Citrus Orchard Foreman Occupational Learning

citrus academy
P.O. Box 461, Hillcrest, 3650
(031) 765-3410

Work Scenario Guide

B3:
Land Preparation

Qualification:	110667 – Occupational Certificate: Orchard and Vineyard Foreman
Work Scenario:	**B3: Land Preparation**
Learning Area:	B: Lead the establishment of new citrus orchard
Scenario Description:	Before your orchard can be built, you may need to prepare the land. You need to oversee any land preparation activities, and ensure that the goals are met effectively and efficiently.

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Content originator:
Citrus Academy

Occupational alignment:
Ukudla Namanzi (Pty) Ltd

Contents

Alignment Information

Qualification

The content of this learner guide is aligned to the following occupational qualification:

<table>
<tr><td>SAQA QUAL ID</td><td colspan="4">Qualification Title</td></tr>
<tr><td>110667</td><td colspan="4">Occupational Certificate: Orchard and Vineyard Foreman</td></tr>
<tr><td colspan="5">Originator</td></tr>
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<tr><td colspan="2">Occupational Certificate</td><td colspan="2">Field 01 - Agriculture and Nature Conservation</td><td>Primary Agriculture</td></tr>
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<tr><td>Undefined</td><td>147</td><td>Not Applicable</td><td>NQF Level 04</td><td>Regular-ELOAC</td></tr>
</table>

Modules

The content of this learner guide is aligned to the following modules of the occupational qualification above.

Module Code	Module Title	Level	Credits
Knowledge Modules			
611202-001-00-KM-01	Plant Structure and Physiology	4	5
611202-001-00-KM-02	Vineyard or Orchard Establishment	3	2
611202-001-00-KM-03	Vineyard or Orchard Manipulation Processes	3	8
611202-001-00-KM-04	Harvesting	3	4
611202-001-00-KM-05	Basic Principles of Plant Nutrition	4	4
611202-001-00-KM-06	Crop Protection	3	3
611202-001-00-KM-07	Assets in Horticultural Production	3	2
611202-001-00-KM-08	Farm Business Management and Farming Process Management	4	8
611202-001-00-KM-09	Human Resource Management and Processes	4	8
611202-001-00-KM-10	Overseeing Farming Resource Utilisation	4	8
Practical Skill Modules			
611202-001-00-PM-01	Organise, Allocate and Monitor Availability and Productive Use of Resources	4	5
611202-001-00-PM-2a	Set Team and Individual Performance Goals to Enhancing Team Performance	4	10
611202-001-00-PM-2b	Control Vineyard or Orchard Practices	4	10

611202-001-00-PM-03	Supply Accurate Daily Orchard or Vineyard and Production Information	4	10
Work Experience Modules			
611202-001-00-WM-01	Vineyard or Orchard Resource Optimisation	4	20
611202-001-00-WM-02	Skilled and Motivated Work Team Output	4	20
611202-001-00-WM-03	Daily Orchard or Vineyard and Production Information Availability	4	20

Learning Outcomes

The content of this learner guide is aligned to the following learning outcomes of the modules above.

Knowledge Topics	
Outcome Code	**Module Title**
KM-02-KT03	**Block establishment**
IAC0304	The practical application of physical and chemical corrective measures such as mechanical soil preparation, pre-planting soil amelioration to improve fertility and soil conditions and methods of pre-plating fertiliser application during soil preparation based on analysis results is discussed
KM-02-KT04	**Crop establishment**
IAC0404	Pre-planting soil improvement such as the correction of pH and nutrient status to improve fertility and soil conditions is explained in terms of the outcome of young plant growth
IAC0405	The methods of pre-planting fertiliser application is discussed in terms of efficacy in a given situation
IAC0406	The correct application of mechanical soil preparation methods is described
KM-05-KT04	**Principles of soil preparation and remediation**
IAC0401	The basic concept and principles of soil preparation and remediation is explained
IAC0402	The importance of soil preparation and remediation is explained
IAC0403	The practical application of physical and chemical corrective measures such as mechanical soil preparation, pre-planting soil improvement for fertility and soil conditions is outlined and motivated
IAC0404	Methods of pre-planting fertiliser application during soil preparation is discussed
KM-08-KT06	**Farm renewal strategy**
IAC0604	Methods and operations to be applied in the establishment of new orchards/vineyards are discussed
IAC0607	Methods and operations to be applied in the replacement of orchards/vineyards are discussed
Practical Skills	

Chapter 1
Soil Characteristics

learning outcomes

The content of this chapter is aimed at helping you to:

- Describe the different properties of soil.
- Identify the different soil categories.

1. Soil

When planning a new orchard, one of the first considerations is the soil in the area you plan to plant the orchard. Good quality soil is vital to growing healthy, productive trees, and sometimes soil requires improvement before it is suitable for an orchard. In this chapter we will discuss the various characteristics and properties of soil, and then deal with the preparation of soil for a planting in the second chapter.

Soil is a natural resource that is a combination of living and non-living components, consisting of finely divided mineral substances, atmospheric gases, water, and living and dead organic material. Soil is created by formation processes over thousands of years, and, as a result of the differences in these formation processes, soil types differ widely across the world.

The living components of soil are considered renewable resources, and the mineral (non-living) components non-renewable resources. As long as the living components of soil remain healthy and continue to function, the mineral components are recycled from the soil through the organic life within it, such as bacteria and other micro-organisms, and back to the soil following the decay and breakdown of dead organic material.

Because most forms of life are dependent directly or indirectly upon soil for their continued existence, soil needs to be maintained in a renewable state. Not taking care of your soil, or using it in such a way that it is eroded or rendered infertile reduces the likelihood that life (in your case, citrus trees) can continue to exist and thrive in the affected area.

2. Soil Potential

definition

Soil Potential

Soil potential refers to the ability of the soil to support plant growth and produce a good quality crop.

Soil potential is an important concept in agriculture. The soil potential determines the type of crop that can be grown in a specific soil, and the volume and quality of crops that can be produced.

Soil potential is judged by the following criteria:

- Soil fertility

- Plant available water
- Soil permeability

These criteria are all influenced by the characteristics of the soil, and especially by the soil texture (discussed later). Soil fertility and plant available water is especially affected by the texture of the subsoil and topsoil, while soil permeability is affected mostly by the texture of the topsoil.

2.1. Soil Fertility

definition

Soil Fertility

Soil fertility refers to the nutrient content of the soil and the ability of the soil to sustain plant growth.

Plants absorb sunlight, oxygen and carbon dioxide from the air, and water and nutrients from the soil. Soil fertility can be thought of as the amount of food that the soil can supply to the plants. Plants need seventeen elements for normal growth. They are:

- **Carbon**, **hydrogen** and **oxygen**, which come from air and water.
- **Nitrogen** is the major essential nutrient element, and also a major plant constituent. Although the atmosphere contains 78% nitrogen, it is not directly available for plant use from the air. In citrus production, nitrogen is taken up from the soil.
- The other **thirteen essential nutrient elements** come from the soil and are iron, sodium, calcium, phosphorous, potassium, copper, sulphur, magnesium, manganese, zinc, boron, chloride, and molybdenum.

Under normal circumstances, the nutrients naturally available to plants from the soil vary with clay content. Generally, the higher the clay content, the higher the soil fertility. There is a limit though, as too much clay content can lead to clay particles binding with nutrients strongly, making fewer nutrients available to the plant.

2.2. Plant Available Water

Plant available water refers to how much water there is in the soil that your trees can access. There is a considerable variation in the capacity of soils to store and release water for your trees to take in. This quality is also referred to as the water holding capacity of the soil.

Water holding capacity is measured in mm water per mm soil. In some clay soils, water holding capacity may be as high as 25mm water per 100mm soil, while it can be as low as 6mm per 100mm soil in sandy soils. Although clay soils can store more water than sandy soils, the water may not be available to the plants during periods of fast growth. Sandy soils retain less moisture, but the water is more readily available to plants.

2.3. Soil Permeability

Soil permeability refers to the ease with which air, water and roots can penetrate the soil. This is determined by the number and size of the open spaces, or pores, in the soil. Clay soils have a large number of pores, but they are very small. Soil with very high clay content does not allow air, water or roots to move freely through it. Sandy soils, on the other hand, have less but larger pores, and air and water move more easily through it.

3. Soil Characteristics

There are several other characteristics that affect the suitability for crop production of the soil. These characteristics include:

- Texture
- Structure
- Layering, or stratification
- Chemical and mineral composition
- Depth

These factors determine the depth of the effective root-zone of the crop, and therefore the production potential of the soil. They also indicate the possible dangers related to crop cultivation and irrigation.

3.1 Texture

Texture relates to the ratio between the different sized particles, being sand, silt and clay, in the soil. Many soil characteristics determining the suitability for specific crops are directly and indirectly related to texture. In general, the finer and more clayey the soil texture is, the more difficult a soil is to work or till. This soil will also have higher water holding capacity, and a lower permeability. The soil surface will also crust more readily.

3.2 Structure

Soil structure refers to the manner in which all the soil particles, including organic material, are arranged to form structural units. Good structure of the surface soil is promoted by an adequate supply of organic matter.

Soil structure results from the natural grouping together of all the various particles that can be separated from each other. The primary particles include the amount and type of clay and organic material, and sand, gravel and stones.

The factors that determine the soil structure include the amounts of particles, ratios between exchangeable and soluble nutrient elements, wetting and drying cycles, soil depth, and tillage practices, among other factors.

Structure is a characteristic of soil that can be relatively easily changed by farming practices. Soil structure has an influence on movement of air, water and roots in the soil, as well as erosion, ease of cultivation and effective soil depth.

Growing plants also change the soil structure as they send their roots into the soil for mechanical support and to gather water and nutrients. Since plant roots move through the same channels in the soil as air and water, good structure allows extensive root development whereas poor structure discourages it.

3.3 Layering or Stratification

It takes about 1,000 years to form a 25mm layer of soil. When soil is being formed, soil particles are separated and accumulate at different depths. Soils are also carried and deposited by water and wind to form layers with different soil properties.

Layers have an influence on the potential of the soil. Roots do not grow and water does not move easily from one layer to another if the properties, especially the texture, differ too much. The sub-surface soil layers must also be such that it does not prevent the flow of sub-surface water.

3.4 Chemical Composition

The chemical composition of soils is mainly determined by the original material from which it developed, its age, its drainage, the climate, micro-organisms that are present in the soil, and the quality of irrigation water.

3.5 Soil Depth

Soil depth refers to the depth to which the roots of plants can easily penetrate. Soil depth influences root growth and the water holding capacity of the soil. Plants that can develop deep root-systems grow better than plants with restricted root systems. Deep soils normally have more available water and nutrients than shallower soils.

4. Soil Degradation

Soil degradation means a decrease in the quality and potential of the soil and can result from a variety of actions or circumstances. Soil degradation decreases the ability of soil to support and sustain life, and therefore negatively impacts agricultural production and other natural resources and thus biodiversity.

In order to measure and monitor soil degradation, it is essential to determine the current soil potential and soil characteristics. This is done through soil analyses and surveys and may include actions such as soil sampling and digging profile pits.

The services of soil scientists are often required to make an initial survey of a new farm and to develop a soil utilisation plan. After this planning process, the status of the soil is monitored on an on-going basis through sampling and analysis. Soil degradation is normally caused by circumstances such as:

- Over-use of soil without replacement of lost nutrients
- Compaction due to heavy vehicular traffic or repeated movement of animals on the surface
- Erosion of topsoil
- De-structuring of soil due to run-off and particle breakdown
- Salinisation of soil due to high carbon and nitrogen deposits from floods, fire, and high volume inorganic fertiliser and crop protection applications
- Depletion of soil nutrients by invasive species
- Pollution of soils by artificial deposits or unbalanced land-use

The nitrogen cycle is a good illustration of the impact that various farming activities have on the nitrogen content of soil. As we have already mentioned, nitrogen is a major plant nutrient and soil component. The manner in which the nature of the nitrogen in the soil changes in the course of the cycle plays a major role in the ability of the soil to support plant growth.

definition

Nitrification

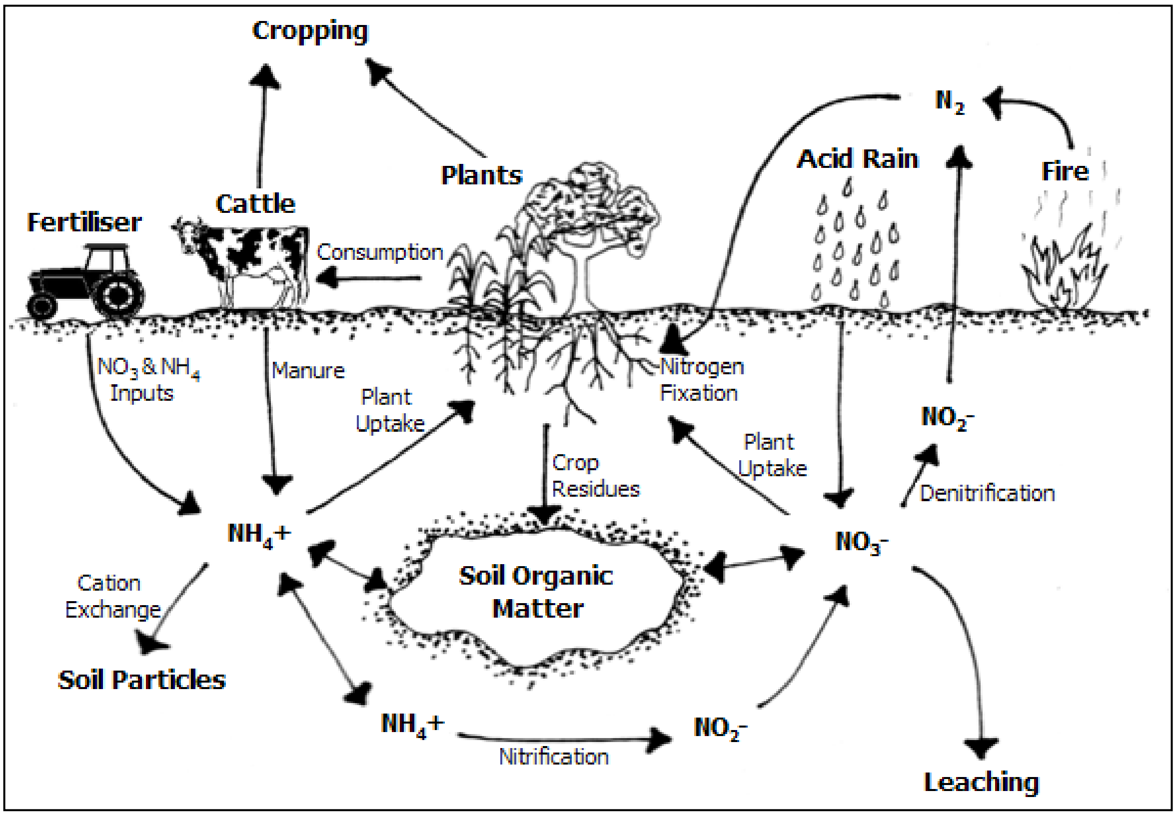
Nitrification means the oxidisation of ammonia ions into nitrite or nitrate ions, as nitrobacteria do.

Denitrification

Denitrification means the conversion of nitrates into nitrites and ammonia.

Nitrogen Fixation

Nitrogen fixation means the natural conversion of atmospheric nitrogen by bacteria found in the nodules of legumes into compounds in the soil that plants and other organisms can use.



The Nitrogen Cycle

5. Soil Erosion

Soil erosion occurs when soil is removed through the action of wind and water at a greater rate than it is formed. When a raindrop hits soil that is not protected by a cover of vegetation and where there are no roots to bind the soil, it has the impact of a bullet. Soil particles are loosened, washed down the slope of the land and either end up in the valley or are washed away out to sea by streams and rivers.

The topsoil is the nutrient-rich upper layer, and gets eroded first. When it is gone, the production potential of the soil decreases severely. Soil covering the surface of the earth has taken millions of years to form and must be protected.

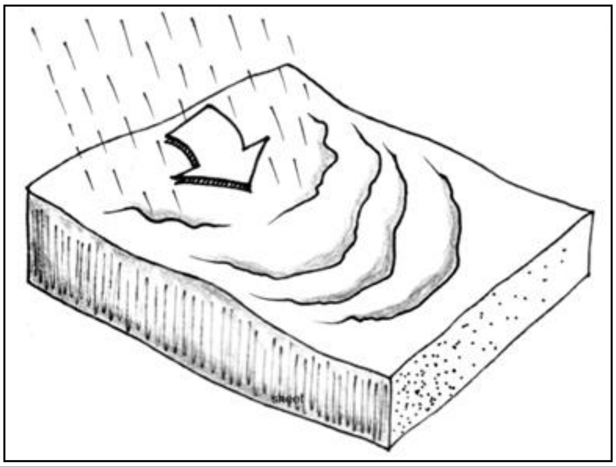
In its natural state in any micro-environment, soil is covered and protected by natural vegetation. Removing natural vegetation to work the land, build on it, or for any other use, results in irreversible changes to the soil and increases the risk of soil erosion. The most common forms of erosion are water erosion and wind erosion.

6. Water Erosion

Water erosion causes two types of problems, being on-site loss of agricultural potential, and the off-site effects of downstream sedimentation, causing flooding and the silting up of reservoirs. The main forms of water erosion are:

- Sheet erosion
- Rill erosion (channel erosion)
- Gully erosion

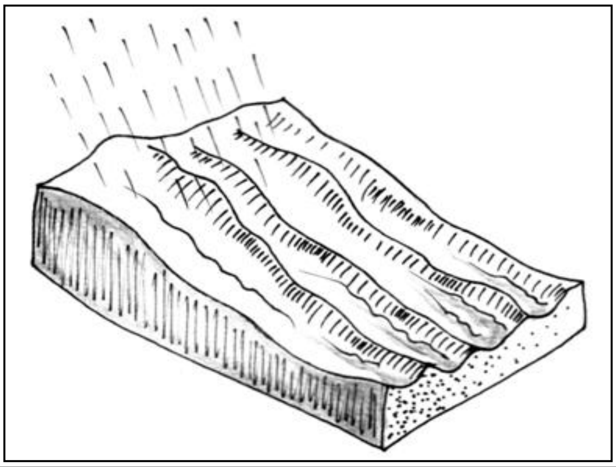
6.1 Sheet Erosion



Sheet erosion

Sheet erosion is characterised by the down-slope removal of soil particles by a thin sheet of water. Sheet erosion causes the entire surface of a field to be gradually eroded in a more or less uniform way. It is a gradual process, and it is not immediately obvious that soil is being lost.

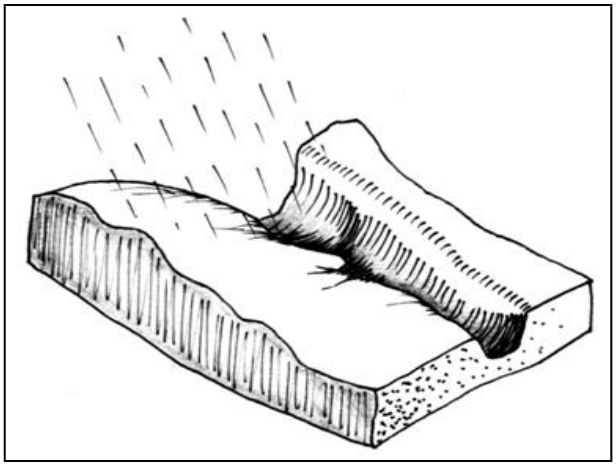
6.2 Rill Erosion (Channel Erosion)



Rill erosion

Channel erosion can occur on steep land or on land that slopes more gently. Because there are always irregularities in a field, water finds hollows in which to settle and low-lying channels through which to run. As the soil from these channels is washed away, the channels become deeper, and miniature dongas (gullies) are formed in the field.

6.3 Gully Erosion (Dongas)



Gully erosion

Dongas (gullies) usually occur near the bottom of slopes and are caused by the removal of soil and soft rock as a result of concentrated runoff that forms a deep channel or gully.

On steep land, there is often the danger of gullies forming. Water running downhill cuts a channel deep into the soil and where there is a sudden fall, a gully head forms at the lower end of the channel and gradually works its way back uphill. As it does so, it deepens and widens the scar that the gully makes in the hillside. Gully erosion is related to stream-bank erosion, in which fast-flowing rivers and streams increasingly cut down their own banks.

7. Wind Erosion

Wind erosion occurs when the land surface is left bare in regions that are arid enough, as a result of low rainfall, to allow the soil to dry out, and flat enough to allow the wind to carry the soil away over an extended period of time. Land may become susceptible to wind erosion as a result of the grazing of animals that remove the protective plant cover, and whose hooves break up the soil, especially round watering points. Arable land that has been left bare is also a major problem.

8. Soil Characteristics and Erosion

There are various soil and land characteristics that impact on the erodibility of the soil, of which the following are the most important:

- Slope
- Soil texture
- Soil structure
- Topography
- Organic material
- Vegetation cover

8.1 Slope

The steeper the slope is, the greater the erosion will be, as a result of the increased speed of water-flow. The length of the slope is also very important, because the greater the size of the sloping area is, the greater the concentration of the flooding water.

8.2 Soil Texture

Soil texture has an effect on the extent of the erosion that will take place. For instance, a heavy rainstorm on a steep slope with sandy soil and no vegetation cover will lead to major erosion. In the same scenario, clay soil will suffer much less erosion.

8.3 Soil Structure

Soil with poor structure, meaning a high level of sand and low clay and organic content, erodes much more readily than a soil with a well-balanced structure. Structure can be altered by cultivation practices. Over-cultivation and compaction cause the soil to lose its structure and cohesion, which is its ability to stick together, causing it to erode more easily.

8.4 Topography

At the crest (top) of the slope the soil is usually well-drained, because soil moisture moves downhill, leaving air in the pore spaces of the soil most of the time. Over time, the fine, clay particles are carried down the slope, leaving the soil at the crest sandy. Plant roots can penetrate easily to deep levels and withdraw enough soil water from there. These soils have a lower erosion potential and are normally more stable.

In the mid-slope area, soil moisture moving from the crest starts to dam up as a result of the clay-rich soil just downhill. The soils are moderately well-drained with a higher erosion potential. In the foot-slope, the soil becomes waterlogged, meaning saturated with water, as a result of the long-term accumulation of clay which does not allow water to infiltrate. Plants that grow on these soils are limited to those that can adapt their root systems to grow laterally above the hard, clayey layer. These imperfectly drained soils have a high erosion potential.

8.5 Organic Material

Organic material is the glue that binds soil particles together and plays an important role in preventing soil erosion. Organic matter is the main source of energy for soil organisms, both plant and animal. It also improves the infiltration capacity of the soil, thereby reducing runoff.

8.6 Vegetation Cover

The loss of protective vegetation through overgrazing, ploughing and fire makes soil vulnerable to being eroded by wind and water. Plants provide protective cover on the land and prevent soil erosion for a variety of reasons. Firstly, plants slow down water as it flows over the soil, allowing much of the water to soak into the ground. Plant roots bind the soil and hold it in place, preventing it from being blown or washed away. Further, plants break the speed of water drops or wind before it hits the soil, reducing its impact.

9. Other Causes of Soil Erosion

Soil erosion can occur for a number of other reasons, such as poor farming practices. These poor practices include ploughing down-slope, instead of along the contours, which leads to gullies forming and soil being washed away. Overgrazing is also a cause of erosion, and occurs when animals are left to graze in the same area for too long. The soil becomes trampled and compacted, and the vegetation cover is reduced and eventually removed.

Erosion is also worsened by farming in areas that are too dry, as this causes the structure of the soil to be destroyed. Reducing the natural plant cover through ploughing and cultivation leaves no protective vegetation layer, also worsening erosion. Badly laid out farms, including improper building placement or spacing between plants increase the risk of gully erosion and increase runoff. Finally, events that remove ground cover, such as uncontrolled veldt fires or deforestation, leave the soil unprotected, increasing erosion.

10. Prevention of Soil Erosion

Fortunately, there are a few measures that can be implemented to prevent soil erosion. Firstly, you should pay special attention to controlling storm water and run-off on and around orchard areas, both while they are being prepared for the establishment of a citrus orchard, and after the orchard has been planted until the plants and a good grass covering has been established.

Where erosion is already occurring, construct small structures such as gabions, weirs and silt traps to ensure that erosion does not become worse. Ensure that the infiltration capacity of the soil is considered in the design of the irrigation system to prevent excess run-off.

Develop a runoff plan with strategic vegetation beds designed to not only decrease the runoff speed of the water, but to also filter irrigation water before it returns to the groundwater system. Use contour ploughing and windbreaks to minimise wind erosion.

Ground cover in between orchard rows, such as grass strips, helps increase soil fertility as well as minimising erosion damage from both wind and water. Allowing indigenous plants to grow along riverbanks can prevent the erosion of these banks.

If soils are already degraded and eroded, re-establishing plants indigenous to the biome and ecosystem or pioneer plant species can help these areas recover if they are not too damage. Conserving natural environments such as wetlands can help in the same way.

Employing minimum or no tillage can limit erosion. Implementing veldt reclamation and stock reduction schemes whereby farmers are encouraged to reduce or withdraw production stock so that the land can recover can also improve soil quality.

You should implement legislation such as the Environmental Conservation Act and a national grazing strategy, as well as other sustainable practices such as employing rotational grazing and crop farming practices. Control veldt fires and cut fire breaks or construct fire barriers from stones.

Although most citrus farms are not situated in topographical areas where slope is a consideration, it is important to remember that cultivation of crops is not recommended on slopes with an elevation of more than 20 degrees.

Cultivar selection and irrigation should take into account soil type to avoid over-irrigation and runoff. Most citrus rootstocks are not suited to heavy soils, but it should be noted that water usage and runoff on very sandy soils would be equally unproductive.

The recommended row direction for citrus planting is north-south, but elevation may necessitate alteration and possibly contour planting. Citrus trees should be spaced 6m by 3m apart and a turning circle of at least 8m around orchards is recommended to avoid degradation that would cause gulley erosion.

It should be noted that citrus growers should beware of using organic compost materials directly on the crop, as this has a proven negative effect on colour development. Research on alternative and sustainable citrus production practices is constantly being done by Citrus Research International and you should consult with them regularly to stay abreast of the latest GAP recommendations.

summary

Chapter 1 – Soil Characteristics

- Good quality soil is vital to growing healthy, productive trees, and sometimes soil requires improvement before it is suitable for an orchard.
- Soil is a natural resource that is a combination of living and non-living components.
- Soil is created by formation processes over thousands of years, and, as a result of the differences in these formation processes, soil types differ widely across the world.
- The living components of soil are considered renewable resources, and the mineral (non-living) components non-renewable resources.
- Soil potential refers to the ability of the soil to support plant growth and produce a good quality crop.
- Soil potential is judged by soil fertility, plant available water, and soil permeability.
- Soil fertility refers to the nutrient content of the soil and the ability of the soil to sustain plant growth.
- Plants need seventeen elements for normal growth, namely carbon, hydrogen, oxygen, nitrogen, iron, sodium, calcium, phosphorous, potassium, copper, sulphur, magnesium, manganese, zinc, boron, chloride, and molybdenum.
- Plant available water refers to how much water there is in the soil that your trees can access.
- Soil permeability refers to the ease with which air, water and roots can penetrate the soil.
- The other characteristics that affect the suitability for crop production of the soil include texture, structure, layering (stratification), chemical and mineral composition, and depth.
- Texture relates to the ratio between the different sized particles, being sand, silt and clay, in the soil.
- Soil structure refers to the manner in which all the soil particles, including organic material, are arranged to form structural units.
- Soil layers have an influence on the potential of the soil, as roots do not grow and water does not move easily from one layer to another if the properties differ too much.
- The chemical composition of soils is mainly determined by the original material from which it developed, its age, its drainage, the climate, micro-organisms that are present in the soil, and the quality of irrigation water.
- Soil depth refers to the depth to which the roots of plants can easily penetrate.
- Soil degradation means a decrease in the quality and potential of the soil and can result from a variety of actions or circumstances.
- Nitrification means the oxidisation of ammonia ions into nitrite or nitrate ions, as nitrobacteria do.
- Denitrification means the conversion of nitrates into nitrites and ammonia.
- Nitrogen fixation means the natural conversion of atmospheric nitrogen by bacteria found in the nodules of legumes into compounds in the soil that plants and other organisms can use.
- Soil erosion occurs when soil is removed through the action of wind and water at a greater rate than it is formed.

- The most common forms of erosion are water erosion and wind erosion.
- The main forms of water erosion are sheet erosion, rill erosion (channel erosion), and gully erosion
- Sheet erosion is characterised by the down-slope removal of soil particles by a thin sheet of water.
- Channel erosion can occur on steep land or on land that slopes more gently.
- Dongas (gullies) usually occur near the bottom of slopes and are caused by the removal of soil and soft rock as a result of concentrated runoff that forms a deep channel or gully.
- Wind erosion occurs when the land surface is left bare in regions that are arid enough and flat enough to allow the wind to carry the soil away over an extended period of time.
- The most important soil and land characteristics that impact erodibility are slope, texture, structure, topography, organic material, and vegetation cover.

assessment activities

- ✓ **Activity P1**: Complete this activity to test your knowledge of soil characteristics.

Chapter 2
Soil Preparation

learning outcomes

The content of this chapter is aimed at helping you to:

- Prepare and improve soil for an orchard establishment.

1. Soil Surveys

When planning a new orchard, one of the first steps to even decide whether an orchard can be planted in a certain area is a soil survey. Soil surveys are the process of sampling and judging the quality and suitability of a certain area for citrus production. These are often performed by or with soil scientists who can perform more detailed tests in laboratories.

Soil samples for chemical analysis are taken in conjunction with the soil survey. From this analysis, physical characteristics such as soil texture and strength are determined, and it can be determined whether any chemical ameliorants should be applied during soil preparation to optimise the soil for tree development and production.

After survey data has been collected through sampling, soil maps are prepared that indicate soil types, defined by the physical and chemical properties of the soil. The aim of a soil survey is to determine whether the soil is suitable for production, as well as if improvement is needed. If the survey shows that the soil is already suitable for citrus production, no improvement is needed, and you can move on to planning the orchard layout.

If, on the other hand, improvement is needed, you will need to figure out what improvements are needed, and whether they are worth it from a cost-benefit perspective. During the survey, the following factors are noted and recorded for each section of the area:

- Appearance, nature, depth and thickness of layers
- Restricting layers in the upper 100cm
- Stones, gravel, concretions and compaction
- Internal drainage and symptoms of poor drainage
- Lateral movement of clay water and salts
- Parent material
- Root depth
- Structure

2. Soil Preparation Methods

The necessary preparation methods for soils will depend on the profile properties, being stratification, texture, pH and salinity. Before soil preparation can be done effectively, a soil survey or at least field inspection of previously surveyed soil areas is required. The basic soil preparation methods that you may need to use are:

- Loosening
- Mixing

- Ridging

In the past, when flood or basin irrigation was still used extensively, levelling and / or contouring of the soil were required. With micro-irrigation systems, these methods are no longer required.

2.1 Loosening

The principle of this method is to loosen the soil without changing the layering. When the soil profile is not stratified, or no lime, gypsum and phosphate are required, you only need to loosen to reduce the soil strength in the top 40cm to 60cm.

Loosening involves the lifting of the soil with a tool and letting it back down without any mixing, in an up-and-down motion. This is usually done with a ripper implement. For this reason, loosening is sometimes referred to as ripping.

The best loosening is achieved by ripping the soil in two directions, of which the deepest is down-slope. The angle between the two directions should be 60°. To improve the lifting action, wings are attached to the ripper tine at an angle of 30° with the horizontal at operating depth. This preparation method is also suitable for soils with clayey, acid, saline or carbonate-rich subsoil. Under these conditions, the subsoil must never be brought to the surface.

2.2 Mixing

Mixing is used to prepare soils that are stratified (too separated into layers, limiting permeability), or when it is necessary to mix lime, gypsum, phosphates or other fertilisers into the would-be root-zone. Mixing is relatively straightforward, and is simply the process of using a tool like a mould board or shear ploughs to mix the soil up. If the soil is very compacted, you may need to loosen it before it can be mixed.

2.3 Ridging

When the depth of suitable soil is limited, the soil from the inter-row spaces can be moved to the area where the trees will be planted. This will create heaped rows (ridges) on which your trees will be planted, giving them more root depth. Ridging has numerous benefits, and is recommended for reasons beyond a lack of depth.

Firstly, ridging (as we have said) increases the depth of suitable soil for roots to grow into. Ridging also improves surface drainage and increases soil temperature, which are both generally positive for your trees. Further, you may save money on agrochemicals and labour by not needing as much fertilisation.

Finally, ridging creates clear rows that lead to more controlled vehicle movement in the orchard, as ridges clearly indicate the inter-row paths. This limits re-compaction and erosion. You should note that the spacing between rows of trees, called the inter-row spacing, varies from 5m to 7m in citrus orchards. The space required for spray machines and other orchard vehicles is usually about 2.5 metres.

Before ridging, any required lime, gypsum or phosphates are mixed with the top 20cm to 30cm layer of soil. The ridges are then built with soil containing the right amounts of nutrients. The mixing process is more effective and cheaper when this method is used, while also saving on fertiliser cost.

The height of the ridge is determined by the thickness of the suitable layer of soil. If this layer is less than 20cm thick, ridging will not improve the potential of the soil sufficiently, although it also depends on the layer below this suitable layer.

Ridging does have some disadvantages which you should consider before implementing it, as it may not be suitable for your specific farm environment. Firstly, the positive of higher soil temperature can be a negative if you are already in a very warm area, as this increased soil temperature may negatively affect the trees if it gets too high.

Further, the water in ridges evaporates faster, so it may not be suitable in very dry, hot areas, where evaporation is already accelerated. Ridging also limits the irrigation systems you can use, as only drip and micro-jets can be used. Finally, the uneven surface can make picking more difficult.

3. Soil Maintenance

Although not technically part of soil preparation, soil maintenance is an important aspect of farming worth discussing here. Even after the soil has been properly prepared, continued maintenance of the soil is needed. This involves:

- Protecting the surface against erosion
- Minimising compaction
- Guarding against salinisation
- Limiting acidification

3.1 Protection Against Erosion

The best method to protect the orchard-floor against erosion is to use a natural grass cover. The orchard floor should not be kept completely free of weeds. The area underneath and between the trees should be weed-free, forming a strip one metre wider than the diameter of the tree canopies. On the rest of the orchard-floor, including the paths between the rows, a natural grass cover must be established as quickly as possible. This is not always possible in low rainfall areas because the paths between the rows are not irrigated.

The width of the grass-strip will decrease as the trees grow and must never reach underneath the canopy. The grass must be mowed frequently, and the cuttings removed. These strips of grass also harbour beneficial insects and play an important role in pest control.

3.2 Minimising Compaction

Compaction of the soil after soil preparation is inevitable, but must be minimised as much as possible. Orchard practises that accelerate compaction are vehicle traffic, while high precipitation rates and salinisation also play a major role.

Vehicle traffic has the most severe impact. All vehicles should be restricted to the 2.5m middle-section in the inter-row paths and must never drive closer to the trees than that. As mentioned before, ridging has the advantage of effectively forcing drivers to stay in this middle section.

When water is applied at a rate exceeding the infiltration rate of the soil, the soil particles float and, on drying out, will settle in a more compacted state. This reduces the infiltration rate even more, with the consequences of more surface compaction. This is also referred to as crusting.

Salinity, and especially an increase in the sodium adsorption ratio (SAR) of the soil, accelerates crusting. Soil analyses will help detect the development of crusting, but the first symptom is runoff halfway through the irrigation cycle.

3.3 Guarding Against Salinisation

Apart from crusting, which is the first symptom of salinisation, accumulation of sodium or reduction of calcium deeper in the profile should be monitored continuously. For this purpose, regular soil analyses are required.

Although the ratio of the cations is a good indicator of developing salinity, the subsoil should also be sampled from time to time. The frequency will be determined by the conditions prior to planting when the profile was analysed. As indicators of developing salinity, the calcium to total cation ratio should be 70% to 75% and the sodium <3.00%.

3.4 Limiting Acidification

Acidification is more active in the sub- than the topsoil. Subsoil sampling is therefore more important to monitor the pH. The ammonium form of nitrogen is the cheapest nitrogen source but also one of the greatest sources of acidification.

Even in fertilisers like LAN, acidification can be a potential hazard for subsoil pH levels. Liming the subsoil alone is not possible and the pH of the sub-soils must be monitored annually. The frequency of sampling can only be determined by historic data.

4. Recordkeeping

By now, you know how important recordkeeping is for citrus production, and soil preparation is no different. During a soil survey, many soil properties are evaluated, analysed, described and recorded. Many of these properties are stable and will not change. These records are therefore valuable for replanting and for future developments, and should not have to be redone. The stable properties include:

- Slope
- Aspect
- Soil depth
- Clay content
- Structure
- Water-holding capacity
- Cation exchange capacity

This is not to say that these qualities can never change, as certain events, and especially farming, can change them. On the other hand, are the variable properties, which are those that can change easily and quickly. These include:

- pH
- Nutrient content
- Resistance

These variable qualities are where soil analyses are most valuable, especially historical data from routine analyses. This data indicates the direction in which the nutritional status of the soil and trees are moving. Records of the variable data should be kept in an easily accessible format for at least three years. The format may vary, but should enable the reader to compare year-on-year figures with ease. Below is an example of a way you could keep records of samples:

example

Historical Data on Nutritional Status

NUTRITIONAL STATUS REPORT					
Orchard:		**Orchard 10**	**Cultivar:**		**Delta Valencias**
Element	**2002**	**2003**	**2004**	**2005**	**2006**
N	2.11	2.45	2.50	2.01	1.87
P	0.11	0.14	0.11	0.12	0.10
K	1.56	1.32	1.09	0.94	0.88
Ca	3.65	3.62	4.06	4.11	3.83
Mg	0.31	0.37	0.41	0.38	0.37
S	0.22	0.19	0.25	0.27	0.23
Cl	0.04	0.01	0.19	0.33	0.47
Na	21	39	117	582	498
Cu	7	21	18	54	21
Fe	74	118	131	163	211
Mn	132	85	46	40	28
Zn	36	29	54	21	14
B	85	107	152	162	228
Mo	1.34	0.42	0.78	0.31	0.55

summary

Chapter 2 – Soil Preparation

- Soil surveys are the process of sampling and judging the quality and suitability of a certain area for citrus production.
- Soil surveys are often performed by or with soil scientists who can perform more detailed tests in laboratories.
- Soil samples for chemical analysis are taken in conjunction with the soil survey to determine physical characteristics such as soil texture and strength.
- After survey data has been collected through sampling, soil maps are prepared that indicate soil types, defined by the physical and chemical properties of the soil.
- The necessary preparation methods for soils will depend on the profile properties, being stratification, texture, pH and salinity.
- The basic soil preparation methods that you may need to use are loosening, mixing, and ridging.
- Loosening (ripping) involves using a tool to loosen the soil without changing the layering.

- The best loosening is achieved by ripping the soil in two directions, of which the deepest is down-slope.
- Mixing is simply the process of using a tool to mix the soil up.
- Ridging is the process of taking soil from the inter-row spaces and moving it to the area where the trees will be planted.
- Ridging increases the depth of suitable soil for roots to grow into, as well as improving surface drainage and increasing soil temperature.
- Ridging creates clear rows that lead to more controlled vehicle movement in the orchard, as ridges clearly indicate the inter-row paths.
- Ridging does have some disadvantages which you should consider before implementing it, as it may not be suitable for your specific farm environment.
- Soil maintenance involves protecting the surface against erosion, minimising compaction, guarding against salinisation and limiting acidification.
- The best method to protect the orchard-floor against erosion is to use a natural grass cover.
- Compaction of the soil after soil preparation is inevitable, but must be minimised as much as possible.
- Recordkeeping for soil preparation and maintenance is very important, and you should keep records of both stable and variable properties.

assessment activities

- ✓ **Activity P2**: Complete this activity to test your knowledge of soil improvement.
- ✓ **Activity F1**: Complete this activity to test your knowledge of the entire module.