Guideline for Establishment of ‘Abundant Orchards’, or Forest Market Gardens

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1. Forest Market Gardens – Abundant Orchards 'Baagh-e-Mutanawe'

Forest market gardening, or the 'Abundant Orchard' approach to small scale farming is a climate-friendly farming system that uses natural forest growth and planting of a range of useful food plants to produce various crops all year round. It's a type of farming that focuses on creating a healthy, balanced ecosystem by mixing annual (only grow for one year) and perennial (grow over several years) plants and sometimes including animals. This approach aims to protect the soil and encourage biodiversity, which helps keep the environment strong and healthy.

In an Abundant Orchard gardening system, these seven layers are replicated with available crops:

1. **Canopy –** Large fruit-bearing trees like walnuts and almonds
2. **Understory** – Short fruit trees like pistachios and peaches
3. **Shrub layer** – pomegranates
4. **Herbaceous layer** – Crops like cowpea, mung beans, lentils, wheat and alfalfa
5. **Rhizosphere** – Root crops such as carrots, garlic and onion
6. **Ground layer** – Ground-cover crops: spinach, grasses, pumpkin and melon
7. **Vertical layer** – Climbing plants such as vines eg Grapes and beans

Definition: Forest market gardening, or 'Abundant Orchards' is a holistic agricultural practice that emphasizes environmental health and yields resilient, abundant results.

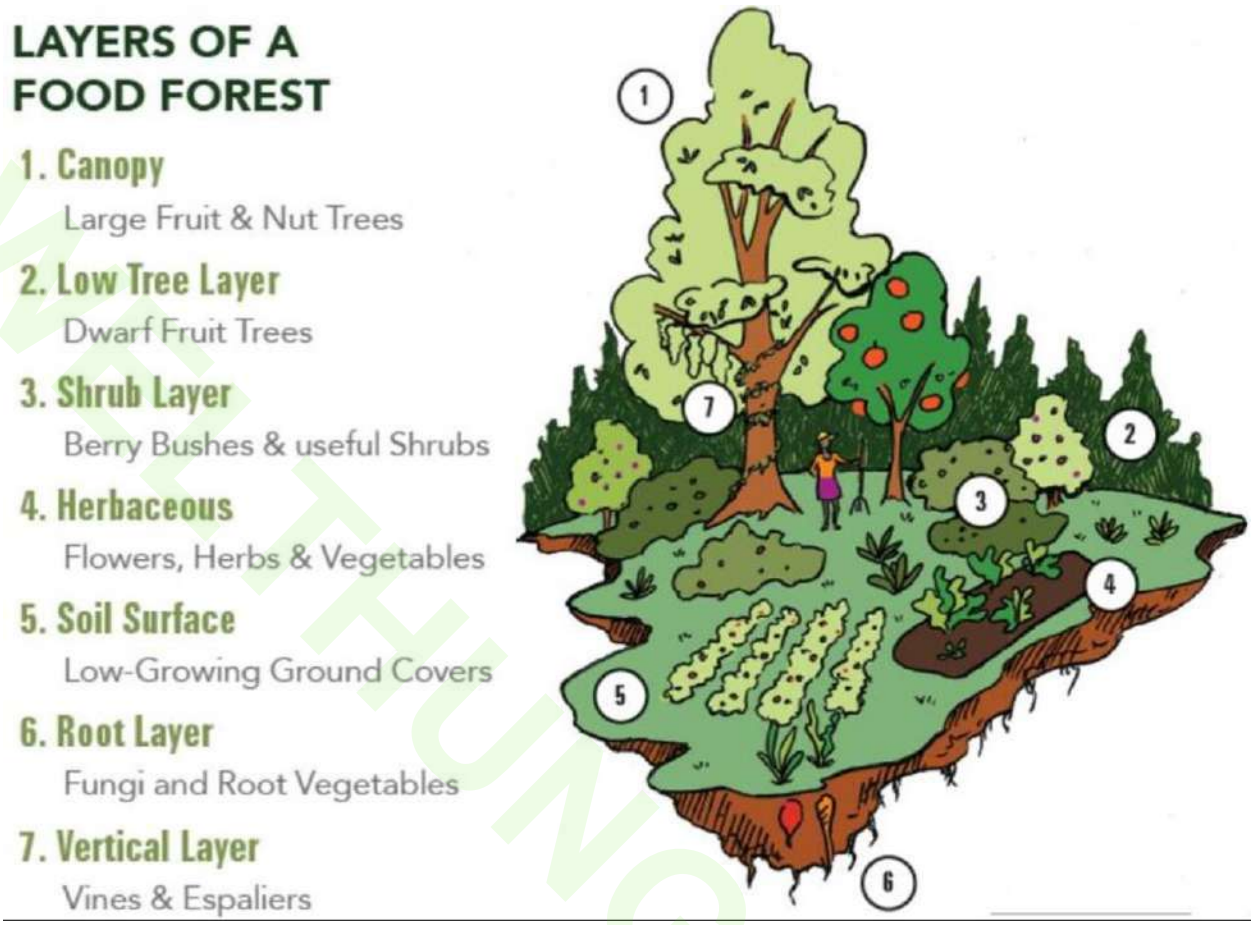


Figure 1: The structure of an Abundant Orchard (also called a Forest Market Garden or Food Forest; image from dug.org)

History of Forest Market Gardening

Forest market gardening, also known as 'Abundant Orchards' or forest gardening, is a sustainable land management method practiced for centuries. This approach, rooted in the ancient tradition of maintaining gardens that mimic natural forest structures, was modernized in the UK by Robert Hart, who adapted the techniques to temperate climates. His work inspired many to adopt and adapt forest gardening principles to their specific climates and ecosystems.

Purpose of Establishing Demonstration Models

Demonstration models of market-oriented orchards serve multiple purposes:

- **Educational:** They act as learning tools for farmers and communities, showcasing the benefits of diverse planting and sustainable agricultural methods.
- **Encouragement for Farmers:** These models inspire farmers to observe, experiment with, and adopt new technologies and methods that can improve their yield and income.
- **Innovation Resource**: Demonstration gardens serve as a resource for innovation, modern technology, and skills for farmers.

- **Biodiversity Promotion:** These gardens promote biodiversity and can help in preserving traditional plant varieties and agricultural practices.

2. Summary of steps for establishing an Abundant Orchard

These steps are outlined in more detail in the manual below.

- Select a location with suitable soil, water access, and proximity to markets.
- Plan the garden layout, including water management systems (contouring with soil and stones so that water infiltrates without runoff), construction of small reservoirs and irrigation systems and pathways.
- Choose a variety of plants that are suitable for the site, taking into account annual rainfall, wind exposure, summer and winter temperature extremes and amount of salt in the irrigation water.
- Choose a variety of plants that can grow together, including trees, shrubs, and ground cover that benefit one another, and plan where to plant each variety, taking into account sun, shade, wind and soil requirements (for example plants that need the soil to be ploughed versus plants that do not tolerate soil disturbance).
- Plough or dig the land and plant the seeds and plants.
- Regular care, such as irrigation, fertilization, pruning, mulching, and eco-friendly pest and disease management.

3. Land formation for water retention

Rainwater harvesting is the accumulation and storage of rainwater and snow melt for reuse in the garden. This water can be directed and stored in small reservoirs or slowed down so that it soaks into the soil where it is stored for plant roots to access. Even in a garden irrigated from groundwater, rainwater and snow melt are important as the water is fresh and capturing it:

- reduces flooding,
- reduces runoff and the loss of nutrients in the soil that is washed away, and
- stores the water in the soil, so that deep rooted plants (trees and shrubs) can grow without irrigation.

Methods of increasing soil water retention include:

Contour ridges and swales

These are ridges dug across the garden along the contour line, usually spaced between 5 meters (for steep slopes) and 20 meters (for almost flat slopes) apart. These ridges can be dug from soil or even made from lines of stones. The purpose is to create a swale that slows down the flow of water across the surface of the soil and allows it time to soak in.

Contour ridges do not have to be deep to be effective, even a swale20cm deep and 100cm wide can slow down the flow of water and protect the land below from erosion. Plants can be planted on contour ridges, and even inside swales in dry areas (Figure 2).

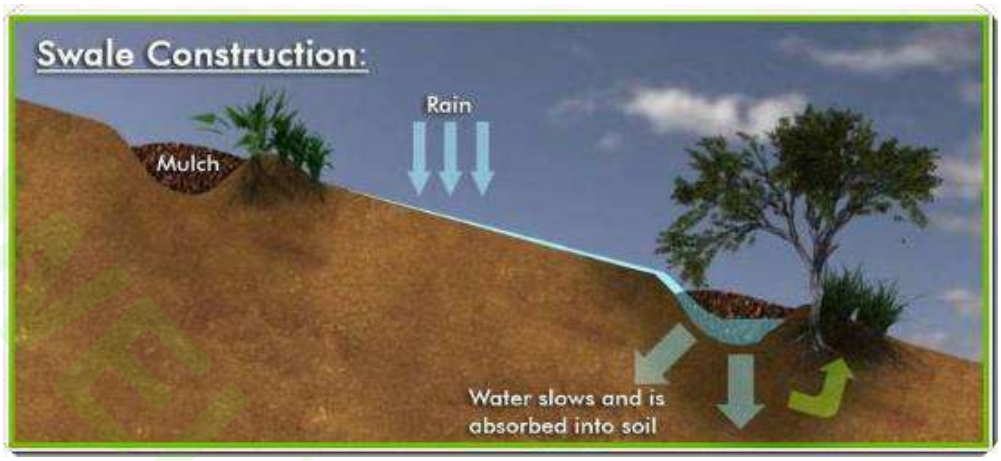


Figure 2: Design of contour ridges and swales on a slope

Figure 3 and Figure 4: Two different types of swale and contour ridges which can be used for water harvesting and to prevent erosion.

Bunding

Semi-circle or crescent shaped bunds facing directly upslope can be constructed using soil or stones. These are useful for increasing runoff water infiltration for individual trees, holding irrigation water, and are particularly useful on steep hillsides. Usually they are placed in staggered rows.

Figure 5 and Figure 6: Semi circle ridges bund for water collection.

Contour bench terraces

Terraces are a series of level strips running across the slope at vertical intervals, supported by steep banks or risers. They are best used in areas of intensive agriculture. The purpose of terraces are to reduce the speed and amount of water run-off to minimize soil erosion.

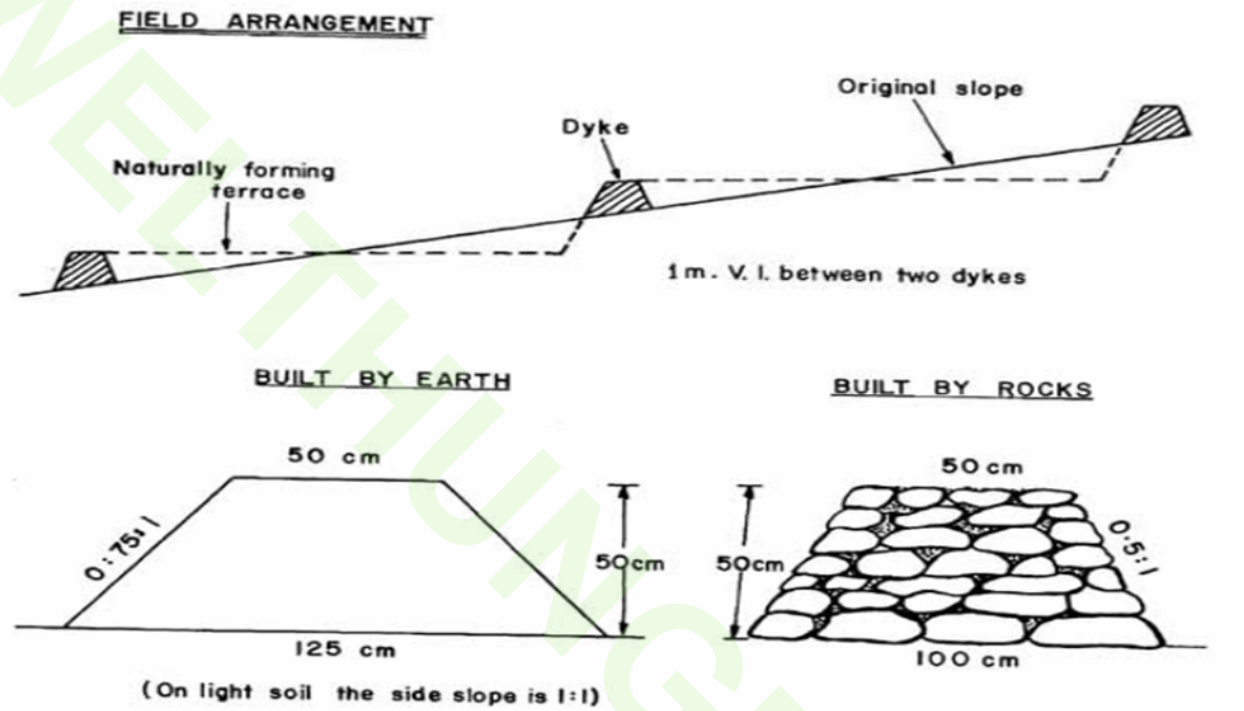


Figure 7: The segment of a terrace, built with earth (left) or stone (right).

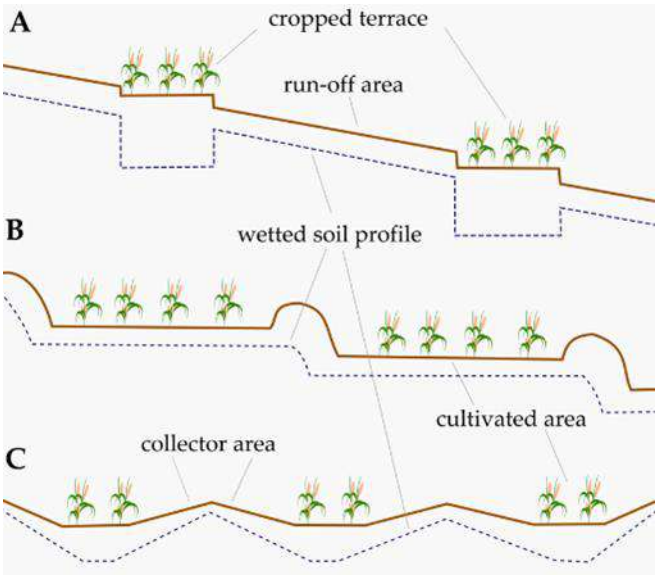


Figure 8: Different types of Contour bench terraces

Figure 9 and Figure 10: Contour bench terraces

Soil cover

Keeping the soil surface covered either with living plants, or with mulch (like a blanket) is a simple way of increasing how much rainfall and snow melt soak into the soil and keep the soil healthy.

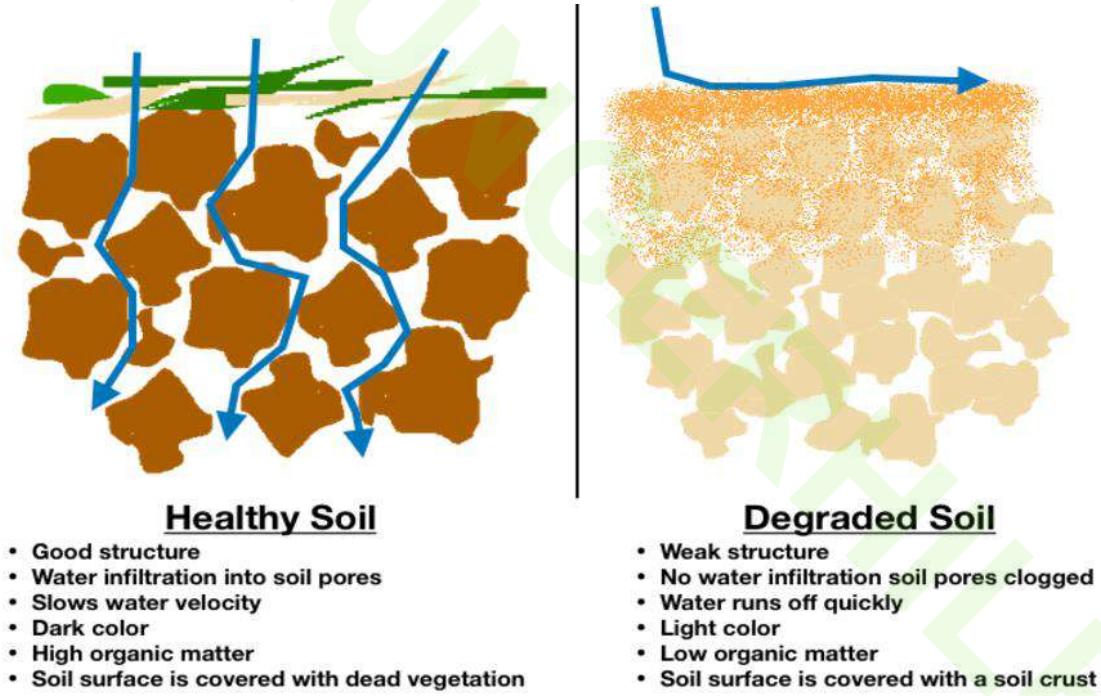


Figure 11: Differences between healthy and degraded soils

Ploughing

Ploughing the soil destroys a lot of the soil structure and soil micro-organisms and fungi that create a healthy soil. It is better not to plough, but if ploughing is required for the crop to grow, ploughing along the contour will create very small ridges that allow the rainfall and snow melt to soak in.

The use of A frames

A 'contour' is a line joining points of equal height above or below sea level, which helps us understand the slope of the land, and where water will flow (water always flows down the slope, across the contour). Our eyes are not very accurate at seeing slope, so an A frame can be used to determine an accurate contour line.

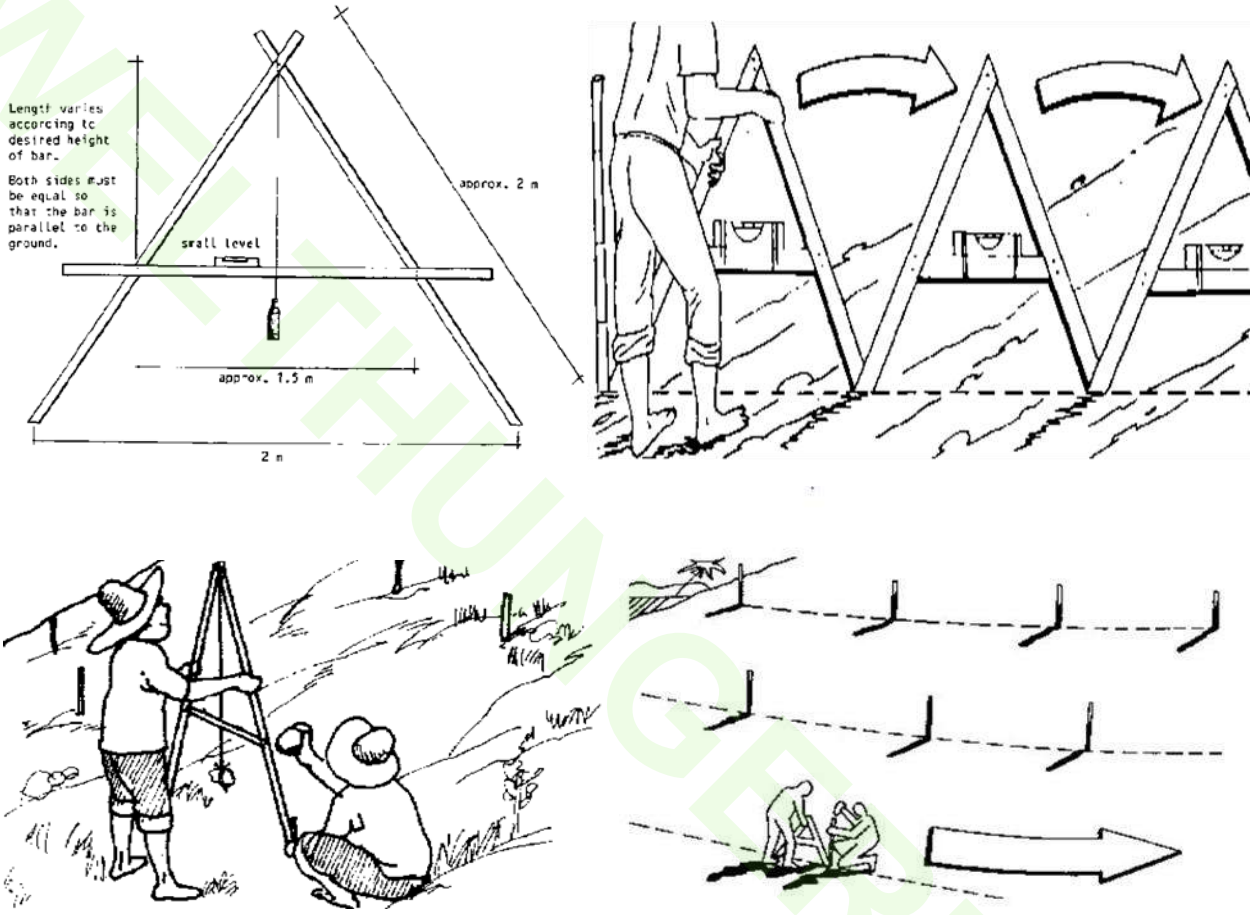


Figure 12, Figure 13, Figure 14 and Figure 15: Using an A-frame on sloped land.

Constructing an A-frame

The A-frame can be made using simple materials (Figure 12):

- two pieces of wood or bamboo about 120 cm long;
- one piece of wood or bamboo about 60 cm long;
- a carpenter's level or 60 cm of string and a stone to be made into a pendulum, and
- nails or string to fasten the A-frame joints together.

Once all the materials are collected, follow this method to construct an A frame:

- Nail or tie the two long pieces of wood together at one end.
- Set the "legs" of the frame on level ground so that the "feet" are one meter apart.
- Fasten the short piece of wood to the legs to make an "A".

- Using the carpenter's level, check that the crossbar is level, and connect the carpenter's level to the crossbar. If you are making a pendulum, hang the string from the top of the "A" and put the A-frame on level ground. Mark where the string crosses the crossbar.

To use the A-frame, follow these steps:

- Put leg A on the ground and move leg B forward or backward until the bubble in the carpenter's level floats to the center (or the pendulum swings to the center mark).
- Mark the position of the legs.
- Move the A-frame, placing leg A where leg B was before, and repeat the process (Figure 13).
- Move across the hillside along the contour, and place a marking stake every 3 to 5 meters (Figures 14-15).

Figure 16: The A-frame can be used for making terraces and leveling.

4. Irrigation water

The type of water the farmer plans to use for irrigation will determine what can be grown in the Abundant Orchard, and how productive the crops will be.

If the Abundant Orchard will be **rainfed**, then the farmer needs to plan a small garden of drought resistant plants and carefully design drains to direct any runoff water to the garden.

If the Abundant Orchard will be planted on **irrigated** land, there will be an opportunity for high productivity and the farmer must consider what plants can be grown together to make the best use of the available water and space. For example; consider planting perennial plants together, or along

the border of the orchard. Consider planting beans to climb up fruit trees, or melons and pumpkins under shrubs and trees to use all the space.

If the Abundant Orchard will be **irrigated from pumping underground water**, it is very important to test how salty the water is, as sometimes the water is contaminated and can be harmful to plants and human health.

Characteristics of Good Quality Irrigation Water for Agriculture:

1. **Low Salinity:** The salinity of irrigation water should be low to avoid damaging plants. High salinity can cause leaf burn and reduce plant growth.
2. **Low Total Dissolved Solids (TDS):** Irrigation water should have a low concentration of dissolved solids. High concentrations of dissolved materials can harm the soil and plants.
3. **Sodium Adsorption Ratio (SAR):** The SAR should be low to prevent the accumulation of sodium in the soil. Excessive sodium can damage soil structure and reduce its permeability.
4. **Appropriate pH:** The pH of the water should be in the range of 6.5 to 8.4 to be suitable for most plants.
5. **Absence of Toxic Materials:** Irrigation water should not contain toxic substances like heavy metals or harmful chemicals that can damage plants and soil.

The appropriate irrigation system for the site will depend on the resources and needs of the area, such as irrigation ditches, trenches, pipes, drippers, and other equipment commonly used in the field. Based on the type of crop being grown, an appropriate irrigation system should be set up for the orchard.

Surface Irrigation:

- **Type of Irrigation:** Furrow irrigation, surface irrigation, drip irrigation and flooding plots.
- **Water Source:** Surface water (river water, pond water, or irrigation ditches), groundwater (wells, springs).
- **System and Equipment:** Pumps, pipes for water distribution from the source to the reservoir or directly to the farm, buckets or barrels for water transportation by people and animals. Gravity helps direct water from the reservoir to the irrigation system.

Managing salty irrigation water

Water that tastes salty or bitter, might not be good for growing all plants. The following table shows what plants could grow in more salty (top of table) and less salty (bottom of table) water.

If you do not have anything to test the water, look at what other plants are growing well in the area and it could give you an idea of how salty the water is in that location.

Table 1: Salt tolerance of plants

Category	EC (mS/m)	Vegetable crop	Orchard trees / fruit	Other
Very salty water; Plants that are 'Tolerant' to salt	>500			
		Beetroot vegetables	Olive	Barley
			Pomegranate**	Cotton
				Grain Sorghum
				Wheat **
Salty water; Plants that are 'Moderately Tolerant' to salt	250-500			
		Zucchini	Fig	Sunflower
		Eggplant **	Pomegranate	Wheat
		Cabbage **	Olive	Oats
		Onion**	Melons **	Soyabeans
				Cotton
				safflower
Moderately salty water; plants that are	80-250			
		Tomato	Grape	Melon

'Moderately Sensitive' to salt		Cucumber	Pistachio	Alfalfa
		Potato	Plum	Cowpea
		Cabbage	Peach	Clover
		Corn / Maize	Almond	Vetch
		Spinach	Apple	Soybeans
		Eggplant	Pear	
		Pumpkin	Cherry	
		Lettuce		
		Cauliflower		
Low salt water; plants that are 'Sensitive' to salt	0-80			
		Bean	Pear	Sesame
		Carrot	Apple	Gram
		Onion	Apricot	Black, or Urd bean
		Turnip		Rice
				Pigeon peas

***with up to 25% yield reduction*

Signs that plants may be suffering from too much salt in the water include:

- Stunted plant growth.
- Plant leaves having a blue-ish to green colour.
- Leaf burn and dead tissue along the outside edges of older leaves.
- Young leaves appear yellow.
- Plants look like they are wilting, even when they have enough water.

To reduce the impact of moderately salty water on crop production, consider the following;

- Salty irrigation water will be less of a problem in sandy soil than in clay soil.
- Plants are more impacted by salty water during germination and at the seedling stage than when they are fully grown. Farmers should irrigate with the best quality water available when plants are germinating and small.
- To wash salt away from the root zone of plants, irrigate more deeply, less often. The worst thing to do with salty irrigation water is to do light irrigation when the weather is hot. This will increase the amount of salt close to the plant roots.
- If salinity is a problem, avoid fertilizers containing chloride
- Drip irrigation allows water with a higher salt content to be used as there is less evaporation.
- Local experience also shows that holding ground water in a surface reservoir for several days before irrigation, reduces the impact of poor ground water quality on plants.

5. Soil

Definition of Soil: Soil is the upper layer of earth in which plants grow. It is a mixture of organic matter, minerals, gases, liquids, and organisms that collectively support life. Soil serves as a natural environment for plant growth and provides essential nutrients and water.

Types of Soil in Agriculture in the north of Afghanistan

Various soil types, each with unique properties, affect agricultural productivity:

1. **Sandy Soil:** This soil has larger particles and feels gritty to the touch. It drains water quickly but does not retain nutrients well and is less fertile without amendments or the addition of organic materials or fertilizers.
2. **Clay Soil:** Made up of very small particles, it feels sticky when wet. It retains water and nutrients well but can become compacted, making root penetration difficult.
3. **Silty Soil:** Medium-sized particles give this soil a soft feel. It retains moisture better than sandy soil and is more fertile, but it may be prone to erosion.
4. **Loamy Soil:** Often considered the best for agriculture, loamy soil has a balanced mixture of sand, silt, and clay. It has good drainage, nutrient retention, and is easy to work with.
5. **Peaty Soil:** Rich in organic matter, it is dark and spongy. It holds moisture well and is acidic, which can be beneficial for certain crops.
6. **Chalky Soil:** Alkaline soil that contains a lot of calcium carbonate. It can be light or heavy but often requires organic additions to improve fertility.

Each type of soil has its advantages and challenges, and understanding these can help in selecting suitable soil management methods to increase agricultural productivity

Healthy soil contains various microorganisms like bacteria, fungi, and nematodes that play a role in decomposing organic matter and nutrient cycling. Keeping soil covered all year around with living plants and with mulch (like a blanket) is the best way to keep soil healthy.

6. Essential Nutrients

The soil contains a lot of nutrients for plant growth.

1. **Macronutrients (Needed in Larger Quantities):** These nutrients are required by plants in high amounts for growth and development. They include:

   1.1. **Nitrogen (N)**, **Phosphorus (P)**, **Potassium (K)**, **Calcium (Ca)**, **Magnesium (Mg)**, **Sulfur (S)**

   1.2. Other important macronutrients that plants need include **Carbon (C)**, **Hydrogen (H)**, and **Oxygen (O)**, which are available in the air and water.

2. **Micronutrients (Needed in Smaller Quantities):** These are essential but needed in smaller amounts. Lack of any of these can impact plant growth. They include:

   2.1. **Iron (Fe)**, **Manganese (Mn)**, **Zinc (Zn)**, **Boron (B)**, **Molybdenum (Mo)**, **Copper (Cu)**, **Chlorine (Cl)**

For healthy plant growth, it's essential to monitor and address nutrient deficiencies, as they can significantly affect crop yield and quality. Nutrient deficiencies can be addressed by adding more of the nutrient, or adjusting the pH of the soil so that the existing nutrients become more available to the plants.

7. Soil pH Levels and Acidity/Alkalinity

Soil pH is a measure of the acidity or basicity (alkalinity) of a soil. The pH scale goes from 0 to 14 with pH 7 as the neutral point.

Figure 17: Soil pH levels

- **pH 4.4**: Extremely acidic soil
- **pH 4.5 – 5.0**: Very strongly acidic soil
- **pH 5.1 – 5.5**: Strongly acidic soil
- **pH 5.6 – 6.0**: Moderately acidic soil
- **pH 6.1 – 6.5**: Slightly acidic soil
- **pH 6.6 – 7.3**: Neutral soil
- **pH 7.4 – 7.8**: Slightly alkaline soil
- **pH 7.9 – 8.4**: Moderately alkaline soil
- **pH 8.5 – 9.0**: Strongly alkaline soil
- **pH above 9.0**: Extremely alkaline soil

For growing most crops and plants, the ideal soil pH level is between 6.0 and 7.3. Some crops, like potatoes, corn, pine, and oak trees, can thrive in slightly acidic soils with a pH between 5.5 and 6.0. Soil testing can help determine the amount of lime needed to increase soil acidity or sulfur to reduce alkalinity.

In Afghanistan, high alkalinity is a common issue for agricultural soils. About 50% of Afghanistan's agricultural land has a pH between 8 and 8.5, 35% has a pH from 8.5 to 9, and 15% shows very high alkalinity, with pH levels above 9.

8. The impact of soil pH on nutrient availability for plants

Nutrients in the soil, whether they are already present or if they have been recently applied, are held in place by chemical bonds, either to clay particles, soil organic matter or other nutrients. Breaking these bonds and making the nutrients available to the plants requires various chemical reactions caused by water, organic acids secreted by plant roots or interaction with microorganisms in the soil. The speed and efficiency of chemical reactions are affected by pH – so pH has a major effect on nutrient availability.

Most nutrients are readily available to plants in soils with a pH range of 6 to 7.5. Outside this range, certain nutrients become either less available or toxic to plants, leading to nutrient deficiencies or toxicities that can hinder plant growth and reduce crop yields

The chart below shows the relative availability of different nutrients at various pH levels.

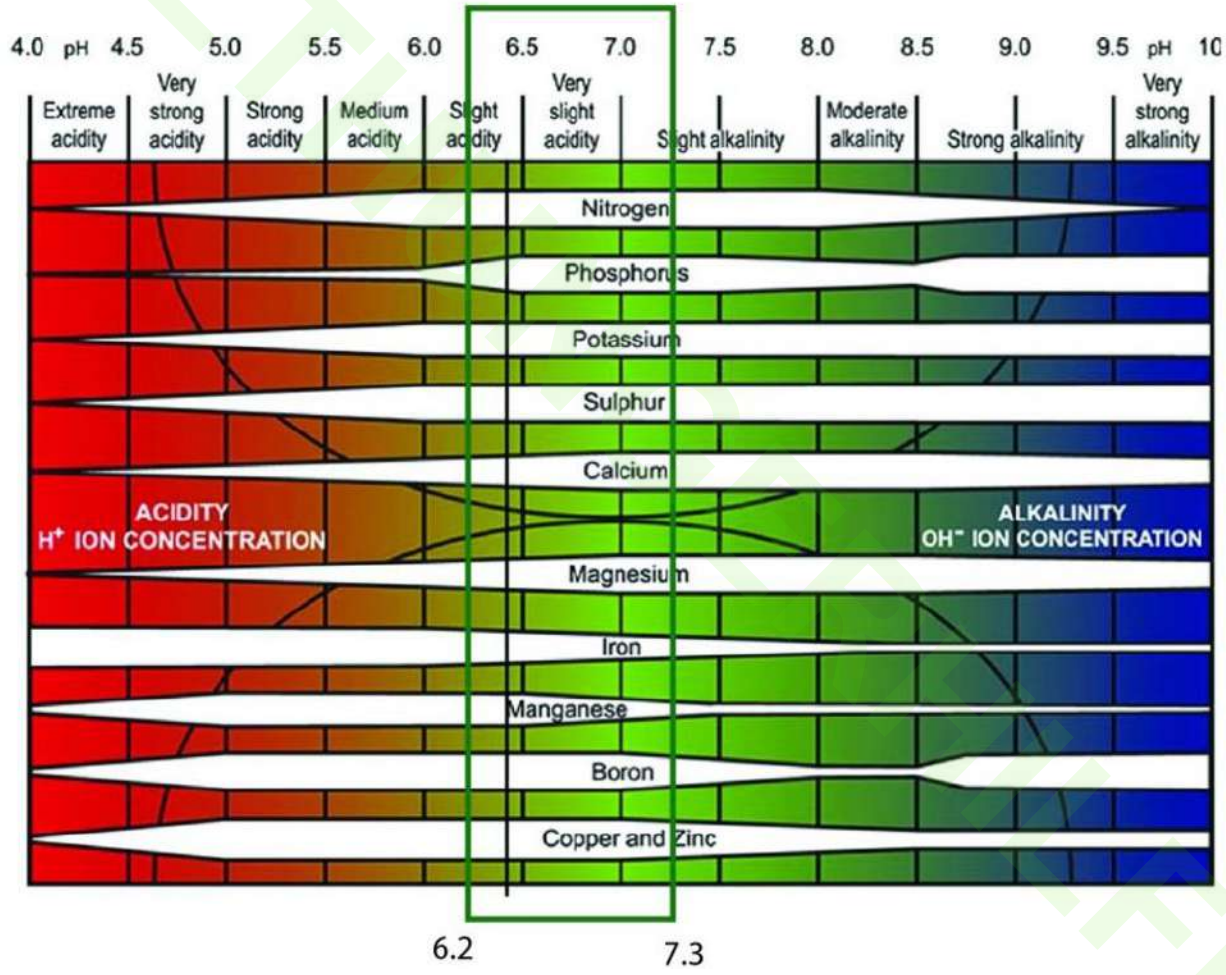


Figure 18: Availability of macro and micro nutrients at different pH levels (Image from: CaluSolv.com/ph-levels-management)

For example, if a soil has a pH of 8.5, most of the major nutrients will be in a form available for plants to use, except for Iron, Manganese and Boron. Phosphorous, Copper and Zinc will be available, but probably not in the quantities for best plant growth,

To increase soil acidity, fertilizers like aluminum sulfate can be used. However, it is essential to only apply them based on soil test results, handle these fertilizers carefully and avoid mixing them with other fertilizers without proper knowledge. Soil acidity can also be increased through the addition of organic matter to the soil by using organic fertilizers.

9. Fertilizers

Fertilization is the process of supplying essential elements to the soil. Applying the right amount of fertilizer helps maintain high-quality soil and achieve desirable yields. Fertilizer application should be based on soil analysis results (soil sample testing) and observation of plant growth.

Organic Fertilizers

1.1. **Compost:** is decomposed organic matter, great for enriching soil. Composting is the biological decomposition of organic materials or organic fertilizers used to enrich the soil and promote plant growth. Compost has more value compared to other types of chemical fertilizers.

Composting is a managed, aerobic (oxygen-required) biological decomposition of organic materials by microorganisms. It involves the breakdown of organic matter by bacteria, fungi, and other organisms, resulting in a nutrient-rich soil amendment

What is the compost

1. Compost is the product of the decomposition of various materials by different microorganisms in the presence of heat, moisture, and air.

2. Compost refers to the additional plant and animal materials, as well as urban waste, that lose their original form under decomposition conditions and turn into powder.

3. Thermophilic Composting: This process involves high temperatures (typically between 40°C and 70°C) that accelerate the breakdown of proteins, fats, and complex carbohydrates by heat-loving microbes

4. Compost can also be naturally prepared, transforming organic materials into a highly rich substance called humus, which makes the soil fertile.

Humus is the stable, final product of composting, rich in nutrients and beneficial for soil health

Benefits of Composting:

- Improves Soil Structure: Compost enhances soil structure, making it more fertile.
- Provides Plant Nutrients: It supplies essential nutrients to plants.
- Increases Water Retention: Organic matter in compost absorbs water, providing a water source for plant roots.
- Retains Nutrients: Compost helps retain essential and trace nutrients in the soil.
- Prevents Soil Erosion: It helps prevent soil degradation.
- Enhances Microbial Activity: Compost increases the activity of beneficial microorganisms in the soil.
- Reduces Soil Compaction: It reduces soil resistance to agricultural tools, making it easier to till and preventing clod formation.

- Cost-Effective: Composting is an easy and economical way to provide plant nutrients.

Compost can be made by layering 1 part 'green' to 3 parts 'brown' materials into a large pile or pit, with water. The pile needs to be a minimum of one square meter in size and will decompose over time (3-6 months) to become compost, or you can turn it every three days to add more air into the pile which will speed up the process (approx. 1 month).

Compost pile ingredients	
'Browns' approx. ¾ of the pile	'Greens' approx. ¼ of the pile
Fall leaves Dried gras Wood chips or saw dust Straw Paper *Too much brown results in a slow composting process*	Freshly picked green weeds (better if they do not have mature seeds) Green grass and plant clippings Vegetable waste from the kitchen Animal manure Animal offal – waste after slaughter Urine (this is strong, so only a small amount is needed) *Too much green results in a bad smelling compost pile*

Cut up the material into small pieces (less than 5 cm) and layer the materials (approximately 1 hand width of 'browns', then 2 finger widths of 'greens', repeated) so it is well mixed. It should be wet enough that when you squeeze a handful, only 1 drop of water comes out.

To check that the pile is composting, place a stick in the middle of the pile and after 3 days check that it is hot. If it is hot, and the pile smells sweet, the material is decomposing well.

Compost pile problems and solutions		
Symptom	**Problem**	**Solution**
The compost has a bad odor.	Not enough air.	Turn it.
The compost is damp and warm in the middle but nowhere else.	Pile too small.	Collect more material and mix with the old ingredients into a new pile.
The heap is damp and sweet smelling but still will not heat up.	Lack of nitrogen.	Mix in a nitrogen source like fresh manure, bloodmeal, or grass clippings.

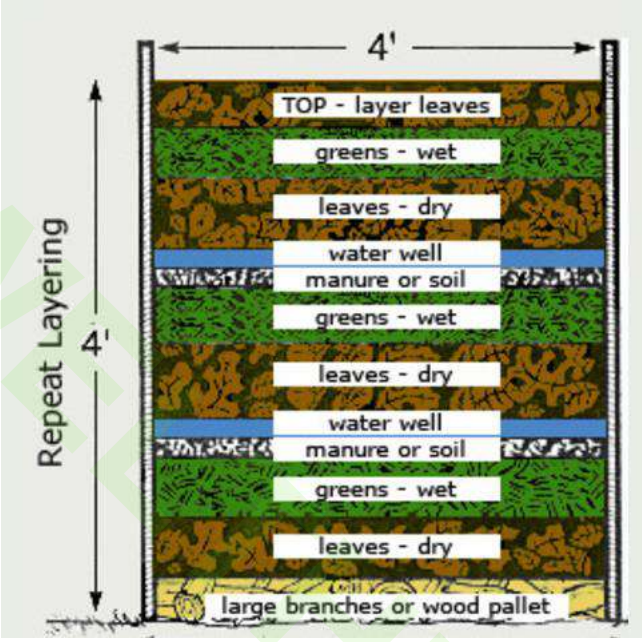


Figure 19: Layers of a compost pile Image from www.northcarolinahealth.com/backyard-composting-php

Figure 20: a fresh compost pile, a decomposed compost pile and the final product

The compost is ready to use when it is brown and well decomposed like soil (see Figure 19)..

To use: Add a handful to each planting hole for vegetables, add to a planting furrow before seeding (eg potatoes or wheat) or dig into the outer root zone of fruit trees.

1.2. **Well-rotted animal manure:** Manure from the animal stable provides essential nutrients for plant growth. Manure should be kept for 3 to 6 months before it is incorporated into the soil. Manure can be applied at a rate of 1 to 2 metric tonnes /jerib.

Figure 21: Well rotted manure

1.3. **Green manure:** is when plants such as grasses or legumes (which can fix nitrogen) are grown to improve soil fertility and water holding capacity of the soil. The crop is grown until it is about to produce seed, then the whole crop is ploughed into the soil to add organic matter (plant roots and leaves) into the soil.

Figure 22: Green Manure crops being ploughed into the soil

1.4. **Processed urine:** Treated to safely add nutrients.

Fresh human (and animal) urine is composed of 95% water and the 5% remaining are amino compounds (such as urea or creatinine), organic anions and inorganic salts making it a source of nitrogen and bioavailable nutrients and micronutrients for plant growth.

Stored urine is considered "safe" for fertilization application as urine contains low numbers of microorganisms compared to faeces and can be safely collected through source separation systems (*Unveiling the impact of human urine fertilization on soil bacterial communities: A path toward sustainable fertilization*, 2024, Rumeau, Pistocchi, Ait-Mouheb, Marsden and Brunel, Applied Soil Ecology 201 (2024) 105471)

Urine can be used fresh or stored for weeks or months in an opaque and airtight container. Dilute the urine with water at a 10:1 water-to urine ratio, and apply it directly to the soil AWAY from the leaves of the plants. Do not allow undiluted urine to directly contact the plant at full concentration.

1.5. **Chicken manure** is rich in essential nutrients like nitrogen, phosphorus, and potassium, making it an excellent fertilizer. However, chicken manure is very strong and can burn plants, so it needs to be diluted with water or other materials.

Chicken manure mixed with water:

- Mix 1 part chicken manure with 1 part water in a large container.
- Stir the mixture well, place a cover on the container (it will have a bad smell).
- Allow the mixture to ferment for 2 to 3 weeks. During this time, the nutrients from the chicken manure will leach into the water, creating a nutrient-rich liquid fertilizer.
- Separate the liquid fertilizer from any remaining solids by straining the mixture into another container through an old cloth. This will remove any undecomposed materials and ensure that you have a smooth liquid fertilizer.
- **Dilution:** Before using the liquid chicken manure fertilizer on plants, dilute it 1 part fertilizer to 4 parts water. This ratio can be adjusted depending on your plants' specific needs.

Benefits of Organic Fertilizers:

- They improve and sustain soil fertility over a long period, promoting microbial activity in the soil.
- They can be made by the farmer from local materials.
- Organic material is usually acidic, helping to reduce the pH of alkaline soils and make nutrients more available to the plants.
- Organic fertilizer feeds the soil and improves soil structure so the soil can store more water. Farmers are self-reliant and are not affected by international market price fluctuations (like for synthetic chemical fertilizers).

Drawbacks of Organic Fertilizers: They vary in nutrient content, and if not properly decomposed, they can sometimes harm plants and increase the amount of weeds in the orchard.

Application Rates, Timing, and Stages for Organic Fertilizers per Hectare

Organic fertilizer can be applied:

- Before planting. Compost can be placed into planting holes or plowed into the soil to mix it.
- Early in the growing season as the plant approaches full growth.

Inorganic Fertilizers

- **Natural Minerals:** Such as potassium nitrate and limestone, which provide essential minerals.

- **Synthetic Inorganic Fertilizers:** Chemically manufactured fertilizers, often available in 50kg bags in Afghanistan. These solid chemical fertilizers offer concentrated nutrients for quick and direct plant uptake.

Figure 23: Types of common fertilizers

Advantages of Synthetic Chemical Fertilizers:

- Contains a fixed, reliable amount of nutrients, especially nitrogen, ensuring consistent results.
- Strong and effective fertilizers that can be applied manually.
- Less work to make and apply (than organic fertilizers), generally affordable, and nitrogen is readily available for plants.

Drawbacks of Synthetic Chemical Fertilizers:

- Do not remain soluble for long periods and requires frequent applications. A lot of fertilizers are leached away before the plant roots can use them, causing pollution and wasting farmers money.
- Lack of ecosystem sustainability, as they do not support soil health or biodiversity. Synthetic chemical fertilizers feed the plants, but kill the bacteria and fungi that create healthy soils.
- Quick solubility may lead to reliance on market availability (e.g., limited potassium K_2O resources in Afghanistan).

Application Rates, Timing, and Stages for Synthetic Fertilizers per Hectare

1. **Urea Fertilizer (White Fertilizer)**
    - **Application Rate:** 50-200 kg per hectare (20 to 40kg/ Jerib) apply half at sowing and half during growing season
    - **Application Time and Stages:**
        - Before planting, during soil preparation and plowing
        - At the early growth stage or tillering stage
2. **Diammonium Phosphate (DAP) Fertilizer (Black Fertilizer)**
    - **Application Rate:** 100-200 kg per hectare (20 to 40kg/ Jerib)
    - **Application Time and Stages:**
        - During soil preparation and plowing, before planting
        - Early in the growing season as the plant approaches full growth

3. **Potassium Fertilizers**

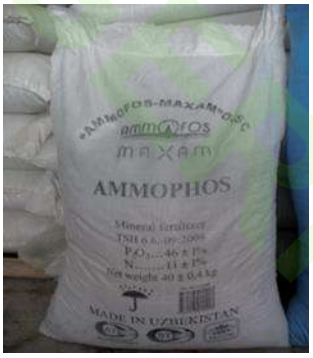
- **Application Rate:** 150-200 kg per hectare (30 to 40kg/ Jerib)
- **Application Time and Stages:**
  - Before planting, as a base application
  - Early in the growing season
  - At the fruit development stage to promote fruit growth and nutrient delivery

کود های نایتروجن دار	تجزیه وتحلیل	مقدار سلفر	مقدار پوتاشیم	مقدار فاسفورس	مقدار نایتروجن
یوریا – کود سفید	46-0-0-0	0	0	0	46
امونیم نایتریت	34-0-0-0	0	0	0	34
امونیم سلفیت	21-0-0-24	24	0	0	21
نایتروفاسفیت	23-23-0-0	0	0	23	23

کود های فاسفورس دار	تجزیه وتحلیل	مقدارسلفر	مقدار پوتاشیم	مقدار فاسفورس	مقدار نایتروجن
دای امونیم فاسفیت (DAP) – کود سیاه	18-46-0-0	0	0	46	18
امونیم فاسفیت(اموفاس)	11-46-0-0	0	0	46	11
سوپر فاسفیت ساده	0-20-0-0	0	0	19-23	0
سوپر فاسفیت تریل	0-45-0-0	0	0	42-49	0

کود های پوتاشیم دار	تجزیه و تحلیل	مقدار سلفر	مقدار پوتاشیم	مقدار فاسفورس	مقدار نایتروجن
پوتاشیم کلوراید	0-0-50-0	0	40-60	0	0
پوتاشیم سلفیت	0-0-50-40	40-45	50	0	0
دای امونیم فاسفیت	10-26-26-0	0	26	26	10

Figure 24 List of Common Synthetic Chemical Fertilizers and Their Nutrient Contents



Note: The numbers in fertilizers (e.g., Urea 46-0-0) represent the percentage composition of nutrients: the first number indicates the percentage of Nitrogen (N), the second represents Phosphorus Pentoxide (P_2O_5), and the third shows Potassium Oxide (K_2O) in the fertilizer.

Application and Addition of Inorganic (Chemical) Fertilizers:

You should be aware that the analysis, decomposition, and grading of chemical fertilizers refer to the presence of the minimum amounts of Nitrogen (N), Phosphorus (such as Phosphorus Pentoxide), and Potassium (such as Potassium Oxide) in the fertilizers, which is always indicated on the bags, cartons, or containers. Please note the number **10-10-10**, which represents 10% Nitrogen, 10% Phosphorus (P_2O_5), and 10% Potassium Oxide (K_2O).

Therefore, each 50-kilogram bag of fertilizer labeled **10-10-10** contains:

- 5 kilograms of Nitrogen (N)
- 5 kilograms of Phosphorus Pentoxide (P_2O_5)

- 5 kilograms of Potassium Oxide (K_2O)

Before applying the fertilizer, you should ensure the quality and fertility of your soil area and always follow the guidelines provided on the fertilizer packaging.

10. Preparing the Land or Area

1. **Select a piece of land** based on the plants you intend to grow, considering crop rotation laws, and prepare the field according to the needs of the trees and plants to be cultivated.
2. **Dig or construct the contour structures** for water infiltration (see Section X).
3. **Plan the irrigation system** based on the available water source, the crops to be planted, and design suitable seed beds based on the location of the contour structures. Consider the irrigation system and the directions in which water is transferred from the source. Make sure to set up the irrigation channels accurately, so they can water all the layers or sections you create.
4. For small areas of cropping, the following land preparation steps can be taken. Remember – ploughing the soil kills the healthy microbes, so it is better to focus plant choices on perennial plants, and where possible, only dig the soil where annual grain crops will be planted.

Plowing: Plowing is the first step of the land preparation process, which should be done before planting crops. This process helps break up hard, compacted layers in the soil , increases the amount of air in the soil and exposes weeds to the sun so they die. Unfortunately ploughing also breaks up healthy soil structure, exposes microbes and fungi to the air so they die and, if ploughed too often can lead to soil structure problems. You should choose an appropriate method for this process and use oxen or a disc for plowing. Plowing Methods and techniques are as follows:

a. **Shallow Plowing:** The plowing depth should be between 5 to 12 cm and should be done immediately after the final harvest of the crops (e.g., in cereals).
b. **Light Plowing:** This plowing has a depth of 10 to 18 cm and is used to improve soil structure.
c. **Medium Plowing:** This plowing reaches a depth of 18 to 24 cm and should be done before winter. It can be used for any type of soil.
d. **Deep Plowing:** This plowing reaches a depth of 24 to 30 cm and should be done before winter and before planting perennial or multi-year plants.
e. **Very Deep Plowing:** This plowing has a depth of 30 to 35 cm and should be used in spring before planting root vegetables.
f. **Full Profile or Full Soil Surface Plowing:** This type of plowing should be 60 cm deep and is used to prepare the area for establishing orchards or gardens.

Traditionally plowing is done:

- For winter growing: in early winter before seeding.
- For Summer growing: in spring to kill weeds, then again before seeding.

Sometimes people plow to mix in the seed after spreading the seed.

Collecting Extra Materials Before Planting: After plowing and before sowing seeds, any materials (such as stones, clod, large roots and weeds) that the plowing has brought to the surface should be collected and removed. Stones that have been collected can be placed on contour to help with water management.

Harrowing: If harrowing the land before sowing seeds is necessary, it should be done after collecting extra materials. This process helps to level the land before sowing.

1. **Rolling the Land:** Rolling or leveling the land before sowing seeds: If leveling the land is needed, it should be used (if harrowing alone is not enough). Rolling should only be used on light soils, not on heavy soils. It is important to ensure that after rolling and leveling, sowing should be done immediately.
2. **Rolling and Leveling after Sowing Seeds:** This process helps reduce soil moisture evaporation and ensures proper seed retention in the seedbed. Various types of rollers can be used, such as wide, milled, or toothed rollers, light or heavy.

Identifying and Determining Planting Plots:

To maintain and keep track of each farmers information, create a table for each plot or planting section and record the following information:

a. Plot or section number
b. Area of each plot or section
c. Name and variety of the plant sown
d. Date of sowing or seed planting

To record accurate and correct information about the area, create a book where the details of the plots or planting sections under cultivation are documented. This book should include diagnostic information (as mentioned in the information table above), along with other activities (such as irrigation system details, fertilization date and type, weed control dates and methods, and pest control activities such as the use of herbicides, fungicides, or insecticides, as well as the dates of agronomic activities like plowing, and harvesting dates).

Seed/Seedling Sowing:

Always use quality seeds and seedlings. To prevent purchasing poor-quality seeds, follow these guidelines:

- **Check Harvest Year / Expiry Date:** Seeds should not be old.
- **Place of Seed Production:** Ensure that the seeds are produced in a similar climate and are suitable for your environmental conditions.
- **Seed Producer's Name:** Ensure that the producer has a good reputation for producing high-quality seeds.
- **Certification availability:** Certified seeds are usually better quality than non-certified seeds. Always test and check seed and seedling samples to determine their quality. At a minimum,

you should visually inspect the seeds to avoid purchasing poor-quality (broken, mixed) seeds. If you have time, test the seed samples germination rates for viability.

Steps for seed germination test:

1. Take a double thick paper towel and moisten it with water.
2. Place a minimum of 10 seeds on one side of the towel.
3. Carefully fold the wet paper towel over the seeds.
4. Place the paper towel and seeds in a plastic bag and seal it, or place it on a glass plate, with a second glass plate as a cover. Place in a warm, sunny location
5. Label it with the variety and the date, and check and record the germination progress every day.

Before Sowing Seeds:

- Consider crop rotation recommendations: Are you choosing the correct crop to plant?
- **Field Inspection:** Is the field properly leveled? Are the remnants of previous plants well processed, and used as mulch?
- **Soil Structure Inspection:** Does the selected soil have a good structure without clods and hard layers?
- **Soil Moisture Inspection:** Is the soil too wet or too dry for seed germination?
- **Sowing Date Inspection:** Is this the right time to sow the seeds, or is it too early or too late?

Types of Seed Planting:

By Hand or Machine: Seeds can be sown manually or using a machine, either a simple seed spreader operated by hand or advanced seed planting machines.

- **Broadcasting Seeds by Hand:** In this method, the seeds are scattered by the farmers as they walk across the field.
- **Sowing Seeds in Beds or Furrows by Hand:** In this method, multiple seeds are planted by farmers in beds or furrows that have been prepared beforehand, then covered with soil.
- **Row Planting by Hand:** In this method, seeds are sown by farmers in organized rows that have been prepared and marked beforehand. The seeds are then covered with soil, or this can be done using a machine planter or seed drill.