**SUSTAINSABLE AGRICULTURE**

**Importance of sustainable agriculture.**

* Sustainable agriculture reduces certain harmful effects on the environment that can pollute it.
* Sustainable agriculture preserves the natural ecosystem which results into healthy produce.
* Sustainable agriculture reduces on the frequent use of chemicals and fertilizers.
* It promotes the culture of raising the animals through feeding on natural feeds.
* There is better protection of animal species through creating a natural balance in the ecosystem.
* Sustainable agriculture maintains the quality of soil, reduces soil degradation and erosion and some of soil water.
* Sustainable agriculture increases bio diversity of the area by providing a variety of organisms with healthy and natural environments to live in.
* Sustainable agriculture enables production of healthy food to human and animals.
* Through reducing on the rate of filling the soil, there is less carbon emitted to the atmosphere and can store carbon stably in the soil.

**Goals of sustainable agriculture**

Sustainable agriculture must nurture healthy ecosystem and support sustainable management of land, water and natural resources while ensuring world food security.

Sustainable agriculture must meet the needs of present and future generations for its products and services while ensuring profitability, environmental health and social equity

Sustainable agriculture must ensure efficiency improvements of resources use, environmental protection and in system resilience.

**Principles of sustainable agriculture.**

1. Improving efficiency in the use of resources is crucial to sustainable agriculture.
2. Sustainability requires direct action to conserve, protect and enhance natural resources.
3. Agriculture that fails to protect and improve rural livelihood and social well being is un sustainable.
4. Sustainable agriculture must enhance the resilience of people communities and ecosystem especially to climate change and market volatility.
5. Good governance is essential for the sustainability of both the natural and human systems.

**Characteristics of sustainable agriculture.**

To meet human needs with a safe, high quality and affordable supply of food and fibre.

To provide access for everyone to nutritious, healthful and affordable food, while ensuring a safe and secure supply of food.

To produce quality food while preserving open space, abundant wild life and other foods of bio diversity.

It protects the natural resource base and prevents degradation of air, soil and water quality, while using natural biological cycles and controls.

It protects environment and promotes environmental stewardship including conserving and improving soil quality, reducing dependence on non renewable resources and synthetic fertilizers and pesticides.

Offer dignified livelihoods and living wages of all workers in the farm and food sector.

Build more independent farmers and ranchers producing agricultural products while ensuring profitable farm income.

Ensuring economic survival of farming and the well being of farmers, their families and communities.

Ensure wide spread stable, good living, prosperous farm families and communities.

Construct more cohesive communities connected through sustainable agricultural production and processing and distribution system based on far and open markets.

**CLASSIFICATION OF SOIL AND WATER CONSERVATION MEASURES**.

There are three major categories

1. Agronomical/ biological measures.
2. Mechanical measures.
3. Soil management measures and vegetative measures.

**AGRONOMICAL/ BIOLOGICAL MEASURES**.

1. Use of cover crops
2. Crop rotation
3. Inter planting
4. Mulching.

**MECHANICAL MEASURES.**

1. Terracing
2. Contour ploughing
3. Construction of binds.

Vegetative measures

Vegetative strips: e g acacia lime at the foot of

1. Protective bush land
2. Natural drainage way protected by permanent grass cover
3. Reforestation.

**SOIL EROSION.**

Eroding agents and factors that influence their ability to erode.

Factors of soil erosion are classified according to the mode of action as follows.

1. Energy group. Potential ability of an eroding agent to cause erosion.

This will depend on the following;

1. Rain intensity in case of rain.
2. Wind velocity in a case of wind
3. The degree of slope(gradient)
4. Volume of agent etc

These provide power of the eroding agent which we call the erossivity of the eroding agent.

1. The resistance group.

This involves how easily can the soil be eroded which we shall call the erodibility.

This will depend on some factors e g physical properties of the soil like structure, weight etc as well as chemical properties.

1. Protection group.

This is the degree of vegetative/plant cover in an area. The more the area is heavily covered, the less are the chances for erosion to take place.

**PHASES OF SOIL EROSION.**

Detachment phase.

This is when the soil particles are dislodged from their position. Detachment agent can include rain splash, poor tillage practices, moving animals, earth quakes.

Transportation phase.

This is where soil particles are moved from one place to another.

Deposition phase.

This is where the eroding agent losses the force and the materials being carried do settle.

**CLASSIFICATION OF SEVERITY OF EROSION**.

This is done depending on the rate of transportation, where the eroding agent has the potential to detach than to transport. We say that the erosion is transport limited. The outer way sand if it is able to transport than detaching we say it is detachment limited and however if the erosioding agent has bout we say it is severe.

The knowledge of transport and detachment helps the farmers to determine the measures to apply.

**ENERGY FOR EROSION**.

They are provided in two forms;

1. Potential energy.
2. Kinetic energy.

**POTENTIAL ENERGY.**

Potential energy of an eroding agent is provided through a difference in elevation between two places (the steeper the elevation, the higher the greater chances of erosion).

**KINETIC ENERGY.**

This is the actual transportation energy of the agent. It will depend on the velocity of the eroding agent.

**MECHANISM OF EROSION.**

1. **RAIN SPLASH EROSION**.

This is the beginning of the erosional process and every important mechanism of soil erosion; dislodges the soil particles, displaces soil particles, damages soil structure, it generates surface run off giving chances for other severe erosion mechanism.

1. **SHEET EROSION**

This is a process where thin layers of soil are moved over an extended surface. It is not easily noticeable by the time; it is noticed bigger amounts of soils will be taken.

1. **RILL EROSION.**

This is where surface run off takes away some soils forming channels of transportation. These channels represent concentration of surface run offs.

As the volume of water gets bigger, the channels also get wider and deeper. Tillage practices can control this.

1. **GULLEY REOSION**.

Bigger channels. Bigger volumes of surface run off are involved if not controlled they can cut up the land rendering unproductive and un passable especially for farm machinery and animals. To control this evaporate measures are required.

1. **SUB SURFACE EROSION**.

This is the movement of water under surface and its said to contribute 1% of the total materials eroded from an area. It destroys the soil structure and chemical combination of the soil.

1. **WIND EROSION.**

For this to occur, certain conditions must be prevailing;

1. There must be an extended area with nos vegetation cover
2. Soil must be dry
3. Soil surface must be Soult
4. Wind velocity (strong enough to remove the soil particles).

**METHODS OF SOIL AND WATER CONSERVATION.**

**MULCHING.**

This is the covering of the top of the soil with dry materials to check the speed of water and maintain soil moisture.

Common materials include;

* Dry grass
* Wood shavings
* Pebbles
* Polythene papers
* Coffee husks

**HOW MULCHES CONSERVE**;

* It improves infiltration and reduces surface run off.
* It provides rough surface thus reduces surface run off.
* It reduces wind velocity since the ground is covered. The chances of wind pick soil surface is less.
* Mulches check its growth of weeds by suppressing weeds that would take some of the nutrients.
* Mulches prevent direct heating of sun rays (isolation) hence evaporation is reduced.
* Mulches sometimes under go decay provides organic matter that bind together soil particles hence reduces the chances of soil erosion agents to affect soil.

**STRIP CROPPING.**

This is the growing of crops in alternating strips aligned on the contour or perpendicular to the direction of wind. The soil removed from its surface of on raw is trapped to the next strip down the slope or down the wind direction.

The strips designed vary depending on erosion hazards. On the steep slopes (with a high erodibility) one may need some better strips (a strip of permanent vegetation which may be pressed 10-20 meters interval).

**ADVANTAGES OF STRIP CROPPING.**

1. It reduces the length of slope that is exposed to erosion
2. The alternating crop strips of different types of crops trap materials that are brown from one strip to another e g through wind.
3. The different types of strips with different types of strips with different types of crops e g the cover crops assist and increase the rate of infiltration which reduces the chances of surface run offs.

**DISADVANTAGES OF STRIP CROPPING.**

1. To work effectively, the strip must be small and this may limit the use of machinery.
2. It reduces surface area. Sometimes these permanent strips may act as breeding places for pests and diseases.

**VEGETATIVE STRIPS**.

They hold the surface run off and also act as the depositional materials.

**WIND RAWS.**

These are rows of plant residues planted across the slope. They protect against wind, water run offs especially to young plants immediately after germination.

**DISADVANTAGES.**

1. They harbor pests
2. They sometimes change into weeds
3. They require labour
4. They harbor disease causing organisms

**CROP ROTATION.**

This is the growing of different crops on the same piece of land in an orderly sequence or different seasons. These crops offer different protection to the ground and at the same time they have different nutrients requirements that their demands are different.

The different crops grow, it will require different management e, g weeding.

**MULTIPLE CROPPING.**

This is the growing of one or several crops at different times in a given area. The number of times the plants or crops are grown is more than expected (increasing) the number of times you plant a crop in a year

.

This brings up a risk of loosing the soil fertility as well as damaging soil structure.

Solutions

* Addition of manure
* Use of crop rotation
* Application of fertilizers

**DANSITY CROPPING**

This is where seeding rate of particular crop is increased.

ADVANTAGE

It increases the protection of the soil as well as it increases the surface run off and increases filtration.

Show how the use of cover crops can be justified as a conservative measure?

**COVER CROPS**

These are crops which are grown on the surface of the soil purposely to cover the ground from the soil agents; should be leafy, should be able to establish quickly, should not grow grow solo, should have deeper roots to resist erosional agents, should not compete with crops, should decompose quickly, examples include pumpkins, beans, peas.

ADVANTAGES OF COVER CROPS.

* They control erosion through reducing the surface run off by checking surface run off.
* Improve water infiltration
* Improve soil structure by holding soil particles together
* The high trees with large leaves do collect rain drops forming large rain drops which if they hit the ground, their effect may cause a soil structure damage and later easily eroded. The presence of cover crops controls it.
* Since the cover crops must be first growing plants they provide quick coverage on the ground which some other plants cannot.
* They help in nutrient recycling as they retain the nutrients that would be leached or eashed away. LIMITATIONS OF COVER CROPS.
* Since most of crops are food crops, it is difficult to convince the farmers to plough them into the soil as they always feel using them.
* It is expensive in terms of buying the seeds like beans.
* It is difficult during harvesting especially in the field of coffee being grown with beans where coffee grows faster than beans.
* These cover crops compete with other grown crops hence poor performance of grown crops.
* There is a risk of not attainment of sufficient ground cover by the cover crops. This may be due to main crop changing the conditions on the ground (shading effect)
* They may not be economic as they involve spending and yet are not to be eaten or sold.

**AGRO FORESTRY.**

This is a practice in agriculture where we encomperate tree growing process e g trees grown annual crops. Trees can be planted in various ways e g;

1. Trees forming alternate rows with crops.
2. Can be planted along contour binds making a mechanical measure
3. Planted trees or terraces

ADVANTAGES.

* Trees can serve as wind breakers.
* They provide shades to bout crops, animals and farmers.
* These trees sometimes act as boundaries to demarcate different plots.
* They help in nutrient recycling.
* Sometimes trees like calyindra have root nodules which contain some bacteria that fixes nitrogen in soil.
* Sometimes act as fodder to the animals. The trees help to stabilize hydrogical recycle of a place.
* They provide timber

They can provide firewood. **CONSERVATION TILLAGE.**

Definition of conservation tillage is the traditional method of farming in which soil is prepared for planting by completely inverting it with a tractor –pulled plough.

Conservation tillage involves planting and harvesting of crops with limited disturbance to the soil surface .Tillage of the soil stimulates microbial soil decomposition of o.m which results in erosion of c02 to the atmosphere .Therefore minimizing tillage promotes sequestration or carbon in the soil.

In the mid west erosion by water is the primary concern ,where as western regions of the country are more susceptible to wind erosion.

Soil erosion removes the productive layer of the top soil reducing crop yields and land value.Soil removed from fields eventually endsup as sedments in dtreams ,rivers or lakes .Sedments collects in surface waters,reducing their water holding capacity.Some crop nutrients and pesticides attach to soil particles and are carried and deposited in water ways along with the soil.

Factors affecting soil erosion by water erosion include;

Rainfall patterns

Erodibility of soil

Slope length and height

Soil cover

Cropping patterns and management.

Conventional tillage machines Such as mould board ploughing,leaves the soil surface bore and loosen the soil particles ,making the susceptible to the erosive forces of wind and water .Conservation tillage practices reduce erosion by protecting the soil surface and allowing water to infiltrate instead of running off.

Conservation tillage practices are grouped into three types.

(Zero tillage)no-till,ridge-till,and mulch-till.keep in mind that no one conservation tillage method is best for all fields .Decisions should based on the severity of the erosion problems ,soil type ,crop rotation.altitude ,available equipment and management skills .

Before adopting a conservation tillage system,first seek advise from:-

* Near by farmers who are successfully practicing conservation tillage.
* Seed ,chemical and other agro business dealers with experience in serving the needs of the conservation tillage.
* Representatives from year local soil and water conservation district ,natural resources conservation services.
* No –till.

No- till leaves soil un disturbed from the harvest to planting .Zero tillage involves planting crops directly into residue .Planting is done in a narrow that hasn’t been tilled at all zero tillage crops are planted with minimum disturb (usually 6 inches or less) seed bed or slot created by once to the soil by planting the seed in un ploughed field with no other land preparation coulters ,row cleaners ,disk openers ,In row chisels,or rote –tillers .A press –wheel follows to provide firm soil –seed contact.

No –till planting can be done successfully in chemically –tilled soil.In crop residues from the previous year ,or when double –cropping after a small grovin.Herbicides are the primary method of seed control ,although cultivation may be used for the emergency weed control.

* Ridge till

This involves planting into a seed bed prepared on ridges with sweeps ,disk ,disk openers ,coulters or row cleaners .The ridge are rebuilt during cultivation .

Ridge –till works best on nearly level ,poorly drained soils.The ridges speed up drainage and soil warm –up .

Cultivation controls weeds along with some herbicides b.

Ridge –till system leaves residues on surface between ridges.

* Mulch –till

Mulch –till uses chisel plows ,field cultivation ,disk,sweeps,or blades to till the soil before planting .The till does not invert the soil but leaves it rough and chidely.Herbic ides and /or cultivation controls weeds in a multh –till system .The effectiveness of mulch –till systems in reducing erosion depends on surface roughness ,amount of residue and tillage dircteion.

* Strip –tillage.

This involves tilling the soil only in narrow strips with the rest of the field left un tilled.

CONSERVATION TILLAGE PRINCIPLES

1. Market reduction in tillage.

The objective is the application of zero tillage or controlled tillage seeding systems that normally do not disturb more than 20-25% of the soil surface.

Zero till seeding may be a desired objective where practicable ,however in the other sytems some type of soil movement may be sytems some type of soil movement may be necessary for example under gravity –fed Irrigated conditions,a per moment raised –bed system with furrow Irrigation may be more suitable and sustainable than a reduced or zero tillage system on “the flat”to replace widely used conventionary tilled system of flood irrigation on flat land ,permanent raised beds are not tilled but only reshaped as weeded between crop cycles.One to four rows are planted on top of the bed depending on bed width and crop .

1. Rentention of adequate levels of crop residues on the soil.

The objective is the retention of sufficient residue on soil surface to protect the soil from water/wind erosion ,Water run-off and evaporation to improve water productivity and to enhance soil physical ,chemical and biological properties associated with long term sustainable productivity.

3.Use of sensible productivity.

The objective is to employ economically unable ,diversified crop rotations to help modate possible weed ,disease and pest problems ,enhance soil biodiversity ,take advantage of biological nitrogen fixation and other soil enhancing properties.

Factors favouring Conservation tillage.

Financial favouring conservation tillage .Versus conventional practices.

It is assumed that conventional tillage is that is more profitable in sleep –sloping ,high rainfall tropical regions for example latin America than in flatter temperate areas for example Canada ,united states since the former would be subject to a higher risk of erosion under conventional tillage.

Machinery and fuel cost.

This is the most important cost item for larger produces so the impact of conventional tillage on these expenditure items is critical .Most analyses suggest that conventional agriculture reduces machinery cost.Zero or minimum tillage means that farmers can use a smaller tractor and make fewer passes over the field .This also results in lower fuel and repair costs.

Pesticide costs.

Off setting lower machinery costs are higher herbicide application under conventional agriculture especially during early adoption period and with no –tillage .Indeed ,herbicides substitute for the use of machinery to keep weeds under control .Site –specific factors are important as permial weeds can present problems of conventional agriculture.

Labour costs.

Much attention has focused on the apparent reduction in labour requirements under C.A .This reduction follows from decreased demand for labour for land preparation at the beginning of growing season.

The economics of conservation agriculture .

Forms in the developed world the impact of this saving is small as labour costs account for under 10 per cent of total per acre cost.However on some firms in the developed world ,the trend towards increased off-form work has made even the relatively small labour saving under C.A attractive.

Fertilizen and other input costs.

Most comparative analysis of the cost of conventional tillage versus conservation tillage assume that other production inputs remain unchanged following a switch to C.A .There is evidence that ,C.A adoption affects nitrogen use by crops and leaching.

Rising land pressure tends to increase the attractiveness of C.A relative to bush fallowing.

Advantages of Conservation tillage.

1. It increases the ability of the soil to store carbon (sequester) while simultaneously enriching the soil.
2. It improves soil water infiltration there by reducing erosion and nitrate run off.
3. Improves the stabilization of soil surface to wind erosion and the release of dust and other air borne particles.
4. Reduces leaching of nutrients due to greater amounts of soil organic matter to provide binding sites .
5. Decrease evaporation and increase yields in drought years.
6. Reduces the number of passages of equipment across the field ,there by reducing the cost of fossil fuel and associated carbon emission to the atmosphere .
7. Reduces the loss of pesticides and other applied chemicals .This is because higher infiltration rates with more surface residues results in less run off moisture holding capacity due to higher soil organic matter that results in less leaching.

**Disadvantages of conservation tillage.**

1. Adoption of reduced tillage in humid ,cool soils would primarily affect the distribution of SOC in the profile ,unless carbon inputs were increased .
2. Specialized ,expensive equipment is required or much hard labour incase of very small scale growers .
3. Requires more herbicides than standard conventional practices to control weeds and other pest
4. Due to laSrge size of the original soil carbon pools, the contribution of conservation tillage can appear to be small and significant amount of time is required to detect changes.
5. Sizable amounts of non-c02 green loose gases (N02 and CH4) can be emitted under conservation tillage compared to the amount of carbon stored ,so that the benefits of conservation tillage in storing carbon can be out weighted by disadvantages from other green house emissions.

**How the technology contribute to socio-economic development and environmental protection.**

Less labour time and cost are required under a reduced tillage system due to fewer tillage trips and cultivation operation for seed bed preparation.

A large number of studies have estimated the potential fuel cost savings as a result of reducing tillage.

Generally reduced tillage systems have lower machinery repair and maintenance costs due to less use of tillage implements.

Zero tillage technology reduces costs of field preparation.

Zero tillage can save farmers around million lifies of water per hectare compared with conventional practices due to the mold on the soil surface which reduces evaporation.

Zero tillage increases soil carbon from 0.1 to 0.7 metric tones.

**AGRO-FORESTRY**

Agro forestry is a land use system in which woody perennials are deliberately grown or retained in association with agricultural crops and animals under the same land management unit either in space or in time or both in which there are interactions between the woody and non woody components of the system.

* Woody perennials-Trees and shrubs
* Trees are 7metres and above
* Shrubs are less than 7metres above
* Deliberately-intentionally
* In space-The way trees are arranged in that piece of land.
* In time-Either now or tomorrow or the other day at the same time or different times.
* Interactions are positive and negative. Interactions are both ecological and economical.

**AGRO-FORESTRY SYSTEMS**

A system in general is arrangement of a component in particular way to serve a purpose.

**COMPONENTS OF AGRO-FORESTRY SYSTEM**

The major components of agro-forestry systems are

The trees and shrubs (woody perennials)

Agricultural crops.

Live stock/pastures

Bees

Fish

Worms

**CLASSFICATION OF AGRO-FORESTRY SYSTEMS**

We have about five criteria for classification but the major ones are three

1. According to components

According to this criteria we have three major classes

Agro-silvo cultural system: This is a combination of trees growing together with agricultural crops. Example include

-**Improved furrow**. Improved fallow involves planting of nitrogen fixing leguminous trees/shrubs on poor soils which are often cut after a season or two when the trees/shrubs have attained maximum biomass. The trees and shrubs are then allowed to shed their leaves which together with their roots are dug and incorporated into the soil.

-**Shifting cultivation**

-**Alley farming (hedge rows inter cropping).**This is the growing of food crops between hedge rows of planted trees or shrubs.

-**Taungy farming**: Trees are grown but canopy is not continuous with crops. Farmers are given incentives and given seedlings to plant trees and crops and they leave when the canopy of trees can’t allow any more crop growing.

-.**Silvo-pastoral system**. This is integration of trees growing with either pasture or live stock on the same management unit e.g. apiculture (bee rearing), trees on range land, fodder banks.

-**. Agro silvo pastoral system**. This is the integration of tree growing; crops together with the live stock under the same management unit e.g. fodder trees that are growing on crop land, poultry in home garden.

2. According to structure

This is spatial arrangement of woody components and vertical stratification of the components and the temporal arrangement of components (how they are arranged in terms of time and space).

**According to space**

-**Mixed agro forestry system**. This is where we have trees scattered on crop land eg home garden.

**-Taungy farming**. Trees are grown but the canopy is not continuous eg low storey trees growing together with upper storey trees.

-**Zonal agricultural system**. Here trees are planted regularly eg boundary tree planting

-**Dense agro forestry system**. This is a system where trees are closely planted and canopy is continuous.

-**Single stratum system**. Which have one level of tree canopy system?

-**Multi strata system**. Here we have trees growing as different species. They grow at different canopy levels at different times eg home gardens

**According to time**

-**Rotational (sequential) system**. The interaction is not at the same time but under the same management unit e.g. shifting cultivation, improved furrows

-**Simultaneous agro forestry system**. We have an overlap of components which is either occasional or permanent. Interaction takes place at the same time e.g. we have trees growing together with animals’ home garden where trees are grown and animals are managed.

According to functional played by the components.

This deals with relationship between the inputs and the outputs especially in the woody components e.g. the functions of woody can be biological, economical, a service or a product from the woody perennials eg improved furrows system. Improved furrow is the alternative of the shifting cultivation.

The major purpose is the nutrient replacement. The product from the improved furrows is nitrogen fixation.

-Economic role

-Fertility is increased since the fertility of the soil is increased.

Fodder bank

4. According to the ecology

It deals with compatibility of the woody component to the environment.

The compatibility of course has to serve a purpose eg in drought areas, we find there drought resistant perennials.

5. According to social economic benefits

This focuses on how the system improves the welfare of the household in relation to the amount of inputs and management intensity considering the division of labor and benefits we have.

Under social economic benefits, we have

Commercial medium and substance system.

There will depend on management levels.

Importance of agro-forestry

**A.PRODUCTIVE FUNCTIONS**

-Supply of food. We have continuous population growth yet the land we are supposed to depend on is fixed and it is becoming scarce.

-Provision of shelter. We have increasing population demand for shelter is also increasing.

-Fuel supply. Other sources of fuel supply are un fordable and expensive to a poor person and therefore the best alternative is fuel from trees.

-Source of income e.g. growing trees for time, you can sell them to get income; animals can be sold to get income.

-Improved distribution of labor. Labor is evenly distributed over a given period of time. All the time people are doing different types of work eg planting trees and rearing animals.

**B.BIOLOGICAL DIVERSITY**

-Agro-forestry has a number of different plant species supporting animals of different plant species supporting animals of different animal species.

-They can also help to provide ecological resilience and contribute towards maintenance or restoration of ecological functions.

-They can link forest fragments and other critical habitants.

-It is used as land scape management strategy.

**C.PROTECTIVE FUNCTION**

Agro-forestry can contribute to maintain soil and water quality.

How agro-forestry provide protective functions

-Through soil fertility restoration and protection

-Reduction in micro climate extremes. It protects solar radiation from reaching the ground surface and at night the tree crown reduces heat loss.

-Reduction of wind erosion. Trees would reduce wind velocity hence reduce wind erosion.

-There are improved soil chemical, physical and biological characteristics. Where have trees we have increased soil aeration and reduced compaction due to presence of root of woody perennials.

There is potential reduction in soil erosion. Soil erosion risks are reduced by lowering Rain fall erosivity. Where there are trees, there is great liter on the ground which protects the soil from erosional agents.

**Water quality**

Agro-forestry reduces the rate at which pollutants rich water ie they trap all sediments and therefore slow down movement of run offs.

**D**. Reducing pressure from natural resources e.g. wet lands and forests.

**E.** Carbon storage and fixation. Agro-forestry is a key in fixing carbon dioxide in the atmosphere in a system. Agro-forestry acts as natural sinks of carbon.

Disadvantages of agro-forestry

-Competition for space, light, nutrients and light. This can be reduced by careful selecting trees species i.e. trees with deep roots than crops and shallow rooted.

-Toxification. There are tree species that produce toxic materials which may affect seed germination or affect crop growth.

-Mechanization is impossible and damage during harvesting e.g. when carrying out tilling or harvesting.

-There is crop damage by live stock.

-It can be habitant for pests and disease causing agents.

AGRO-FORESTRY SPECIES

CHARACTERISTICS OF AGRO-FORESTRY TREE SPECIES

Good agro-forestry specie should should be multipurpose ie producing various products and services.

-It should have high economic potential i.e. it should produce economic products and bi-products.

-It should have light canopy to allow light to pass through and serve lower plants.

-It should have high coppicing ability ie have high ability to regenarate after cutting.

-It should be easy to establish from seeds and get rid off.

-It should have high rapid growth rate i.e. high biomass production rate .

-It should have deep roots systems to reduce competition with annual crops.

-It should have efficient nutrient uptake ability on top layers.

-It should be nutritious and palatable to act as fodder for live stock.

-It should have high feeding value and non toxic to livestock.

-It should not cause/give management problems to the owner e.g. tree species with thorns.

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**MULTIPURPOSE TREE AND SHRUB SPECIES IN AGRO-FORESTRY**.

Multipurpose tree and shrubs are those which are deliberately kept and managed for more than one product or service with which are economically or ecologically motivated in multiple output land use system.

ADVANTAGES OF MULTIPURPOSE TREE SPECIE IN AGROFORESTRY

-It tends to increase organic matter content and protect soil from erosion.

-It plays a role of modifying soil temperature.

-It decreases acidification of the soil by increasing soil PH through addition of bases

-It provides multiple products

-It makes atmospheric nitrogen available for crop utilization.

-It increases soil fertility through nutrient recycling and therefore increase productivity.

-It makes labor more cost effective.

-It decreases crop vulnerability to diseases as a result of high nitrogen content in the crops.

-Chemical fertilizers are not used which reduces the cost of production and maximize the returns.

-It brings up leached iron to be available to plants.

**TREE SPECIE SELECTION FOR AGRO-FORESTRY SYSTEM**

**factors considered in specie selection**

-**suitability of the tree specie** **to specific technology**. The specie selected should suit the purpose of which the specie is selected for.

-Suitability of the specie to farmers attitudes preferences and needs. The specie should meet the farmers requirements e.g. if the farmer’s need is fuel wood then don’t take the specie for fodder.

-Consider adaptability of the tree species to specific site requirements.

-Inherent characteristics and complementarities of the growth habits. These are inherent characteristics of trees which should be considered eg what characteristics can increase negative attributes of agro forestry.

-Silvo cultural requirements-Growth requirements for trees, easy handling and management, compatibility of tree species with crops, biomass productivity, coppicing ability, and resistance level to insect and pests etc.

AGRO-FORESTRY COMPONENT INTERACTIONS

These are influences of one component on the performance of other components in the entire system.

There is tree crop interface (TC I).This is an imaginary area above or below or bellow the ground upon which the trees and crop components of an agro-forestry system exert influence on each other e.g. nutrient competition.

**Positive interactions**

-Both trees and shrubs of woody perennials may provide nesting and food for birds. This is important because birds will help in controlling pests in nearby plants.When leaves and twigs fall from trees add organic matter on soil and this increase soil fertility and there increase crop productivity.

-Tree leaves and branches, intercept solar radiation as well as providing the shed reducing water loss through evapo transpiration and this results into increased soil moisture and reduce soil temperature hence an increase in crop yields.

-Light demanding weeds are suppressed due to presence of trees that reduce competition of crops and weeds.

-Trees protect soil from erosion and improve the biological & physical properties.

-Woody perennials attributes soil fertility through nitrogen fixation, recycling nutrients and all these are used by crops that improve the yield of crops.

**negative interractgins**

-There is competition for nutrients, light and space.

-There is competition for water.

-Trees harbor pests and diseases.

-Trees produce toxic chemicals.

**Management of negative effects.**

-To make the right choice: choose the species that are compatible to one another under fertility conditions.

-Carry out root pruning especially woody components.

-Carry out canopy pruning to reduce on the amount of canopy to allow enough light to reach the ground.

-Carry out irrigation where there is competition for water.

-Proper spacing.

-Application of organic or inorganic fertilizers for nutrient addition.

Tree animal interface

This is an imaginary area above or bellows the ground upon which trees and animal components of agro-system exert an influence on each other.

**Positive interactions**

-The animals provide manure to tree components and therefore production increases.

-Animals may eat and trump on weeds that would otherwise compete with trees especially the early stages of development.

-Trees would provide fodder to the live stock

-The animals benefit from shed provided by the trees thus reduces heat stress and these results in weight gain and increased milk production.

-Some species of trees act as medicinal to animals.

**Negative interaction**

-Mechanical damage i.e. animals can eat or damage tree components hence low productivity

-Trees harbor parasites.

-Some trees are poisonous to animals

AGROFORESTY EXTENSION AND ADOPTION

This is a non formal education system aimed at improving the lives of the poor especially the rural people through growing and management of the trees together with agricultural crops.

**Social economic issues to consider in agro-forestry extension**

1 you consider the benefits that come from non woody products eg leaves and seeds.

2 Traditional knowledge of trees. In some countries, farmers are knowledgeable about the trees in terms of management, ecology and what it can be used for.

3. Land and tree tenure system. These should be a key in agro-forestry extension because they affect extension.

4. Local community organizations. These are initiative of the area.

5. Infrastructure and marketing system.

6. Income alternative. Consider the income the farmers would get from other systems.

7. The distance of community to forest and land less people.

8. Availability of labor. Agro-forestry demands labor to run agro-forestry systems.

9. Tree establishment. Trees can be established from seeds and we must consider whether planting materials are available.

10. Educational level and age. it is important to consider educational level because people understand differently and age because people have different language they use eg young and elder.

11. Gender.The role played by different sex and their categories.

**COURSE WORK**

1(a) Describe the advantages of organic matter in the soil.

(b) What are the factors that affect the decomposition of plants and animal tissues?

2(a) Describe the effect of temperature on crop productivity.

(b) Explain both physiological and behavioral mechanisms by which terrestrial plants avoid excess loss of water.

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