full forest canopy growth and formation.
14. Developing energy saving technologies e.g. energy saver stoves to reduce total energy requirement and demand for forest based energy sources.
15. Controlled grazing and stocking rates to reduce destruction of forest vegetation.
16. Developing sustainable forest utilisation technologies like bee keeping, fish farming to enable sustainability and profitability.
17. Controlling population growth rates to reduce the pressure put on forest resources and land.

CHALLENGES FACED IN CONSERVING FORESTS RESOURCES.

1. Corruption, in the forestry department protection units that fail to regulate these exploiting forest resources due to personal benefits.
2. Climate change, that has reduced tree growth and has resulted into death and extinction of many tree species.
3. Conservativeness, of most people living near forests to the need and value of forests to the ecosystem and dangers of over exploitation.
4. Population increase, that has led to increased competition for land between

forestry and other land use activities.

5. Limited trained labour, to implement the forest conservation and protection.
6. Fire outbreak, that destroy valuable tree species hence, destroying forest products.
7. Most tree species indigenous to most Ugandan forests have long term gestations, thus, take a lot of time to mature and reach full utilisation age, making it hard to protect them throughout their gestation.
8. Weak legislation on forest protection from the government and its agencies like NEMA against forest destruction.
9. Tree pests and diseases that attack and destroy a valuable quantity of trees in most natural forests.
10. Poor land tenure policies and ownership laws that make it difficult to conserve forest reserves.

MAJOR TREE HUSBANDARY PRACTICES.

1. Training using stakes, for tree species which produce many branches.
2. Mulching, to suppress weeds and conserve moisture.
3. Weed control, to reduce competition for growth factors.
4. Protection against livestock, from trampling and browsing.
5. Side Pruning, to allow light penetration to lower layers of the canopies.
6. Root pruning, to reduce overlapping of lateral roots into crop fields and farm structures.
7. Controlling of pests and diseases, e.g. cancers, nematodes, wood beetles e.t.c. to allow proper growth and development.
8. Proper spacing, to allow maximum nutrient utilisation.
9. Application of fertilizers and manure, to enrich nutrient supply in the soils for plant uptake.
10. Coppicing, to encourage new growth.
11. Pollarding, to encourage lateral growth/branching.
12. Lopping, to allow utilisation of fresh and palatable branches that are out of reach of livestock as fodder.

13. thinning, to reduce on over crowding.
14. Gapping/ gap filling, to achieve optimum plant population per unit area.
15. Earthing up, to encourage water infiltration and retention in the soil.
16. Irrigation, to supply water during dry spells or seasons.

UNIT FOUR: CROP IMPROVEMENT.

COURSE OUTLINE; Be sure you have covered the following;

Reasons for crop improvement.

Principles of crop improvement i.e.

i). Selection

ii). Introduction.

iii). Breeding/Hybridization.

Current issues and development in crop improvement.

CROP IMPROVEMENT.

This is the art and science of manipulating and altering the genetic make up of a crop to get offsprings that are superior to their parents.

OBJECTIVES OF CROP IMPROVEMENT.

1. To develop and produce varieties of crops that are more productive in terms of yield.
2. To develop quick and early maturing crop varieties.
3. To improve on the pests and disease resistance of crops as to reduce costs of

their control.

4. To develop crops that adapt to the environmental conditions yet producing high yields.
5. To produce crops that have high quality yields that are more appealing to consumers e.g. better taste, size, colour e.t.c.
6. To improve on the storage/keeping quality to reduce perishability.
7. To develop varieties with seeds which are easier to germinate.
8. To produce crops with desired agronomic characteristics such as good height for easy harvesting.
9. To develop crops that have a better response to fertilizers and other soil amendments for and extensive crop production.

METHODS OF CROP IMPROVEMENT.

These include; i). Selection

ii). Introduction.

iii). Breeding(Hybridization).

1. SELECTION.

This is the identification and isolation of individual crops with desirable characteristics to be parents of the future generations.

This can be natural or artificial.

Natural selection is based on the principle of survival for the fittest where, crops that are better suited to the environment survive and the less suited die off.

Artificial selection is based on observable plant characteristics that a farmer bases on to choose planting materials.

METHODS OF SELECTION IN CROPS.

a). Pure line selection;

In his method, a single good performing plant is chosen and its offsprings used to develop a new variety. It is used to improve self-fertilised plants.

Procedure Of Conducting Pure Line Selection:

- A large number of plants with desirable qualities are identified.

- Seeds are collected from the identified plants and kept separate.
- The seeds are planted separately in isolated fields to prevent contamination by off types.
- The performance of the seeds from each plant is monitored and the best performing plant noted.
- The seeds of the best performing line are multiplied and released as new variety.

b).Mass selection;

Seeds are collected from many good performing plants and mixed together before sowing.

It is used for breeding self-fertilized plant species (Dioecious plants).

Procedure For Conducting Mass Selection;

- Seeds from all similarly appearing and best performing crops are selected.
- The seeds are mixed together to get a mass of seeds.
- The mixture is sown and seeds from the best performing and most vigorous plants that sprout are obtained.
- The seeds are then collected and marked as a new variety.

ADVANTAGES OF MASS SELECTION.

- It is rapid, simple and can handle a large population easily.
- Cheap to conduct.
- The cultivar is phenotypically fairly uniform though it is a mixture of pure lines.

DISADVANTAGES OF MASS SELECTION.

- The traits of interest need to have high heritability for effectiveness.
- Requires uniform environment to achieve optimal selection.
- Phenotypic uniformity is less than in cultivar produced by pure line selection.
- If progeny testing is not done, heterozygote can not be distinguished from homozygous dominant genotypes.

c). Pedigree Selection;

This is a selection method in which the breeder/farmer keeps records of the ancestors of a cultivar, which is used to determine the choice of a variety to use. i.e. selection is based on the records of performance of he ancestral generations.

2. INTRODUCTION.

This involves the improvement of plants by bringing in crops from other centers of origin to an area where they can survive.

The introduced crops may be in form of planting materials or pollen from suitable varieties for conducting artificial pollination.

However quick, this method may have associated problems of;

- ✓ Introducing pests and diseases to an area.
- ✓ Requiring a lot of research which is expensive to facilitate.
- ✓ Failure of the plant introduced to adapt to prevailing environmental conditions.

3. HYBRIDIZATION.

This is the crossing of pure lines to produce a hybrid.

OR. It is the crossing of different varieties or species of plans to produce hybrids.

It is mainly used in breeding for disease resistance.

Hybrid cultivar are produced by crossing inbred lines that have been evaluated for their ability to produce hybrids with superior vigour over those of their parents.

NB. Hybrid vigour refers to the special and desirable characteristics shown by plants as a result of breeding e.g. disease resistance, quick maturing, better taste e.t.c.

Procedure For Hybridization;

- ➢ Plants with desirable qualities are selected.
- ➢ In cross pollinated plants, seeds selected are selfed to obtain homozygous offsprings (pure lines).
- ➢ Self fertilized plants are already homozygous due to natural selfing.
- ➢ Seeds of the pure lines are then collected and planted.
- ➢ The male parts of the plants to serve as females (receptors) are removed before they mature to prevent self pollination.

- The females and males are then labeled for easy identification during crossing.
- The flowers are then covered; in females to prevent natural cross pollination and in males to prevent contamination of pollen with foreign or stray pollen and ease collection of pollen for crossing.
- Crossing is then carried out; pollen from the bagged males are collected and dusted on the females and labeled.
- Seeds are then collected after maturity and sown.
- The offsprings of the F2 generation are tested at various stations to find out suitability to various conditions.
- If found desirable, the seeds are multiplied, given names and number and released to farmers as a new variety.

ADVANTAGES OF HYBRIDIZATION.

- ✓ It brings about variation in plants.
- ✓ There is increased fruit size and number (i.e.improved yield).
- ✓ Increased resistance to diseases and pests.
- ✓ Early maturity.

DISADVANTAGES.

- ✓ The seeds from hybrids can not be used successfully to raise new crops (i.e. because they lose hybrid vigour due to inbreeding).
- ✓ Hybrids need maintenance of parent stock from which seeds are produced yearly.
- ✓ Hybrid seeds are expensive.
- ✓ May require high level of management to obtain high yields.

UNIT FIVE: GENERAL PRINCIPLES OF CROP PROTECTION.

COURSE OUTLINE; Be sure you have covered the following areas;

Crop protection measures.

Effects of wees, pests and diseases on crop production

Methods of managing weeds, pests and diseases on crops; i.e.

Cultural methods

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Mechanical methods

Biological methods

Chemical methods

Integrated approaches

Legislative measures.

Effects of crop protection measures on the environment.

How to minmise the effects of crop protection measures on the environment.

CROP PROTECTION

WEEDS AND WEED CONTROL

WEEDS:

These may be defined as;

1). Plants growing out of a place.

2). The unwanted plants that grow in the garden and interfere with the normal crop growth.

IDENTITY OF WEEDS:

Weeds are identified by their common names or their botanical/scientific names, which are internationally known and accepted.

They are named and classified according to; specific features, place where they are found and persons who discovered them.

The international system of naming requires that, no two plants share the same name. The first name is the Genus and the second one, the Species.

EXAMPLES OF COMMON WEEDS IN EAST AFRICA

a). **NARROW LEAVED WEEDS**

COMMON NAME	SCIENTIFIC NAME	LIFE SPAN	MODE OF PROPAGATION
Nut grass	Cyperus rotundus	Perennial	bulbs
Couch grass	Digitaria scalarum	Perennial	rhizomes
Lemon grass	Cymbopogon afronadus	Perennial	splits
Star grass	Cynodon dactylon	Perennial	splits
Bristly foxtail	Setaria verticillata	Annual	seeds
Wild finger millet	Eleusine indica	Annual	seeds
Cat's tail	Sporobolus pyramidalis	Perennial	splits, seeds

b). BROAD LEAVED WEEDS.

COMMON NAME	SCIENTIFIC NAME	LIFE SPAN	MODE OF PROPAGATION
Black jack	Bidens pilosa	Annual	seeds
Tick berry	Lantana camara	Perennial	seeds
Pig weed	Amaranthus spp	Annual	seeds
Goat weed	Ageratum conyzoids	Annual	seeds
Witch weed	Striga spp	Annual	seeds
Oxalis	Oxalis spp	Perennial	bulbs
Sodom apple	Solanum incanum	Perennial	seeds
Thorn apple	Datura stramonium	Annual	seeds
Macdonald's eye	Galinsoga parviflora	Annual	seeds
Black night shade	Solanum nigrem	Annual	seeds
Tridax	Tridax procumbens	Annual	seeds

CLASSIFICATION OF WEEDS:

a). ACCORDING TO LIFE SPAN (GROWTH CYCLE)

1. ANNUAL WEEDS

these grow and complete their life cycle within one year. They have rapid growth rate and in case they are left in an area for a long period of time without any control, they become difficult to control. e.g. goat weed, thorn apple.

2. BIENNIAL WEEDS

These grow and complete their life cycle within two years.

Vegetative growth is achieved in the first year followed by abundant production of seeds in the second year. They reproduce only from seeds and infest crops which are poorly managed.

3. PERENNIAL WEEDS

These require more than two years to complete their life cycle.

They reproduce by seeds and vegetatively. Their stems may grow above or below the ground. They are adapted to long season crops e.g star grass, spear grass e.t.c.

b). **ACCORDING TO LEAF MORPHOLOGY:**

1. BROAD LEAVED WEEDS

These occur mostly in arable land. The leaves have net venation.

They are mainly annual and perennial e.g Oxalis, Lantana, Witch weed, Black jack e.t.c.

2. NARROW LEAVED WEEDS

These include grasses and sedges.

The leaves have parallel veins and the growing point is protected by the leaf sheath at early stages of vegetative growth.

a) Sedges; are monocot with solid and triangular stem. They are found in poorly drained soils.

Propagation is through modified rhizomes like in Cyperus spp. They also reproduce by means of underground tubers and are difficult to control.

b) Herbaceous weeds; have water filled succulent stems. They are hard to control using chemical means due their succulent nature. e.g pig weed, black jack, goat weed, black night shade, wondering jew e.t.c.

c). ACCORDING TO HABITAT:

1. AQUATIC WEEDS

These grow in soils that have either standing water or are permanently wet.

They are further divided into; Floating hydrophyte, Emergent hydrophyte, and Sub-

mergent hydrophyte.

e.g water lettuce, water hyacinth and Elodea spp.

2. TERRESTRIAL WEEDS

These cannot compete their life cycle in moisture regime as for aquatic weeds. i.e they grow well in well drained soils. e.g black jack, tick berry e.t.c

FACTORS CONTRIBUTING TO COMPETITIVE ABILITY OF WEEDS:

1. Produce large quantities of seeds which increase their chances of survival.
2. Have long dormancy periods allowing them to escape harsh conditions of the environment i.e they remain viable in the soils for a long period of time awaiting conducive germination conditions.
3. Seeds have several modes of dispersal, allowing easy spread over a wide area.
4. Ability to propagate vegetatively, increases their chances of multiplication e.g couch grass.
5. Elaborate and extensive rooting system to compete in limited supply of nutrients.
6. Short life cycle, allowing quicker multiplication. i.e can complete their life cycle within restricted rain regime.
7. They are hardy, therefore, able to thrive even under conditions of limited moisture, adverse soil conditions and climate.

BENEFITS OF WEEDS/ POSITIVE EFFECTS OF WEEDS:

1. Some weeds have medicinal value to humans and farm animals e.g roots of Sodom apple, used to treat constipation.
2. Leguminous weeds fix nitrogen in the soil.
3. Act as soil cover, preventing soil capping due to the impact of rain drops.
4. Add organic matter to the soil up on decomposition.
5. Some are edible to both man and livestock e.g pig weeds, wondering jew.

6. Some weeds are used for thatching during construction of farm buildings e.g spear grass, thatching grass.
7. Some weeds are used for fencing e.g Lantana for hedge fencing.

HARMFUL EFFECTS OF WEEDS:

1. Compete with crops for nutrients, space, light, moisture therefore reducing crop yield.
2. They are parasitic to cultivated crops e.g witch weed.
3. Lower quality of Agricultural produce e.g Mexican marigold give an unpleasant flavour t milk when dairy cows feed on them.
4. Some weeds are poisonous to man and livestock e. g thorn apple, unripe Sodom apple.
5. Some produce poisonous substances that suppress the growth or germination of cultivated crops i.e they are Allelophatic e.g couch grass.
6. Some act as alternate hosts for insect pests and diseases e.g black jack for Aphids.
7. They block irrigation channels, making it difficult for water to flow freely in irrigated land.
8. Aquatic weeds block navigation and deprive aquatic animals off oxygen.
9. Lower the quality of pasture e.g tick berry suppresses pasture undergrowth.
10. Irritate workers thus, reducing their efficiency e.g double thorn.

WEED CONTROL:

Weed control involves the elimination of weed population or stopping the introduction of weeds in an area not previously infested with weeds. This is done to minimise competition with crops for growth factors.

Several methods are employed in the control of weeds and these include;

Mechanical/physical weeds control

Cultural weed control

Biological weed control

Chemical weed control

Legislative method.

FACTORS TO CONSIDER WHILE CHOOSING A WEED CONTROL METHOD:

1. Applicability of the method; e.g weed control by cultivation can not apply in areas with extremely steep slopes due to increased rates of soil erosion.
2. Availability $ suitability of tools; e.g in case a farmer needs to use herbicides for weed control, there is need to have a knap sack sprayer.
3. Cost of weed control; where possible, go for cheaper methods to avoid unnecessary costs that lower farm profits.
4. Dispersal of seeds; weeds can be controlled effectively if the way in which the weed seeds disseminate are known and counter measures under take.
5. Dormancy periods; while controlling weeds, dormancy period is to be considered as they have long dormancy periods.
6. Environmental factors; rainfall, wind, temperature and humidity should be suitable for a method to choose for use.
7. Habitats of the weeds; a xerophytic weed thriving under dry and arid conditions will die if the field is flooded with water.
8. Life cycle of the weeds; annual and biennial weeds can be controlled effectively if the land is cultivated before seeding stage of the weeds. Perennial weeds require deep cultivation to dig out rhizomes, bulbs e.t.c by which they propagate.
9. Method of reproduction; weeds propagate by either seeds or vegetative parts or even both. Seeded weeds should be removed or smothered before seeds formation stage while vegetatively propagated weeds should be exposed to sun heat to dry and die.
10. The extent of weed infestation; if the weeds have established themselves and widely spread, they need an extensive controlling programme e.g integrated management.

1. MECHANICAL WEED CONTROL:

This involves suppression of or elimination of weed growth through the use of farm implements/tools like panga, hoes, slashers e.t.c.

It involves the application of physical energy.

Methods of mechanical weed control include;

a). Tillage or cultivation;

this is the opening and loosening of the soil by hand tools or tractor drawn implements.

How Tillage Controls Weeds:

- ✓ it buries the entire plant, allowing it to rot thus, killing it completely.
- ✓ it causes depletion of food reserves, by repeatedly removing top growth whenever it reaches sufficient size.
- ✓ it exposes the underground parts to extreme temperature for desiccation.

Advantages Of Tillage In Weed Control:

- ✓ cheap for small scale farmers.
- ✓ incorporates crop residues into the soil.
- ✓ increases water infiltration of the soil
- ✓ improves air circulation within the soil.
- ✓ Earthing up during tillage encourages root growth.

Disadvantages Of Tillage In Weed Control:

- ✓ it pulverizes the soil, destroying soil structure.
- ✓ Encourages water loss by evaporation.
- ✓ It is expensive in large scale production.
- ✓ It is laborious to farmers under large scale production.
- ✓ Creates suitable conditions for germination of buried weed seeds.

- ✓ May encourage spread of soil borne diseases through tillage implements.
- ✓ Encourages loss of organic matter and soil nutrients.
- ✓ May encourage soil erosion.
- ✓ May not effectively control perennial weeds.
- ✓ May damage crop roots.

b). Slashing or Mowing;

Is the mechanical removal of shoots from growing weeds. It can be used to prevent tall growing weeds from flowering and setting seeds.

c). Uprooting of weeds;

this is done where weeds are scattered or crops are too close to allow mechanical cultivation.

It is best done when the soil is moist and before seeds are produced.

d). Heat treatment;

This involves exposure of weeds to strong heat.

Burning weeds over an extended area destroys valuable surface trash that would normally be returned to the soil through decay or cultivation.

2. CULTURAL WEED CONTROL:

These are the crop husbandry practices carried out on the farm during crop growth without the use of chemicals.

Methods of cultural weed control include;

1. Mulching; smothers weeds thus, preventing weed growth.
2. Cover cropping; smother weeds.

3. Crop rotation; weeds associated with certain crops will not germinate when rotated e.g striga in cereals and sugar cane.
4. Use of clean planting materials; prevents introduction of weeds into the farm.
5. Proper spacing; creates little space for weeds growth or form a canopy which suppresses weeds.
6. Clean seedbed; starts off crops on clean bed to effectively compete with weeds.
7. Flooding; discourages growth of all non-aquatic weeds.
8. Intercropping; provides a dense plant population to suppress weeds.
9. Cleaning of farm tools and implements properly before or after use on the farm to avoid introduction of weeds & weeds seeds.

3. BIOLOGICAL WEED CONTROL:

This is the use of living organisms to control weeds.

It aims at reuniting weeds and their natural enemies to achieve sustainable weed control. These natural enemies of weeds are often referred to as biological control agents.

Care should be taken to ensure that the biological agent does not have adverse effects on the crop plants.

Examples of biological control agents include;

- Grazing livestock e.g goats in coconut and cashew nut plantation.
- Use of herbivores fish to control aquatic weeds.
- Use of moths to control cacti.
- Beetles to control water hyacinth.

CONDITIONS FOR USE OF BIOLOGICAL WEED CONTROL:

- Inaccessible areas such as rocky and steep locations.

- Low priority areas for weed control.
- Situations where biological control is the only option.
- Where chemical control may not be too expensive or not effective.

CHARACTERISTICS OF A GOOD BIOLOGICAL AGENT:

- Should be economical to maintain by the farmer.
- Should be specific in action to attack only the target weeds.
- Should multiply faster to over weigh the weed population.
- It should be easy to eradicate.
- Not transmit other infections to the crops.

ADVANTAGES OF BIOLOGICAL WEED CONTROL:

- ✓ It is environmentally friendly.
- ✓ It saves on labour.
- ✓ No additional inputs needed hence, cheaper.
- ✓ It is host specific i.e does not kill soil micro-organisms.

DISADVANTAGES OF BIOLOGICAL WEED CONTROL:

- ✓ It requires a lot of research.
- ✓ The agents may destroy predators as well.
- ✓ Control is slow in case of low population of the agent.
- ✓ High initial costs.

4. LEGISLATIVE/PREVENTIVE WEED CONTROL:

This involves government laws which prevent the introduction of noxious weeds in a country or the spread from one part of the country to another.

OR. It involves measures taken to prevent the introduction, establishment and spread of some weeds in non-infected areas.

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

free.

5. CHEMICAL WEED CONTROL:

Toxic chemicals known as herbicides are used to kill, suppress or modify weed growth in such a way to prevent weed interference with crop establishment, growth and yield.

Herbicides are chemicals used to kill and inhibit the growth and development of weeds.

WAYS IN WHICH HERBICIDES WORK TO KILL WEEDS;

- ★ Inhibiting the nitrogen metabolism.
- ★ Killing the cells.
- ★ Causing abnormal tissue development.
- ★ Inhibiting photosynthesis.
- ★ Inhibiting respiration.

CLASSIFICATION OF HERBICIDES:

This may be based on one of the following:

- ★ Formulation
- ★ Time of application
- ★ Mode of application
- ★ Selectivity.

1). **Formulation**:

This is the physical form of herbicides i.e.

a) Liquids.; are soluble in water or oil.

they are highly concentrated or toxic e.g Dalapon, paraquat.

b) Wettable powder; finely ground particles, that form suspensions with water before application. Constant agitation is required to avoid clustering. e.g Atrazin, Simazine, Duron.

c) **Granules**; occur in form of granules e.g Duron.

2). **Time of Application:**

a) **Pre-emergence Herbicides**; are applied soon after crop seeds have been sown but before they emerge. They kill the germinated weeds such that crops germinate in a weed free environment. e.g Atrazine, Simazine.

b) **Post-emergence Herbicides;** are applied after crop germination or transplanting or at different stages of crop growth.

e.g 2,4-D, M.C.P.A, paraquat Glyphosate e.t.c

3. **Mode Of Action**:

a) **Contact Herbicides**; kill only the parts of the plant with which it comes into contact. They are applied to the foliage e.g paraquat, propanil.

b) **Translocated/Systemic Herbicides;** kill the whole plant eve if it comes into contact with only a small part of it.

i.e they are absorbed into the plant and translocate to all parts of the plant. e.g 2,4-D, amitrole, atrazine.

4. **Selectivity**:

a) **Selective Herbicides**; this will kill or impair the growth of certain plant species when applied to a mixed plant population but cause no injury to others e.g 2,4-Diamine, Atrazine, Basagran. e.t.c

b) **Non-selective Herbicides**; This is will indiscriminately kill all plants that they may come into contact with e.g Glyphosphate (round up), Gramaxone(paraquat)

FACTORS AFFECTING SELECTIVITY & EFFECTIVENESS OF HERBICIDES:

1. Stage of growth of the plant; young plants are more susceptible to herbicides action because of their high growth activity.
2. Physiological/metabolic factors; the ability of a crop to neutralise toxic herbicides varies and thus, affects selectivity and efficiency of herbicides.
3. Herbicide characteristic; herbicides which interfere with photosynthesis are non-selecttive.

4. Concentration; under high concentration, herbicides kill all kinds of plants.
5. Formulation; oil formulations are more toxic to plants.
6. Method of application; high selectivity is attained by placing the herbicide where the weed is and away from the crop.
7. Leaf angle; leaf angles which are inclined e.g grasses are less susceptible as compared to horizontal angles such as dicot.
8. Nature of leaf surface; plants with thickened waxy cuticles on the surfaces retain less herbicides e.g cactus, wondering jew.
9. Height of the plant; selectivity is attained when weeds are shorter than when the crops or taller than thr crops.
10. Location of the growing points; dicot are more susceptible to herbicides because their growing/terminal buds are more exposed than monocot.
11. Difference in rooting system; shallow rooted plants are more susceptible to herbicides than deep rooted which require herbicides with long residual effect.
12. Specialized structure; plants with underground structures such as rhizomes, and bulbs e.g Oxalis are not easily killed by herbicides.

HOW MAXIMUM EFFECTIVENESS OF HERBICIDES CAN BE ACHIEVED:

1. Apply the herbicide at the correct stage of weed growth.
2. Apply at recommended rate; avoid over dilution of herbicides.
3. Avoid spraying in windy weather for uniform spraying.
4. Avoid spraying on rainy days because rain can dilute the herbicides before it acts on weeds.
5. Ensure correct speed of operation while spraying herbicides.
6. Ensure adequate moisture in the soil for pre-emergence herbicides.
7. Ensure adequate wetting during spraying for proper dosage to kill weeds.
8. Correct timing of pre-emergemence herbicides.
9. The spray equipment should be in a good working condition.

10. Use clean water for mixing the herbicides.
11. Do not use expired herbicides for effective killing of weeds.
12. Use of correct herbicides for the intended purpose to ensure faster action of the chemical.

FACTORS INFLUENCING THE CHOICE OF HERBICIDES:

1. Climatic factors e..g wind, temperature.
2. Costs of the herbicides.
3. Methods of application of the herbicides.
4. Methods of crop propagation and management.
5. Stages of crop and weed growth.
6. Type of crop in which weeds are to be controlled.
7. Weed species present in the field.

ADAVNTAGES OF USING HERBICIDDES:

1. Requires less labour than mechanical cultivation.
2. Adapted to control notorious/bothersome weeds eg. couch grass
3. Does not disturb crop roots and underground structures.
4. Makes control of weeds in certain crops easier eg. wheat, barley
5. Efficient in both wet and dry soil conditions as compared to mechanical cultivation.
6. Maintains soil structure.
7. Cheaper than mechanical means on large scale farming.
8. It is a quick method of weed control.
9. It is suitable for crops with difficult morphology like sisal
10. Reduces the number of tillage hence, controlling soil erosion.

DISADVANTAGES OF USING HERBICIDES

1. Requires skilled labour in mixing and application.
2. Poisonous to the environment and the user.
3. It is uneconomical/expensive in small scale farming.
4. May not be locally available.

SAFETY PRECAUTIONS IN THE USE OF AGRO-CHEMICALS.

1. Carefully read and follow manufacturer's instructions.
2. Wear protective clothings like overalls, breathing masks, gloves and boots.
3. Bath thoroughly after handling the chemicals.
4. Do not unblock nozzles by blowing with the mouth.
5. Avoid spraying against wind/ don't spray on a windy day.
6. Dispose off empty containers and left overs eg. by burying them.
7. Do not wash spraying equipment in water sources used by livestock and humans.
8. Store chemicals out of reach of children and away from food.
9. Never smoke or eat while while spraying.
10. Keep finger nails short and clean.
11. Clean the spraying equipment thoroughly before and after use.
12. Check the sprayers for proper performance eg. trigger valves and nozzles for leaks.

CROP PESTS:

Definitions::

A crop pest refers to any organism that is harmful or destructive to plants.

Their effects may be seen directly by damaging the plant or indirectly through introduction of disease causing organisms.

CATEGORIES OF PESTS:

Pest are drawn from a wide range of organisms.

Most important crop pests include; insects, mites, nematodes, rodents, birds, fungi, bacteria, and viruses.

However, of the above, insects are the most commonly identified pests of major crops i.e. they are more successful than others.

CLASSIFICATION OF PESTS:

1). According to the nature of the mouth parts:

a). **Biting and chewing pests;**

These have their mouth parts modified into mandibles.

They bite and chew succulent or less fibrous plant parts eg. leaves, stems, fruits.

They also create tunnels into plant parts and produce.

Examples include; termites, grass hoppers, locust, rodents, crickets, caterpillars, e.t.c.

b). **Piercing and sucking pests;**

These have their mouth parts modified into proboscis.

They pierce through and withdraw juices from plant parts like leaves, fruits, stems causing withering.

They spread disease causing organisms from infected to uninfected plants through saliva.

Examples include; mealybugs, white flies, aphids, adult butter flies e.t.c.

2). According to the time of attack/where damage takes place:

a).**Field pests;**

These attack the crops while still in the garden.

Examples include; mites, nematodes, birds, rodents.

Damages Caused By Field Pests:

1. They attack roots, reducing water and nutrient uptake.
2. Cause tattering of leaves.
3. Cause wilting of crops.
4. They cause defoliation (i.e loss of leaves), reducing photosynthetic area.
5. Introduce toxic saliva that injure crops eg. nematodes.
6. Premature fall of fruits eg. fruit flies.
7. Eat leaves reducing quantity of produce.
8. Introduce disease causing organisms.
9. Tunneling of stems eg. maize stalk borer.

b). **Storage Pests:**

These attack and destroy crop produce while in the stores.

Examples include; maize weevil, bean bruchid, rodents, angoumois grain moths e.t.c.

Damages Caused By Storage Pests:

1. Introduce bad smell on produce.
2. Bore holes into seeds, reducing viability.
3. Cause a change in taste of produce, by mixing produce with excreta.
4. Discolouration of produce/tainting produce.
5. Eat produce, reducing quantity.
6. Loss of nutritional value, by eating contents.
7. Lumping of produce, making processing difficult.
8. They mix with produce, lowering quality.

HOW CROP LOSSES DURING STORAGE CAN BE CONTROLLED:

1. Avoid mixing of new and old produce.
2. Proper drying of produce before storage to reduce moisture content.

3. Cleaning and disinfecting the store to reducing hiding grounds.
4. Keep the stores rain proof, to reduce moisture in the store.
5. Proper ventilation, to reduce humidity.
6. Sealing off cracks to prevent entry by pests.
7. Seed dressing with chemicals before storage.

REASONS FOR DRYING CROPS BEFORE STORAGE:

1. Controls seed borne diseases.
2. Meets market requirement.
3. Preserves seed viability.
4. Prevents germination in store.
5. Maintains quality.
6. Reduces total weight.
7. Reduces decay or rotting.
8. Reduces pests damage in stores.

REASONS FOR THE SUCCESS OF INSECTS AS CROP PESTS:

1. High rates of multiplication; due to high fertility rates.
2. Small sizes; for hiding from predators.
3. Possesion of wings; for flight allowing dispersal over a wide area.
4. Possesion of legs; for movement on land.
5. Dormant stages; that allow survival during food shortage.
6. Possesion of waxy cuticle; prevents desiccation in terrestrial environment.
7. Dull colours; for camouflage in presence of predators.

METHODS OF PESTS CONTROL:

1). CULTURAL METHODS;

1. Weed control; to destroy alternate hosts for pests eg. in control of aphids.
2. Use of clean tools and equipment; to prevent the spread of pests.
3. Use of clean planting materials; to prevent the spread of pests and ensure a healthy start of the crops.
4. Trap cropping; to reduce the population of the pests.
5. Here, a trap crop is planted early t attract pests and then destroyed together with pests eg. in bean leaf beetles.
6. Timely planting; to give the crops an early start before the build up of pests. Planting early avoids infestation and damage because the plant is beyond the vulnerable stage.
7. Timely harvesting; the harvesting dates of some crops can be altered to reduce or avoid potential pests damage.
8. Proper tillage; to expose pests to harsh conditions.
9. Proper spacing of crops; too control movement and attack by pests eg. in ground nuts to control aphids.
10. Proper pruning; to discourage favourable micro-climate leading to reduced build up of pests.
11. Proper drying of produce; to give the produce resistance against pests attack.
12. Mulching; reduces the movement of pests eg. banana weevils and improves soil conditions for proper growth of crops.
13. Flooding; to suffocate the pests to death.
14. Growing resistant varieties; to reduce the chances of pests damage on crops and crop produce.
15. Manuring; to discourage some pests eg. eel worms before their attack on crops.
16. Closed seasoning; to deny the pests hosts to survive on hence, starvation to death.
17. Crop rotation; to destroy or break the life cycle of pests on the field.
18. Field hygiene; which involves destruction of all crop residues from the previous

planting to deny the pests hide outs.

2). CHEMICAL METHOD;

This involves dusting, spraying or fumigating a crop or crop produce with a substance specifically harmful to that particular organism.

A pesticide is therefore, a chemical used to control, repel, attract or kill pests.

Examples of common pesticides include; Aldrine, DDT, Lindane dust, Malathion dust, Rogor e.t.c.

MODE OF ACTION OF PESTICIDES:

a). Destruction By Ingestion;

Here, stomach poisons must be eaten by the target organisms.

It is selective in the sense that, it only kills those organisms that consume it. eg. Di-eldrine, Flourine, Lead arsenate.

b). Destruction By Contact;

These include broad spectrum pesticides that kill any organisms that come into contact with them.

They are absorbed through the skin or cuticle of the pests.

They can be sprayed directly on the pests or on the foliage of the crop at risk.

c). Destruction By Suffocation;

These act by interfering with respiration and are applied as fumigants. eg. methyl -bromide.

CHARACTERISTICS OF A GOOD PESTICIDE:

1. Should not be harmful to man and the livestock.
2. Should be non-toxic to the environment.
3. Non-toxic to useful organisms.
4. Should have a long term residual effect to reduce rates of application.
5. Should not have residual effects on crops.

6. Highly poisonous to the target organisms.
7. Readily available.
8. Affordable to most farmers.
9. Require least possible skills to apply.

PRECAUTIONS WHEN HANDLING & APPLYING PESTICIDES:

1. All equipment used in spraying pesticides should be thoroughly washed before and after use.
2. Allow correct time lag between spraying and harvesting of produce for consumption.
3. Empty containers of pesticides should be burnt.
4. Wear protective clothing when applying pesticides for protection against spray wash.
5. In case the pesticide is taken in by mistake, seek medication immediately.
6. Keep all records of pesticides application fr effectiveness.
7. Do not eat, drink or smoke while spraying to avoid inhaling the pesticides.
8. Do not blow blocked nozzles with mouth to avoid taking in chemicals.
9. Spray facing the direction of wind.
10. Read and carefully follow manufacturer's instructions.
11. Avoid rainy conditions to ensure correct concentrations.
12. Ensure proper mixing of the pesticides for effectiveness.

ADVANTAGES OF CHEMICAL PESTS CONTROL:

- ❖ It is less laborious i.e. its an easy method to use.
- ❖ It is a quick method of pests control.
- ❖ May have a broad spectrum action i.e. killing even complex pests.
- ❖ It is more predictable compared to biological methods.

- ❖ Relatively cheaper on large scale production.

DIADVANTAGES OF CHEMICAL METHODS:

- ❖ Expensive to buy chemicals especially for small scale use.
- ❖ Application requires skills.
- ❖ Some pests may develop resistance (the residual population).
- ❖ May be toxic to the environment.

3). PHYSICAL/MECHANICAL METHODS:

It involves using barriers, traps, or any physical means to prevent or reduce pests problems.

Mechanical control methods can be rapid and effective but are mostly suited to small, acute pest problems.

MEHTODS OF MECHANICAL PESTS CONTROL:

1. Air suffocation; to encourage build up of carbon dioxide which inhibits pests multiplication or survival leading to death of pests.
2. Creation of physical barriers; eg. rat guards on post of granaries prevent rats from climbing into the stores.
3. Hand picking and killing; to destroy the pests hence, reducing their population. Special traps may be used here.
4. Use of explosives; to scare away birds causing them to migrate or die.
5. Use of lethal temperature; involves application of extremes of temperature i.e too high or too low to control pests development.
6. Scare crows; these are human figure-like objects set to scare away birds and other animals from crop fields.

4). BIOLOGICAL METHODS:

This is the deliberate use of a living agent or natural enemy or predator to control pests.

The control agents can either control the pests by feeding on them eg.

Lady bugs on aphids, or by causing fatal diseases to the pests eg. virus sprays on army worm caterpillars.

WAYS OF USING NATURAL ENEMIES;

1). Importation/Classical;

Involves control of insect pests using introduced natural enemies.

2). Augmentation;

Is the mass culturing and periodic release of natural enemies.

3). Conservation;

Is the enhancement of numbers of already existing natural enemies.

FACTORS THAT AFFECT THE EFFECTIVENESS OF A BIOLOGICAL AGENT:

a. Age of the agent.
b. Level of training offered to the agent.
c. Adaptability of the agent to the conditions of the environment.
d. Population of the agent in relation to that of the pests.
e. Type of pests in question.
f. Rate of multiplication of the pests and the agent.
g. Searching ability of the agent.

CHARACTERISTICS OF A GOOD BIO-CONTROL AGENT:

1. Should adapt to a wide range of environmental conditions.
2. Have a faster growth rate i.e early maturing.
3. Easy to eradicate should need arise.
4. Should be specific in action.
5. Easily accessible.

6. High reproductive potential, to multiply in a short time.
7. Should be environmentally friendly.
8. Should have a narrow host range.
9. Should have efficient search ability.

ADVANTAGES OF BIOLOGICAL PEST CONTROL:

- ★ It is cheaper to use.
- ★ Requires little attention by the farmer.
- ★ It is environmentally friendly.
- ★ Not harmful to non-target organisms.
- ★ Development of resistance by pests is unlikely.

DISADVANTAGES:

- o May not be locally available.
- o Effects are unpredictable i.e. farmer has no control over the agent.
- o Level of pests control may not be sufficient.
- o Requires a lot of research which may be expensive.
- o The method is slow i.e may not save the crops faster.

5). INTEGRATED PESTS MANAGEMENT (IPM):

This is the combination of all effective, economical and environmentally friendly pests control methods into a single but flexible approach to managing pests.

It gives priority to non chemical methods first and resorts to chemical means when all the other methods have failed.

ADVANTAGES OF IPM:

- ✓ Environmentally friendly since it reduces pesticide use.
- ✓ Reduces hazards to agricultural labour.
- ✓ Easy to adopt i.e. simple method.

LIMITATIONS TO IPM:

- o It is difficult to come up with standard combination of methods.
- o Less knowledge of farmers on IPM.
- o Reluctance of farmers in adopting IPM strategies.
- o Requires clear understanding of pest ecology and agro-ecosystem.

CROP DISEASES:

A disease may be defined in any of the following ways;

i). It is a harmful physiological disorder on a plant.

ii). It is any abnormal condition that damages a plant and reduces its productivity or usefulness to man.

iii). It is a condition that interferes with, impairs or disturbs the normal performance of a plant.

iv). It is a deviation from good health resulting into poor performance of a plant.

GENERAL SYMPTOMS OF CROP DISEASES:

1. Chlorosis i.e. yellowing of leaves due to chlorophyll degradation or failure in its formation.
2. Rotting of roots or rooting systems.
3. Rotting of storage organs.
4. Sunken lesions on the stems.
5. Stunted growth of the plant or plant organs (Hypoplasia).
6. Excessive growth of the plant pr plant parts (Hyperplasia).
7. Swelling of plant organs (Hypertrophy).
8. Wilting i.e. partial drying of the plant.
9. Excessive gum formation on trees.
10. Spots/patches on the leaves, flowers and fruits.
11. Mottling of leaves.
12. Curling of leaves.
13. Reduced internode.
14. Low yield of plants.
15. Yellow strips on the leaves, along the mid ribs/veins.

CLASSIFICATION OF PLANT DISEASES:

Plant diseases can be classified in many different ways, however, the most important one is based on the causal organisms thus;

i). Fungal diseases.

ii). Viral diseases.

iii). Bacterial diseases.

iv). Deficiency/Nutritional diseases.

REASONS WHY FUNGAL DISEASES ARE DIFFICULT TO CONTROL:

(XTICS WHICH HAVE CONTRIBUTED TO THE SUCCESS OF FUNGI AS PLANT PATHOGENS):

1. They have a high reproductive rate; producing several spores for rapid multiplication.
2. Have perenating structures for survival.
3. They produce resistant spores allowing continuity of the species.
4. Several species exist making them hard to control.
5. Few people have knowledge on control of fungal pathogens, allowing their survival.
6. chemicals for their control are expensive.
7. Exhibit greater diversity in form of formation and habitats thus, hard to control.
8. They have a wide host range, surviving from season to season.

ECONOMIC IMPORTANCE OF FUNGI:

1. They cause a majority of known plant diseases.
2. They cause some diseases of man.
3. They act as food for human beings e.g. mushrooms.
4. Some of them are very poisonous to man and his livestock e.g. causing irreversible loss of appetite.
5. They are employed in commercial preparation of some vitamins.
6. Employed in production of organic acids.

HOW DISEAESES SPREAD FROM ONE PLANT TO ANOTHER:

1. By contact of animals containing pathogens to plants.

2. By contact of plants to plants i.e. infected plants to a healthy one.
3. Through infected planting materials such as seeds, cuttings.
4. Through irrigation water.
5. Rain splash that may carry fungal spores from infected to healthy plants.
6. Sucking pests like Aphids from infected G'nuts to healthy ones.
7. Through crop residues allowing survival of pathogens.
8. Organic manure e.g. compost that contains pathogens.
9. Mulching materials.
10. Through weeds; hosting vectors or pathogens of crop diseases.
11. Through wind in form of air currents that spread fungal spores.
12. Use of infected implements e.g. tillage implements.

HOW CROP DISEASES ARE CONTROLLED:

a). CULTURAL METHODS;

1. Crop rotation; to break the life-cycle of disease pathogens and prevent the build up of diseases on the farm.
2. Use of healthy planting materials, that are free from pathogens.
3. Planting tolerant or disease resistant varieties which can withstand disease attack.
4. Weeding to remove plants that may be alternative hosts of the disease causing organisms.
5. Proper drainage of the soil, to prevent water borne diseases.
6. Removal and burning of diseased plants, to avoid spread of pathogens.
7. Timely planting of crops, to escape disease build up.
8. Practicing closed season, in order to starve the disease causing organisms to death.

9. Pruning, to reduce the micro-climate for microorganisms which spread diseases.
10. Close spacing; to create a micro-climate for micro organisms which spread diseases e.g G'nut rosette hence, minimizing their spread.
11. Use of disinfected tools; to prevent the spread of some diseases.
12. Soil sterilisation by heat treatment; to destroy spores of fungi.
13. Timely harvesting of crops; to escape attack by pathogens that emerge later in the rainy season.
14. Proper storage of crop produce; to minimise mould attack on seeds.
15. Timely seedbed preparation; to expose the pathogens to harsh environmental conditions.
16. Irrigation/flooding of crop fields; to suffocate the pathogens.
17. Field hygiene by burning of crop residues; to kill pathogens.
18. Proper drying of crop produce before storage; to prevent mould attack.
19. Destruction of volunteer crops; that may be a source of infection.
20. Manuring; to increase the rate of crop growth for resistance against diseases.

b). CHEMICAL METHODS:

Seed dressing with chemicals to destroy the pathogens.

chemical soil sterilization to destroy the pathogens.

Spraying with chemicals against the pathogens.

c). LEGISLATIVE MEASURES:

By imposing quarantine to resist the movement of planting materials or crop produce from the affected areas.

d). BIOLOGICAL METHODS:

By using a living agent (bio-control agent) against the pathogens or vectors.

e). INTEGRATED DISEASE MANAGEMENT:

Involves combining all the other methods of disease control while giving priority to non-chemical methods.

REVISION/GUIDING QUESTIONS

1 a). Define the term weeds.

b). State the benefits and harmful effects of weeds.

2 a). How would you classify weeds?

b). Discuss the various methods of weed control including their advantages and disadvantages.

c). Discuss the factors affecting herbicide selectivity and effectiveness.

3 a). What are storage pests?

b). Describe the damages caused by storage pests.

c). What are the features that contribute to pests persistence?

4 a). What is a disease?

b). Discuss the general symptoms of crop diseases.

c). How does a disease spread in crops?

d). Discuss the various methods of disease control.

5 a). State the factors that you would consider before adopting a pest control method.

b). Discuss the various pests control measures.

c).Define IPM and discuss the elements of IPM.

6 a). What are the advantages of growing mushrooms compared to other crops?

b). Describe the procedure of raising oyster mushrooms indoor as a high value crop.

7 a). Expalin the considerations made when choosing the species of mushrooms to be grown on the farm.

b). Describe the post-harvest handling practices for pepper to maintain its quality.

8 a). Discuss the agronomic practices involved in raising passion fruits up to harvesting.

b). What conditions may lower the market value of passion fruits after harvesting?

9 a). Define the following terms as used in crop improvement;

i). Germplasm.

ii). Cultivar.

iii). Land race.

iv). Hybrid vigour.

b). Explain the procedure of conducting mass selection in crop breeding.

c). Describe the problems associated with crop introduction as a method of crop improvement.

10 a). What are the reasons for carrying out crop improvement by crop breeders?

b). Explain why most polyploids are sterile.

c). What are the benefits of using genetically modified organisms?

d). Why have farmers resisted the adoption of genetic engineering and genetically modified organisms in Uganda?

THE END

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