

A GUIDE ON MODERN FARMING TECHNIQUES TO RESPOND TO CLIMATE CHANGE  
CHALLENGES IN THE NIGER DELTA REGION

**FOR CROP PRODUCERS**

ON THE PROJECT

“EMPOWERING WOMEN AS KEY LEADERS IN PROMOTING COMMUNITY-BASED CLIMATE CHANGE ADAPTATION AND DISASTER RISKS REDUCTION INITIATIVES IN NIGER DELTA REGION”

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## INTRODUCTION

Climate change is expected to increase existing problems and create new combinations of risks, particularly in Africa. The situation is made worse due to factors such as widespread poverty, overdependence on rain fed agriculture, inequitable land distribution, limited access to capital and technology, lack of public infrastructure, such as roads, long term weather forecasts and inadequate research and extension.

Agricultural adaptation strategies are being employed by farmers in various countries in Africa in addressing the effects of climate change. The common agricultural adaptation strategies used by farmers include the use of resistant varieties of crops, crop diversification, changes in cropping pattern and calendar of planting, conserving soil moisture through appropriate tillage methods, improving irrigation efficiency, afforestation and agro-forestry.

Agricultural adaptation strategies to climate change impacts entails taking the right measures to reduce the negative effects of climate change by making the appropriate adjustments and changes. Below are some of the adaptation strategies:

**Planting of resistant varieties of crops:** Emphasis on more resistant crops in those areas could help in reducing vulnerability to climate change

**Crop diversification:** Diversification towards high value crops is practiced in the medium to long term. Crop diversity is a high priority adaptation measure in both irrigated and non-irrigated areas. To avoid crop production risks due to rainfall variability and drought, different planting methods is very common to most farmers whereby crops are planted before the onset of rain (dry land) on uncultivated land. Others were planted immediately after rain, while still other plots were planted a few days after the first rains. Tilling of lands commences in the fields prior to cultivation on the third week after the onset of rain which also destroys early germinating weeds and reduces weeding.

**Mixed cropping:** Mixed cropping involves growing two or more crops in proximity in the same field. The system is commonly practiced. This is where cereals (maize, sorghum), legumes (beans) and nuts (groundnuts) are grown together. The advantages of mixing crops with varying attributes are in terms of maturity period (e.g. maize and beans) and drought tolerance (maize and sorghum).

**Improved irrigation efficiency:** Success of climate change adaptation depends on availability of fresh water in drought-prone areas. Improved irrigation efficiency will become an important adaptation tool, especially in dry season, because irrigation practices in the dry area are water intensive.

**Adopting soil conservation measures that conserve soil moisture:** Soil conservation techniques are increasingly practiced in Burkina Faso, Kenya, Senegal, and Niger. This ensure proper timing of different farming activities, burying of crop residues to replenish soil fertility, burning crop residues to enhance quick release of nutrients and allowing livestock to graze on farmlands after harvesting crops so as to

improve soil organic matter. There is also the practice of contour ridges as a strategy to minimize soil erosion to encourage better root penetration and enhance moisture.

It is noted that local farmers conserve carbon in soils through the use of zero tilling practices in cultivation, mulching and other soil management techniques. Natural mulches moderate soil temperatures and extremes, suppress diseases and harmful pests, and conserve soil moisture. Before the advent of chemical fertilizers, local farmers largely depended on organic farming, which also is capable of reducing GHG emissions.

**Planting of trees (afforestation):** Tree planting is the process of transplanting tree seedlings, generally for forestry, land reclamation, or landscaping purposes. It involves planting seedlings over an area of land where the forest has been harvested or damaged by fire or disease or insects. Rural farmers in most of the Africa countries have been planting trees as a way of adapting to the effect of climate change.

However, the above strategies should be applied by farmers in performing the ten major steps from crop selection to harvesting

## TEN MAJOR STEPS IN CROP PRODUCTION CHAIN

1. Crop Selection
2. Soil Information
3. Land Preparation
4. Seed Selection
5. Seed Sowing
6. Irrigation
7. Crop Growth
8. Fertilizing
9. Protecting Crops from Flood Damage
10. Harvesting

### 1. CROP SELECTION:

This is more complex than it sounds. As any given crop - say Maize - can have different varieties to select from. So the choices for the farmer are;

When will the crop be ready?

Will it cope with my climate?

Does it cope well with drought or very wet weather?

Will it suit the soil type?

Many newer varieties of crop have been developed which are hybrids, which will not set seed and hence the farmer has to buy in new seed every year which makes farming expensive. Also, some varieties have been bred to cope with certain diseases, resistant varieties of Cassava, Maize, Soya bean, and Cow pea for example. All these factors need to be decided by the farmer before he plants the crop.

Selecting crops is straight forward for farmers. They have to look at market conditions, including pricing and distance to sell the crop, the land suitability, since certain crops do best in certain soil types and climate regions, and cost of production. On the surface, it may look like producing Cassava, as an example would be more profitable than soybeans, looking at yield potentials and market prices per unit, but if Cassava cost more to grow, in stems, pesticides, fertilizer, and harvest, soy beans may actually be more profitable per acre. Then the farmer must consider the local soil conditions.... soy beans may like a sandier soil, where Cassava may like a loamier one, so this is considered.

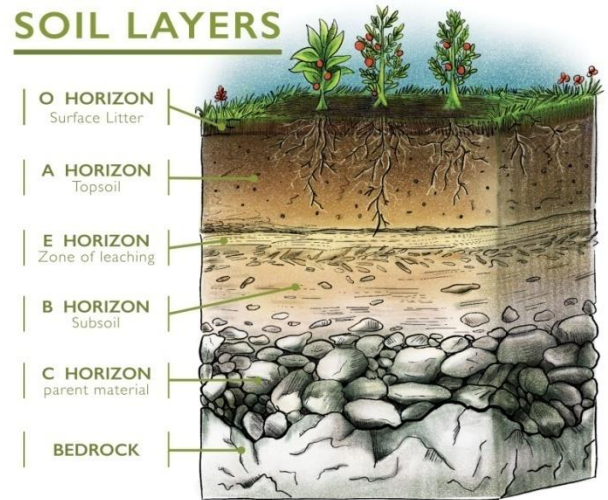
Another thing is what equipment the farmer has, or has access to. If the farmer doesn't have this equipment, all other issues being equal, the farmer might choose another crop rather than investing in it.

Crop rotation is another factor. If the farmer grows the same crop on the same land, the soil may become depleted of critical nutrients that the crop needs, or insects that prefer that crop become tolerant to the pesticides he is able to use and so entrenched in the soil, that he cannot successfully produce that crop any longer.

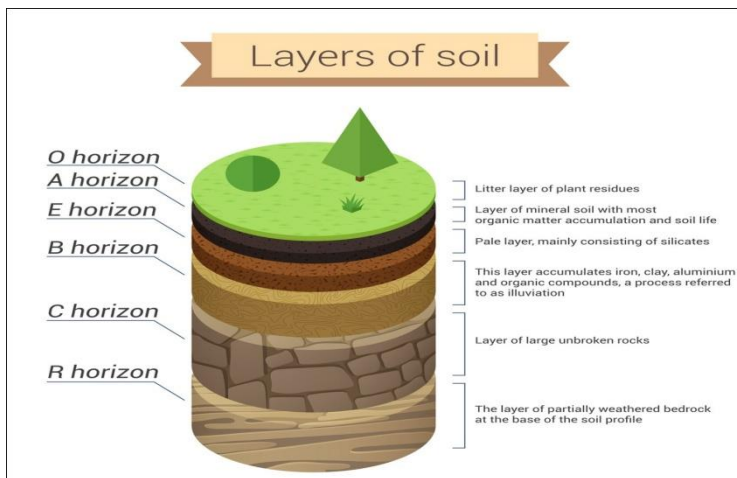
Part of the process of selecting a crop, or even a seed variety of a certain crop is tradition and local preferences. All of this is taken into consideration by the farmer when he is planning his planting choices each year.

Soil is a natural body consisting of layers (soil horizons) that are primarily composed of minerals, mixed with at least some organic matter, which differs from their parent materials in their texture, structure, consistency, color, chemical, biological and other characteristics. It is the loose covering of fine rock particles that covers the surface of the earth.

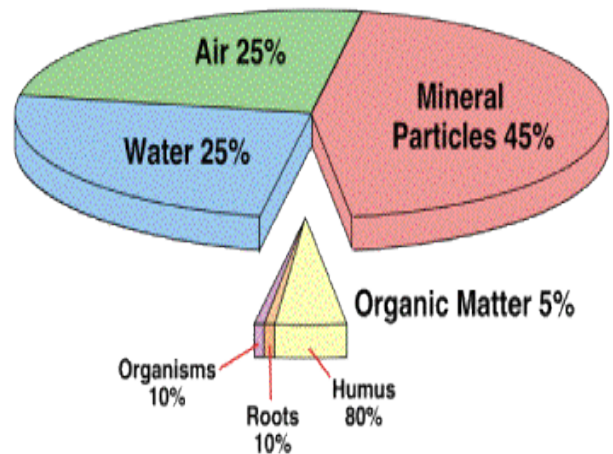
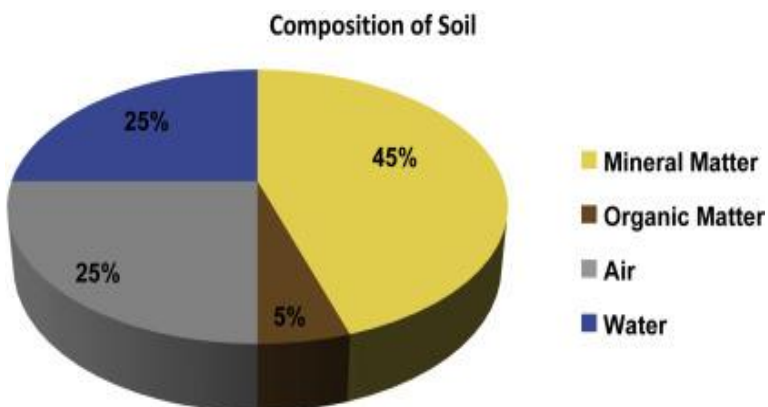
### SOIL LAYERS



PARK SEED



## 2. SOIL INFORMATION



A soil survey of the land area should be conducted. Soil survey reports include:

- Description of soil, topography, climate
- Soil classification along with the base map & soil profile characteristics.
- The nutrient level of the soil.

A soil survey report is prepared on the basis of soil characteristics such as soil structure, soil texture, soil types, etc.

The soil survey report will help in deciding the suitability of the area for agricultural and non-agricultural uses; the type of crop production it's suitable for; land cultivation principle to adopt, and the nutrient level in the area. This information will help when deciding on the use of manure and fertilizer and the application rates.

### **3. LAND PREPARATION**

Soil preparation is an extremely important step. You might be thinking that is an easy job by just digging a hole and plant your seedlings. Water the crop few time and then a few weeks later, the crop will be ready to harvest. Although it's easy for most cases, it is not always the case. If you want to obtain the best qualitative and quantitative yield then you will have to follow appropriate steps. You must know pre and post-conditions for planting your crop. You must be familiar with all primary and essential requirements for growing your crop. You must be aware to the different climate effects on your crop and how to care your crop against climate and pests attack. To attain the healthiest production, knowledge of these things is crucial.

Mostly, beginner give up just because they can't achieve their desired results. It's because they don't know even the most basics conditions for growing the crop. There are a few most important factors that really matter to attain the best and maximum yield. One of the most important factors among them is a **Land Preparation**. If you prepare your land properly then you will obtain phenomenal production. Do you know the procedure of soil preparation? Well, either you are a beginner or an expert, this guide will explain 5 steps of land preparation in details. After reading this guide carefully, you will be capable to prepare soil like a professional.

#### **Steps in Land Preparation**

You will learn 5 steps in land preparation from basic to advance. First step is to choose the best place for growing your crop. After selecting an appropriate place, next step is to test your soil for the pH and either land contains the best nutrients or not before land preparation. You will learn about the ideal pH and how to maintain that for your crop. Moreover, you will learn the complete composition of different chemical fertilizer for soil preparation such that which, why and how to add these fertilizers during the soil preparation to obtain maximum and beneficial results. Finally, in last two steps, you will learn about the importance of soil structure, soil composition and soil amendment.

## Step 1: Choosing the Best Location

Location for planting does matter for the ideal growth. Do you think is it better to sow your crop on a random spot even without selecting a suitable place? No, not at all. You must select an appropriate place for planting your crop. Keep in mind the following points for choosing the best suitable site for your crop.

- *Choosing a sunny spot*

To achieve the best results, **your crops should obtain sunlight for at least 6 hours**. It is best not to grow your crop under the shades. You might be thinking that shades are necessary for a few crops to protect them from a very hot climate. Yes, few crops require shades. However, in a specific time span, they also require sunlight for ripening the fruits. So there is no escape from sunlight. Therefore, you should grow your crop in a sunny spot where they may have direct sunlight and when shades require you can protect them by utilizing the shades. **Greenhouses have the capability to get and prevent shades as per requirement**. If you can purchase green-house, then its best for raising seedlings.

- *Picking up a good drainage site*

You should provide well-drained soil to your crop for ideal growth. Never ever grow your crop on the soil which holds water every time. After the rain, where water is pooling then it's mean that soil is not well-drained. Ideally, your land should be flat otherwise waterlogging can be occurred in your garden. Waterlogging is a severe problem and it will destroy your crop.

- *Avoid root system*

During land preparation, a tree's root system can create subtle problems for the farmer. If you have enough space for farming, then **try to grow you crop 10-20 feet away from a tree**. However, if you have small space then you can check the roots by digging the hole. Where you don't find any root, you can start planting. So try to avoid from root system as much as possible.

## Step 2: Test for Soil Preparation

After choosing an appropriate place for gardening, testing the soil is very important step. After testing the soil, you will come to know that what's already there in the soil. Which steps you should take to improve your soil. This will allow you to improve the fertility of the soil if required or prevent you from overloading it with different nutrients. By testing, you can figure it out the pH of soil, amount of nitrogen, phosphorus, and potassium. Moreover, you can also test for soluble salts and soil texture, etc. However, these tests don't reveal the possible diseases, insects and chemical residues.

- *How to test the soil?*

There are two simple but important ways to test the soil. Firstly, the **soil test kit** is commonly used for testing the soil which is really inexpensive. If you have a small garden then it is recommended for you to purchase this from a local garden store beside your garden. Secondly, you can contact the Local

Cooperative extension service office of your country. For professional farmers, this is a recommended method.

- ***Appropriate pH for the soil***

To measure the pH of the soil is very important before planting the crop. The pH affects the availability of minerals and nutrients and shows that either a plant is capable to absorb and regulate the enough amount of nutrients from the soil or not. Different crops require different level of pH. However, **in most cases, the pH of the soil should be around 6.0 – 7.5**. A very high or low pH leads to poor growth or even worse in some cases.

The pH range varies from 0 to 14. 0 shows extremely acidic, 7 shows normal and 14 shows extremely alkaline. Usually, the pH of the soil doesn't hit the extreme level. In most of the cases, soil pH falls somewhere between 5 and 9.

- ***How to adjust the pH of the soil?***

After testing your soil, you will obtain the level of pH for your soil. If your soil pH is in the ideal range which is 6.0 to 6.5 (slightly acidic) then you don't need to do anything. If your soil pH is high then lower the pH by adding peat, sulfur and different organic compound like compost or manure. If a soil test shows low pH then you can increase pH by adding lime or wood ash.

### **Step 3: Addition of N-P-K Fertilizers During Soil Preparation**

Nitrogen (N), Phosphorus (P) and Potassium (P) are primary and essential nutrients for plants growth. When you buy a chemical/ synthetic package of fertilizer, then you can see three values parted with dashes like N-P-K. Each number specify the net percentage weight of these nutrients in the package.

- ***Importance of Nitrogen (N)***

Nitrogen is an extremely important element for soil. So enough amount of nitrogen should be added into the soil during soil preparation. It promotes stem growth and strengthens the leaf. It is a cause of dark green color such that it can be found in broccoli, lettuce, and herbs, etc. If you want to provide nitrogen to your crop naturally then add aged manure and apply alfalfa meal or seaweed. Fish and blood meal are other rich sources of nitrogen.

- ***Importance of Phosphorus (P)***

Phosphorus is a very essential element for soil. So enough amount of phosphorus should be added into the soil during soil preparation. Phosphorus is crucial for root development and early stages of plant growth. Moreover, it is also essential for the formation of seeds and fruits. For example, it is important for cucumbers, peppers, and tomatoes. Rock phosphate and bone-meal are the rich sources of phosphorus.



- ***Importance of Potassium (K)***

Potassium is an extremely important element for soil. So enough amount of potassium should be added into the soil during land preparation. It promotes root development and resists against diseases and stress. Moreover, it enhances the flavor and textures of fruit. It is crucial for garlic, turnips, radishes, and carrots. For increasing the potassium into the soil, add greensand, gypsum and wood ashes.

The most important point, every farmer should keep in mind, that don't add an excessive amount of chemical fertilizer to the plant. Instead of benefits, it damages the roots and lessens the availability of other compounds. You can apply natural organic compound because these release their benefits slowly. However, don't add fresh manure into the soil because it can also burn the roots and can be a cause of various diseases.

**Step 4: Select and Prepare Soil Structure**

After testing the soil, you will be able to adjust the ideal pH level and essential nutrients for the crop. Prepare soil which is another important factor to attain exemplary crop. For example, soil having too much water can be a cause of fungal infections and resulting as root rot. On the other hand, if there is a deficiency of water, then it can be a cause of malnourished and resulting as dehydrated plants. There are three types of soil so different crop has different types of soil requirements.

- ***Clay Soil***

If you have clay soil then prepare soil by adding well-rotted compost, peat moss and add coarse sand to add texture to the soil. Soil should be well-drained to prevent waterlogging.

- ***Sandy Soil***

If you have sandy soil then you should add peat moss, human and aged-manure, some extra nitrogen alongside sawdust. Moreover, you should also add heavy clay soil for the improvement of soil. Prepare soil such that water pooling can't occur even after the heavy rainfall.

- ***Silt Soil***

To improve the nutrients of the silt soil, add well-rotted compost, aged horse manure, and coarse sand.

- ***Common soil amendments***

While preparing your soil, you should be familiar with these amendments and amend your soil when needed.

- **Compost:** It lowers the pH of the soil and increases the nutrients.
- **Lime:** It raises the soil pH and helps in loosening the soil.
- **Manure:** It is a good conditioner and adds nutrients into the soil.

- **Peat Moss:** It helps to retain water in the soil and have the ability to lower the pH.
- **Topsoil:** it is not used alone and works with other amendments and use to replace existing soil.
- **Sand:** it is used to improve the drainage of the clay soil.
- **Bark:** By utilizing this you can improve the soil structure.

### Step 5: Adjusting the Soil Composition

Adjusting and composition of different organic compound are extremely important for soil. You have already learned about the importance of pH for the best growth of any crop. How to maintain the ideal pH level for the healthiest crop by adding the fair quantity of lime and sulfur if necessary. After testing, you figure it out that either clay, sand or another topsoil you should add to prepare the soil to attain the best possible mixture for your soil. Soil should contain a fair amount of nitrogen, potassium, and phosphorus as you have learned in this guide. If your test reveals the deficiency of oxygen in the soil then you should add gypsum or perlite which aerate the soil to improve oxygen content for soil.

#### - *Addition of organic material to prepare soil*

You can add organic material into the soil as much as you want. However, for preparation of the best garden soil, there should be half soil and half organic material. Organic material contains shredded brown and green leaves, vegetables, fruits scrap, and horse manure. You can also add wood chips into the soil. Although you can add fish and meat as an organic material into the soil, we recommend you not to add these scraps into your soil.

#### - *Mix organic material and soil with a shovel*

Mostly, beginner farmer don't mix organic material with the soil well. After adding organic material into the soil, always make sure to prepare soil. Mixing may take 2- 3 times. For mixing, you should turn the soil again and again with stiller or shovel. If it's not mixing well, you can add water slightly. This good mixture will grow the best lush green crop.

#### - *Flatten the surface and make rows*

After mixing the organic material with the soil, you should flatten your soil and keep your soil loose. You should walk onto the specified walkways. The distance between two seedlings various from crop to crop. **Some crops require raised bed for their ideal growth**, so try to provide them. Now it's totally up to you, that which crop you want to grow. So try to plant them apart according to their requirements in different rows.

Now that you know complete details of land preparation for the healthiest crop. If you follow these steps, then you will obtain matchless yield.

## 4. SEED SELECTION

During planting season, there are crucial decisions to make to ensure a rewarding harvest. The following are the stages to follow to ensure a bumper harvest: Good harvests start with good seed selection. Good

quality seeds are essential for the growth of strong and healthy crops which can resist diseases or even drought. Healthy seeds can be bought from trusted sources like certified seeds stockiest (IITA). Farmers can produce their own seeds too. In that case, then, seed selection plays a major role in determining the crop yield. Best seeds offer higher yields. There are several diseases that are transmitted via the seeds. If infected seeds are used for the next crop, seed-borne diseases are transferred into the farm. Seed selection should therefore start by obtaining seeds from healthy plants. Small, shriveled and broken seeds contain less nutrition for the developing seedling. By removing these inferior seeds, the farmer is able to grow stronger and healthier seedlings. In a crop field, farmers may observe differences in traits between plants. Some plants may have characteristics that are more desirable. During the growing season, the farmer can try to observe these differences and mark preferred plants with a ribbon or with a marker pen. During the harvesting season, the seeds of these plants can be reserved as seed for the next crop. In this way, the farmer can slowly improve the quality of their varieties.

The selection of seeds may also be based on market preferences such as the size of the plant, colour or fruits size, number of grains per plant, among other desirable traits. Undesirable seeds that are too small, spotted, deformed or discoloured should not be chosen for planting. Certified seed should be ordered and purchased from an approved shops and other stockists. The use of uncertified seed may lead to spread of viruses and fungal diseases. Farmers should ensure the seeds are handled and stored properly.

Poor storage of seed results in excessive sprouting and sprout breakage which in turn leads to poor crop development, irregular germination and growth of crowded plants that require thinning. Intercropping Farmers should consider intercropping cereals with other leguminous crops such as cowpeas, groundnuts, soya beans, and nuts. This can help fight noxious weeds such as striga in the farm. The striga weed roots cannot attach to the root system of the leguminous plants and will therefore die.

The Push-pull farming technology is a proven farming method that helps control the parasitic weed while providing farmers with desmodium for fodder and other legumes that provide an extra income.

**Proper spacing:** If crops are planted at recommended spacing, the plants cover the ground quickly reducing the need for weeding. In areas of reliable rainfall, weed-free conditions in properly spaced maize need to be maintained until the crop is about 45 cm high. At this stage the crop itself suppresses weeds and further weed control measures become unnecessary. In areas of less reliable rainfall, weed-free conditions should be maintained until flowering to minimize the risk of moisture stress at this critical stage.

**Timely planting:** Maize planted at the right time has vigorous growth and becomes well-established before the growth of weeds. The seeds should be planted at the onset of the rains. This allows the seeds to establish before weeds develop. Weed control Hoeing is the most common weed control method used by small-scale farmers. This is commonly followed by hand weeding to remove the weeds that grow after digging. Weeding should be done three to four (3 to 4) weeks after planting. For a healthy crop, weeding should be done two or three (2 or 3) times because a young maize plant is very sensitive to weed competition.

**Push–pull technology** is a strategy for controlling agricultural pests by using repellent "push" plants and trap "pull" plants.<sup>[1]</sup> For example, cereal crops like maize or sorghum are often infested by stem borers. Grasses planted around the perimeter of the crop attract and trap the pests, whereas other plants, like *Desmodium*, planted between the rows of maize, repel the pests and control the parasitic plant *Striga*.



## 5. SEED SOWING

Growing from seed is so satisfying: it saves a huge amount of money, you have the joy of watching your seedlings grow and the satisfaction of achieving mature, healthy plants which are well suited to your growing area. From sweet peas to sweetcorn, cowpea and cassava - you can fill your beds and pots with as many plants as you want.

Here are some useful tips to make sure your organic seed sowing is super successful.

The six steps

Choose organic seeds a well -treated seed good for planting

Make your own organic seed sowing compost. If you are sowing in trays/pots indoors or in a greenhouse, mix equal parts loam (garden soil) and sharp sand. If you have it, add in some finely sieved leafmould. Seeds carry their own nutrients, so they don't need an enriched potting compost to germinate.

Sow into firm compost or soil. Whether sowing indoors or out, prepare the soil by making sure there are no large lumps and firming it down.

Follow the instructions on the seed packet - they should tell you when to sow, how deep, how far apart, and whether the seed needs to be covered. Many seeds like to be covered by the equivalent of their size in soil depth, but some wild flower seed needs light to germinate and can rest on top of the prepared soil.

Watering is important. Make sure the soil is damp from the beginning, and maintain that dampness while germinating and growing. Too wet, and the seeds can rot; too dry, and they won't survive to put down roots. Use the rose on the watering can - it makes a fine spray and doesn't wash the seeds away.

Thin out young seedlings. If you've sown thickly, the roots will compete for water and nutrients and the young plants may become leggy. Carefully lift seedlings out of the soil, separate and re-plant - either in pots if you're growing under cover, or in elsewhere in the growing area outdoors.

**Fumigation** is a technique where a fumigant at specific temperature and pressure can exist in a gaseous state. This fumigant or chemical, in sufficient concentration, will be used to eradicate pests. This fumigation process is often a necessary procedure to be able to quickly and thoroughly eradicate pests. The fumigation is much more effective than other methods of pest control as the fumigant gas circulates and spreads to all areas of infestation that other systems are less effective in and unable to reach.

## 6. IRRIGATION

Water is an essential element for survival. About seventy percent of the human body consists of water; plants contain almost 90 per cent of water. Still, we have to depend on some outside sources to fulfill the water requirements of our body.

Similarly, the crops require water for their growth and development. The process of supplying water to the crops is known as irrigation.

Nutrients may also be applied to the crops through irrigation. The various sources of water for irrigation are wells, ponds, lakes, canals, tube-wells, and even dams. Irrigation offers moisture required for growth and development, germination, and other related functions.

Water moistens the soil and thus helps in penetration of roots even into the dry field. The frequency, rate, amount and time of irrigation are different for different crops and also vary according to the types of soil and seasons. For example, during dry season, crops require a higher rate of water as compared to raining season.

Let us have a look at different types of irrigation and the methods used for irrigation.

### **Types of Irrigation:**

1. Surface Irrigation
2. Localized Irrigation
3. Sprinkler Irrigation
4. Drip Irrigation
5. Centre Pivot Irrigation
6. Sub Irrigation
7. Manual Irrigation

### 1. *Surface Irrigation*

In this system, no irrigation pump is involved. Here, water is distributed across the land by gravity.



### 2. *Localized Irrigation*

In this system, water is applied to each plant through a network of pipes under low pressure.



### 3. *Sprinkler Irrigation*

Water is distributed from a central location by overhead high-pressure sprinklers or from sprinklers from the moving platform.



#### 4. *Drip Irrigation*

In this type, drops of water are delivered near the roots of the plants. This type of irrigation is rarely used as it requires more maintenance.



#### 5. *Centre Pivot Irrigation*

In this, the water is distributed by a sprinkler system moving in a circular pattern.



#### 6. *Sub Irrigation*

Water is distributed through a system of pumping stations gates, ditches and canals by raising the water table.

#### 7. *Manual Irrigation*

This a labour intensive and time-consuming system of irrigation. Here, the water is distributed through watering cans by manual labour.



- Traditional Methods
- Modern Methods

### **Traditional Methods of Irrigation**

In this method, irrigation is done manually. Here, a farmer pulls out water from wells or canals by himself or using cattle and carries to farming fields. This method can vary in different regions.

The main advantage of this method is that it is cheap. But its efficiency is poor because of the uneven distribution of water. Also, the chances of water loss are very high.

Some examples of traditional system are pulley system, lever system, chain pump and dhekli. Among these, the pump system is the most common and used widely.

### **Modern Methods of Irrigation**

The modern method compensates the disadvantages of traditional methods and thus helps in the proper way of water usage.

The modern method involves two systems:

- Sprinkler system
- Drip system

#### *Sprinkler System*

A sprinkler system, as its name suggests, sprinkles water over the crop and helps in an even distribution of water. This method is much advisable in areas facing water scarcity.

Here a pump is connected to pipes which generate pressure and water is sprinkled through nozzles of pipes.

#### *Drip System*

In Drip system, water supply is done drop by drop exactly at roots using a hose or pipe. This method can also be used in regions where water availability is less.



## 7. CROP GROWTH

Monitoring crop growth and performance during crop developmental stages is an important aspect of agricultural management. It enables the farmer to implement timely interventions that ensure that optimal yield is obtained at the end of the season.

Stress factors often prevent crops from developing at the rate they are capable of. Examples include:

- Poor water availability (e.g. in-season drought)
- Extreme temperatures (heat)
- Competition among plants for sunlight, nutrients, water or space
- Nutrient deficiency (e.g. artificial fertilizer or manure)
- Uncontrolled use of chemicals (toxicity)
- Fungal, bacterial or viral infection
- Attack from insects or other organisms, above or below the ground

Some of the above arise from shortcomings in labor investment on the plot

## 8. FERTILIZER APPLICATION

Plants must have light, moisture and nutrients to grow. The sun provides light. Moisture comes from rainfall or irrigation. Nutrients come from fertilizers, compost or manure. If plants are not growing well, fertilizing them will help only if a lack of nutrients is the cause of the problem. Plants grown in poorly drained soils, in excessive shade, or in competition with tree roots will not respond to fertilizer.

Fertilizers are either organic or inorganic. Examples of organic fertilizers include manure (poultry, cow or horse), bone meal, cottonseed, or other naturally occurring materials. Inorganic fertilizers are man made products. They usually have a higher nutrient content.

### Buying Fertilizers

The three numbers on fertilizer containers are the fertilizer analysis, a 100-pound bag of 10-20-10 fertilizer contains 10 pounds of nitrogen, 20 pounds of phosphorus, and 10 pounds of potassium. This equals a total of 40 pounds of nutrients. The rest of the fertilizer, or 60 pounds in this example, is a carrier or filler such as sand, perlite, or rice hulls. A complete fertilizer is one that includes all three elements.

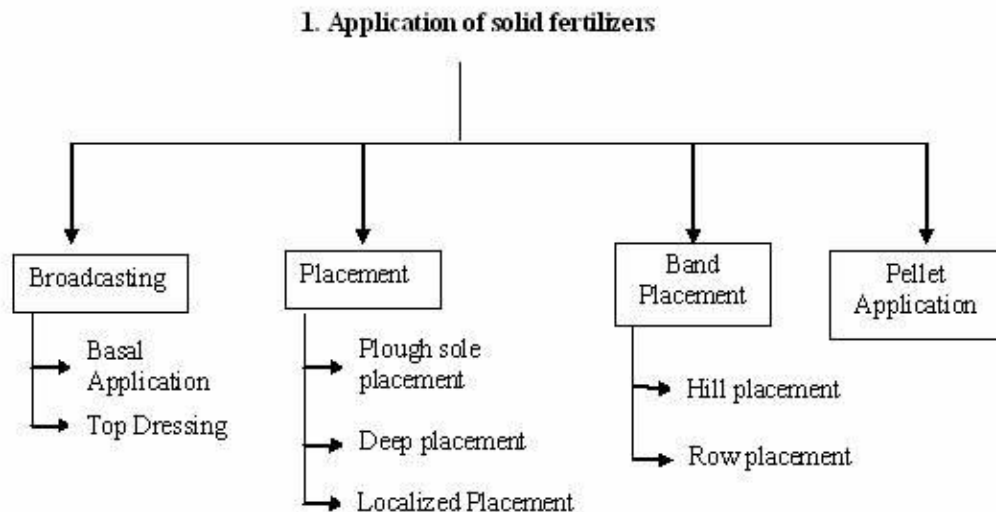
All parts of a plant need nitrogen for growth—the roots, leaves, stems, flowers and fruits. Nitrogen gives plants their green color and is needed to form protein. A lack of nitrogen causes the lower leaves to turn yellow and the whole plant to turn pale green. On the other hand, too much nitrogen kills plants.

Phosphorus is needed for cell division and to help form roots, flowers and fruit. Phosphorus deficiency causes stunted growth and poor flowering and fruiting.

Plants need potassium for many of the chemical processes that allow them to live and grow. A potassium shortage shows up in various ways, but stunted growth and yellowish lower leaves are common symptoms in many plants. When you buy fertilizer, consider the cost per pound of the nutrient(s). Generally, higher analysis fertilizers and larger containers are less expensive. For example, a 50-pound bag of 10-20-10 may

not cost any more than a 50-pound bag of 5-10-5 fertilizer, but the 10-20-10 bag contains twice the nutrients.

## METHODS OF FERTILIZER APPLICATION:



### a) Broadcasting

1. It refers to spreading fertilizers uniformly all over the field.
2. Suitable for crops with dense stand, the plant roots permeate the whole volume of the soil, large doses of fertilizers are applied and insoluble phosphatic fertilizers such as rock phosphate are used.

Broadcasting of fertilizers is of two types.

#### i) Broadcasting at sowing or planting (Basal application)

The main objectives of broadcasting the fertilizers at sowing time are to uniformly distribute the fertilizer over the entire field and to mix it with soil.

#### ii) Top dressing

It is the broadcasting of fertilizers particularly nitrogenous fertilizers in closely sown crops like paddy and wheat, with the objective of supplying nitrogen in readily available form to growing plants.

#### Disadvantages of broadcasting

The main disadvantages of application of fertilizers through broadcasting are:

- i) Nutrients cannot be fully utilized by plant roots as they move laterally over long distances.
- ii) The weed growth is stimulated all over the field.
- iii) Nutrients are fixed in the soil as they come in contact with a large mass of soil.

## *b) Placement*

1. It refers to the placement of fertilizers in soil at a specific place with or without reference to the position of the seed.
2. Placement of fertilizers is normally recommended when the quantity of fertilizers to apply is small, development of the root system is poor, soil have a low level of fertility and to apply phosphatic and potassic fertilizer.

The most common methods of placement are as follows:

### *i) Plough sole placement*

1. In this method, fertilizer is placed at the bottom of the plough furrow in a continuous band during the process of ploughing.
2. Every band is covered as the next furrow is turned.
3. This method is suitable for areas where soil becomes quite dry upto few cm below the soil surface and soils having a heavy clay pan just below the plough sole layer.

### *ii) Deep placement*

It is the placement of ammoniac nitrogenous fertilizers in the reduction zone of soil particularly in paddy fields, where ammoniac nitrogen remains available to the crop. This method ensures better distribution of fertilizer in the root zone soil and prevents loss of nutrients by run-off.

### *iii) Localized placement*

It refers to the application of fertilizers into the soil close to the seed or plant in order to supply the nutrients in adequate amounts to the roots of growing plants. The common methods to place fertilizers close to the seed or plant are as follows:

#### *a) Drilling*

In this method, the fertilizer is applied at the time of sowing by means of a seed-cum-fertilizer drill. This places fertilizer and the seed in the same row but at different depths. Although this method has been found suitable for the application of phosphatic and potassic fertilizers in cereal crops, but sometimes germination of seeds and young plants may get damaged due to higher concentration of soluble salts.

#### *b) Side dressing*

It refers to the spread of fertilizer in between the rows and around the plants. The common methods of side-dressing are

1. Placement of nitrogenous fertilizers by hand in between the rows of crops like maize, sugarcane, cotton etc., to apply additional doses of nitrogen to the growing crops and
2. Placement of fertilizers around the trees like mango, apple, grapes, papaya etc.

### c) Band placement

It refers to the placement of fertilizer in bands.

Band placement is of two types.

#### i) Hill placement

It is practiced for the application of fertilizers in orchards. In this method, fertilizers are placed close to the plant in bands on one or both sides of the plant. The length and depth of the band varies with the nature of the crop.

#### ii) Row placement

When the crops like sugarcane, potato, maize, cereals etc., are sown close together in rows, the fertilizer is applied in continuous bands on one or both sides of the row, which is known as row placement.

### d) Pellet application

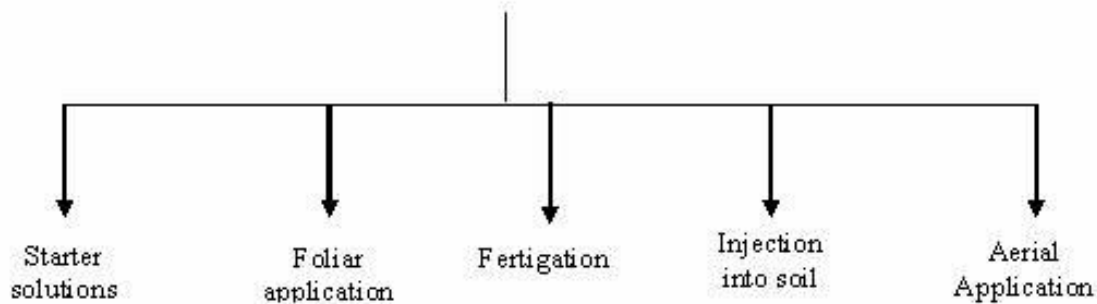
1. It refers to the placement of nitrogenous fertilizer in the form of pellets 2.5 to 5 cm deep between the rows of the paddy crop.
2. The fertilizer is mixed with the soil in the ratio of 1:10 and made small pellets of convenient size to deposit in the mud of paddy fields.

### Advantages of placement of fertilizers

The main advantages are as follows:

- i) When the fertilizer is placed, there is minimum contact between the soil and the fertilizer, and thus fixation of nutrients is greatly reduced.
- ii) The weeds all over the field cannot make use of the fertilizers.
- iii) Residual response of fertilizers is usually higher.
- iv) Utilization of fertilizers by the plants is higher.
- v) Loss of nitrogen by leaching is reduced.
- vi) Being immobile, phosphates are better utilized when placed.

## 2. Application of liquid fertilizers



a)

### *Starter solutions*

It refers to the application of solution of N,  $P_2O_5$  and  $K_2O$  in the ratio of 1:2:1 and 1:1:2 to young plants at the time of transplanting, particularly for vegetables.

Starter solution helps in rapid establishment and quick growth of seedlings.

The disadvantages of starter solutions are

- (i) Extra labour is required, and
- (ii) the fixation of phosphate is higher.

### *b) Foliar application*

1. It refers to the spraying of fertilizer solutions containing one or more nutrients on the foliage of growing plants.
2. Several nutrient elements are readily absorbed by leaves when they are dissolved in water and sprayed on them.
3. The concentration of the spray solution has to be controlled, otherwise serious damage may result due to scorching of the leaves.
4. Foliar application is effective for the application of minor nutrients like iron, copper, boron, zinc and manganese. Sometimes insecticides are also applied along with fertilizers.

### *c) Application through irrigation water (Fertigation)*

1. It refers to the application of water soluble fertilizers through irrigation water.
2. The nutrients are thus carried into the soil in solution.
3. Generally nitrogenous fertilizers are applied through irrigation water.

### *d) Injection into soil*

1. Liquid fertilizers for injection into the soil may be of either pressure or non-pressure types.
2. Non-pressure solutions may be applied either on the surface or in furrows without appreciable loss of plant nutrients under most conditions.

3. Anhydrous ammonia must be placed in narrow furrows at a depth of 12-15 cm and covered immediately to prevent loss of ammonia.

*e) Aerial application.*

In areas where ground application is not practicable, the fertilizer solutions are applied by aircraft particularly in hilly areas, in forest lands, in grass lands or in sugarcane fields etc.

## **9. PROTECTING CROPS FROM FLOOD DAMAGE**

Flooding happens when heavy rain falls and the ground is unable to drain the water fast enough. Most plants can withstand flooding which doesn't last for long (unless it is a severe torrential flood which washes away everything in its path), but prolonged flooding can cause great damage to crops. In many areas, floods are happening more often, or with greater severity. It is important that crops are protected from flooding, particularly in areas which are vulnerable to flooding.

### **Different Ways Of Protecting Crops Include**

**Planting trees in upland areas and keeping the soil covered:** Planting trees in upland areas reduces run-off (rainfall on Mount Kenya used to take a year to flow from the top to the river then the ocean. It now takes a week because of deforestation). When the soil is not covered by vegetation, mulch or crop residues, it will be more exposed to the impact of rainfall. When the soil is protected by mulch, adjacent trees and shrubs, or cover crops (these are usually leguminous crops such as pigeon peas, lablab, velvet beans etc), the water flow is slowed down, so the water has more time to infiltrate into the ground rather than run off the land, washing away high nutrient soil with it

**Build dikes to protect crops from floods:** Dikes are barriers or walls built to protect the land from water damage. They can be built using soil, stones, rocks, sand bags or wood. If properly built, dikes can protect crops from flooding. A dike can slow water flow (for example, if made of stone) or divert water (in the case of clay or concrete dikes), or direct water flows to specific crops or other locations such as an irrigation channel. Dikes will also help to prevent the loss of topsoil when there is heavy rainfall. If using soil to make dikes, it needs to be high clay content sub-soil, preferably on top of a stone base. Clay soil should be compacted thoroughly to ensure that water does not break through. Sand bags, or wire netting could be used to reinforce the dike, giving it more strength. Grass could be planted on the dike to slow down erosion. Appropriate technical expertise is required before building a dike.

**Plant flood-tolerant varieties of crops:** Plant crops that are tolerant to flooding. Most root vegetables are naturally flood tolerant. And varieties of crops such as wheat and rice are being developed to be more resistant to floods.

**Improve the drainage of land before planting crops that do not grow well with too much water:**

Crops can be grown in raised beds, on ridges, or on mounds to improve drainage. Ridges help to drain excess water, keeping it away from the plants. Excess water can be drained if there is somewhere for it to go, or a storage pond could be dug at the lowest part of the garden/farm to store surplus water and allow it to soak into the subsoil slowly. The pond should be filled with stones or gravel to prevent mosquitoes breeding. Ridges can be made using oxen- or donkey-drawn ridgers or using hand hoes. The distance between ridges varies from crop to crop, and is also affected by the soil type. As an example, ridges can be made 60cm apart for planting maize. The depth can be up 30cm, but again will depend on the soil type and slope.

**Plant early-maturing varieties of crops:** Early-maturing varieties of crops are useful because they take less time to mature. It is therefore easier to avoid the flooding season. They are likely to be ready before, or can be planted after, the flooding season.

**Promote floating gardens:** People who live in areas regularly covered by water (for example large areas of Bangladesh), and who are unable to grow crops because there is very little available land, or land that regularly floods, can build floating gardens. Floating gardens are built using aquatic weeds as a base on which vegetables can be grown

**Build flood-proof grain storage facilities:** Storage facilities should be built on level ground that is well-drained and not prone to flooding. They should be raised above the flooding level and should be insect- and rodent-proof.

## **10. HARVESTING**

Harvesting is the act of removing a crop from where it was growing and moving it to a more secure location for processing, consumption, or storage. Some root crops and tree fruit can be left in the field or orchard and they can be harvested right there as needed by the farmer, but most crops reach a period of maximum quality—that is, they ripen or mature—and will deteriorate if no proper attention is given to it and left exposed to the elements.