FACILITATOR GUIDE

Crop Establishment

Level 2

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Title:		**Monitor the Establishment of a Crop**					
Applied Title:		**Monitor the Establishment of a Citrus Orchard**					
Field:		Agriculture and Nature Conservation					
Sub-Field:		Primary Agriculture					
SETA (SGB):		AgriSETA					
Skills Area:		Crop Establishment					
Context:		Citrus Production					
US No:	116079	**Level:**	2	**Credits:**	4	**Notional Hours:**	40
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Directions

1. Learning Material

This guide has developed to assist the facilitator in presenting this unit standard. The guide contains all necessary material to ensure that the facilitator will be able to assist the learner to attain the competencies required by the unit standard.

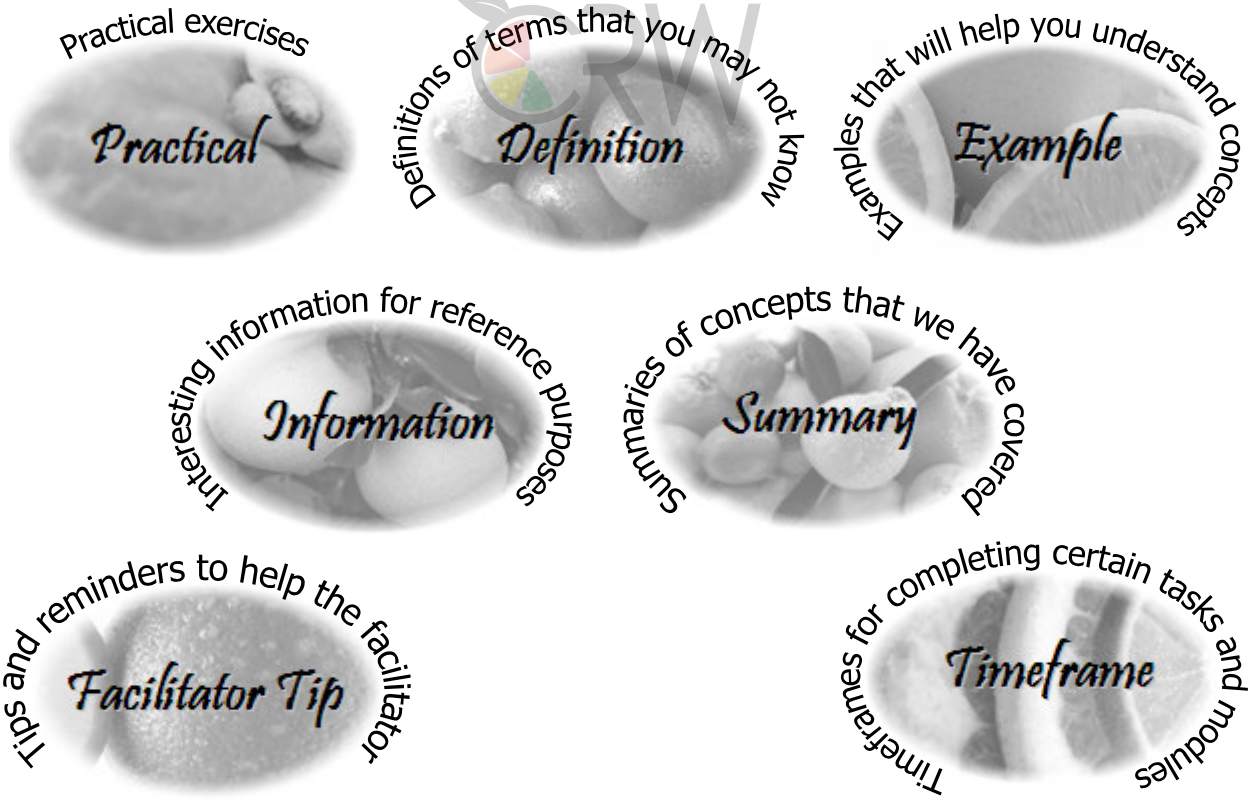
This set of learning material consists of the following guides:

- ***Learner guide*** that contains all the information required by the learner to attain competency in this unit standard
- ***Facilitator guide*** that is a copy of the learner guide but contains additional instructions for the facilitator.
- ***Assessment Guide for Assessors and Facilitators*** that contains all the documentation needed by the assessor and facilitator to assess the competency of the learner against this unit standard.
- ***Assessment Guide for Learner and Learner Workbook*** that contains the documentation required by the learner to complete the assessment, along with the worksheets and practical exercises that the learner needs to complete as part of the formative assessment.

Please ensure that you are familiar with the contents of all of these guides before presenting this unit standard.

Although the learner and facilitator guide contains all the information required for attaining competency in this unit standard, references to additional resources (both printed and electronic) are provided for further study by the learner.

Information in boxes is indicated by tags that show:



2. Learning Program Timeframe

This is a summary of the timeframe for this learning program. You will be reminded of the time allowed for each module as you work through the guide.

Process	*Total Allocated Time*	*Theoretical Learning*	*Practical Learning*	*Activities*
Complete Program (Including summative assessment)	**40h**	**19h 30min**	**20h 30min**	**9**
Learner Orientation and Ice Breaker	30min	15min	15min	n/a
Purpose, Introduction and Learner Directions	30min	15min	15min	n/a
Introduction to Citrus Production	45min	30min	15min	n/a
Session 1 (Chapter 1)	5h	3h	1h activities 1h plant inspection and pre-planting care of plants in nursery or farm environment	1
Session 2 (Chapter 2)	7h 30min	4h	1h 30min activities 2h site visit seeing tools for orchard layout in use; time in tool shed of farm maintaining and storing tools or shadowing the tool store man	2
Session 3 (Chapter 3)	9h	6h	3h activities	3, 4 and 5
Session 4 (Chapter 4)	12h 45min	3h 30min	4h 15min activities 5h participating in orchard layout and orchard establishment	6,7,8 and 9
Preparation for Assessment and revision	4h	2h	2h	n/a

3. Technical Program Specifications

Format	Programmed instruction workshop, combined with structured internship format as prescribed for learnership, skills program or short course.
Target Learner Description	A typical level 2 learner has functional numeracy and literacy skills, but a minimal level of experience. **EE Ratios:** 1 Male:1 Female 8 PDI:2 W 1 Employed:1 Unemployed
Articulation Options	Nil formal in place
Delivery Mode	A combination of small group mode and individual mode
Training Method and Activities	**Program Instruction:** This program forms part of an apprenticeship where coaches provide practical training in the fields requiring functional competency. The theoretical study section of the training is conducted as a 4-day workshop in the Cohort group format. Additional training activities include buzz groups, rotating role-plays, simulations, games and brainstorming sessions, and group discussions.
Learner Support Strategies	Learners are inducted by "explore strategies to learn program". Learners are supplied with all resources and aids as required by the program, including: • Objects and devices such as equipment • Manuals and guides • Visual aids

Facilitator Tip

This unit standard is aimed at level 2 learners.

- A typical level 2 learner might only have been exposed to the working world for a short time.
- Explain concepts and define words in a simple, clear and concise manner throughout the learning program to help the learner where possible.
- Take special care to facilitate for ALL learners. Allow them opportunities to share experiences, prior knowledge, translate into their mother tongue for each other, and enjoy the learning process.
- The examples given in this resource guide might be for a different geographical area or commodity to what the learner is exposed to. Please adapt your examples according to the learning context.

4. Facilitator's Checklist

Facilitator Tip

This checklist has been designed to assist you in delivering the best possible facilitation to the learners. Please use it and supply whatever resources you might have in short supply at your venue of learning.

Preparation	*Yes*	*No*
Content Knowledge I have sufficient knowledge of the content to enable me to facilitate with ease.		
Application Knowledge I understand the program matrix and have prepared for program delivery accordingly.		
Ability to Respond to Learners Background and Experience I have studied the learner demographics, age group, experience and circumstances, and prepared for program delivery accordingly.		
Enthusiasm and Commitment I am passionate about my subject and have prepared my program delivery to create a motivating environment with real commitment to success.		
Enterprise Knowledge I know and understand the values, ethics, vision and mission of the Citrus Academy and the service provider under whose auspices the program will be conducted, and have prepared my program delivery, reporting and administrative tasks accordingly.		
Equipment Checklist:		
Learner Guides: 1 per learner		
Learner Assessment Guides: 1 per learner		
Writing material and stationery for facilitator and learner		
White board and pens		
Flip chart paper		
Proxima projector and screen		
Notebook computer and program disk		
Documentation Checklist:		
Attendance register		
Course evaluation		
Learner course evaluation		
Portfolios of evidence		

5. Proposed Floor Plan

No floor plan is prescribed for this training module.

Introduction

1. Purpose

A learner achieving this unit standard will be able to establish a citrus orchard and monitor the correct establishment of crops as well as ensuring that planting is placed and spaced as required. This unit standard forms part of the prior learning required in the areas of plant manipulation and plant propagation.

Learners will gain specific knowledge and skills in establishing the crop and will be able to operate in a plant production environment implementing sustainable and economically viable production principles.

They will be capacitated to gain access to the mainstream agricultural sector, in plant production, impacting directly on the sustainability of the sub-sector. The improvement in production technology will also have a direct impact on the improvement of agricultural productivity of the sector.

2. Learning Assumed to Be in Place

It is assumed that the learner has successfully completed the unit standards listed below:

NQF Level	*Unit Standard Number*	*Unit Standard Description*
1 (ABET 4)	Literacy and Numeracy	
1	116200	Plant crop under supervision
1 (F)	116157	Demonstrate an understanding of the basic concept of sustainable farming systems
1	116205	Propagate plants
1	116206	Fertilise soil and attend to basic plant nutrition

It is important to ensure that the learners who are undertaking this learning program has already completed the correct prior learning modules, to ensure that they are not unfairly disadvantaged by the learning process, and can be supported accordingly.

Do not forget to complete the Diagnostic Assessment (Step 3 in the Assessment Guide).

Introduction to Citrus Production

You have to complete this section as follows:

Total time	*Theory*	*Practical*
45min	30min	15min

While this section does not form part of the unit standard as such, it is essential for the learner's orientation to the learning context. Please take time to ensure that the learners have a thorough understanding of this section.

1. Introduction

This learning material has been developed in the context of citrus production, which means that the skills area is dealt with in terms of and as applied to citrus production. To help the learner place the material in the right context, it is necessary for the learner to understand the background to citrus production, and the manner in which a citrus plant produces fruit.

2. Background

Citrus originates from the subtropical regions of south-east Asia. In the wild, citrus trees in these regions produce fruit all year round, and the fruit are small, poorly coloured and blemished. In the absence of effective production practices, citrus trees do not produce fruit suitable for the market.

Citrus production is largely concerned with management of the practices and processes that manipulate the tree to produce high yields of marketable fruit. Production management, together with the selection of superior varieties and plant improvement, can be seen as an on-going effort to influence the natural tendencies of the tree.

Consumers want the fruit of their choice to be available at all times. Fruit should look good, be unblemished, well-coloured (superior exterior quality), taste good (high interior quality) and be of the right size. At the same time, the citrus producer wants orchards that will provide high yields over an orchard lifespan of 18 to 30 years. On top of all this, the citrus orchard must be managed in such a way that production practices have the least possible impact on the natural environment. Commercial citrus production management is about achieving these objectives efficiently and cost effectively.

3. Citrus Planting

Citrus trees are planted in rows in orchards. The planting distance, also called tree spacing or espacement, between rows and between trees within rows, is determined by numerous factors including climate, variety, and soil type. A typical tree spacing is 6m between rows by 3m between trees, meaning that 555 trees per hectare (ha) are planted (1ha = 10,000 m^2).

Once planted, trees take three or more years before bearing fruit that can be marketed. Thereafter, per tree and per hectare yields steadily increase to 40 to 70 t/ha – depending on cultivar and variety – after a further 4 to 7 years. If the trees are well looked after, this level of production will remain fairly constant until trees start to decline naturally.

Yield

Yield refers to the amount of fruit produced, and can be expressed in terms of:

Tree yield	kg per tree	kg/tree
Orchard yield	tons per hectare	t/ha
Export yield	15kg carton equivalents per hectare (10kg carton equivalents for soft citrus)	cartons/ha

4. Lifespan

The average economic lifespan of a commercial citrus orchard varies between 18 and 30 years, and can be as high as 30 to 60 years in hot, dry areas. Citrus is therefore viewed as a long-term crop. For citrus production to be profitable, the orchard must produce high yields of quality fruit every year, and do this consistently over a long period of time.

In citrus production the challenge is therefore to make production decisions and take actions to ensure high annual production of marketable fruit, while ensuring that these decisions and actions contribute to the long-term sustainability of the orchard.

5. Citrus Plant Phenology

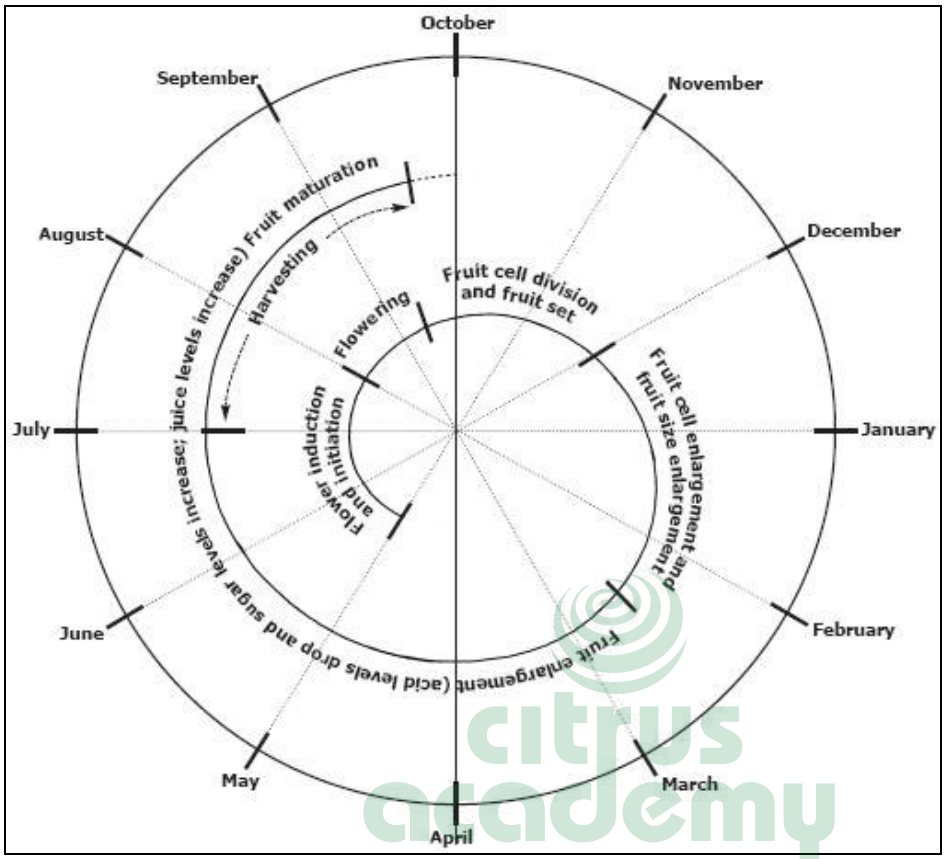
This is a difficult concept for level 2 learners and should be handled with care and extra attention.

Phenology

Phenology refers to regularly recurring biological phenomena and the environmental and climatic factors that influence them. In citrus, phenology specifically refers to the annual cycle of the citrus tree.

Understanding the phenology of the citrus tree is essential to understanding the reasoning behind many of the practices and actions employed in citrus production. For example, the timing of fertiliser applications is linked to the phenology of the tree, with most fertilisers being applied at appropriate times to optimise flowering, fruiting, fruit development and fruit maturation.

The figure and table below set out the annual cycle of the citrus tree with regard to fruit production. Please note that this figure and table reflect the approximate flower and fruit development cycle of a valencia orange tree, and that the phenology of various cultivars differ.



Stage	***Description***	***Time Period***
Flower Induction and Initiation	Flower initiation is the induction and differentiation of vegetative buds into flower buds at a cellular level, and cannot be seen with the naked eye.	May to July
Flowering	Flowering or "bloom" is when blossoms appear on the tree.	August to Mid-September
Cell Division and Fruit Set	Cell division is the period when cells making up the fruit increase in number. Fruit set is the period from flowering or "bloom" until the end of fruitlet drop, after which the final fruit load is determined.	Mid-September to November
Cell Enlargement and Fruit Growth	Cell enlargement is the period during which cells making up the fruit increase in size. Fruit growth is the period during which the fruit grows and develops.	December to Mid-February
Fruit Maturation and further Fruit Growth	During this period fruit enlarges further and matures internally, meaning that the flavour, sugars and acids reach their optimum levels.	Mid-February to September
Harvest		July to September

It is important to note the term **citrus season** refers to the period from when flower initiation begins to the harvest. The season is generally from the beginning of August of one year to the end of July of the next year, although harvesting may extend to September and October for late cultivars.

6. Citrus Learning Material

The following citrus specific learning material is available from the Citrus Academy:

Skills Area	***Description***
Enterprise Selection, Planning and Establishment	Concerns itself with identifying the various components of an agricultural enterprise, and with the selection and planning processes for a new enterprise, and looks at the physical layout of a farm, with specific reference to infrastructure, orchard layout, etc.
Propagation	Concerns the various methods and requirements for the multiplication of plant material of specific varieties that possess desired qualities.
Crop Establishment	**Concerns the establishment of a new citrus orchard, in terms of the physical planting of trees and the care for young trees.**
Plant Structures and Functions	Considers the structure and function of various plant parts and the manner in which nutrients, water, air and sunlight is taken up and processed.
Plant Nutrition and Soil Management	Concerns itself with plant nutrients, in terms of the requirements of the citrus plant and the supplementation of nutrient elements through fertilisation, with specific reference to the timing and manner of application.
Water Quality	Considers the various factors that influence water quality and manners in which water quality can be measured and controlled. Considers furthermore the effect of water quality on tree and fruit growth and development, in combination with effective irrigation, fertilisation and pest control.
Plant Manipulation	Concerns various types of physical and chemical plant manipulation, with specific reference to pruning, girdling and the application of plant growth hormones, and tools and equipment used for this purpose.
Irrigation	Looks at the technical aspects of orchard irrigation, with reference to the types of irrigation systems, the installation of new irrigation systems, and the repair and maintenance of an irrigation system. Also concerns irrigation scheduling, and measures to ensure effective irrigation.
Pests, Diseases and Weeds	Concerns the identification of pests, diseases and weeds that threaten citrus production. Also considers various methods of effective control, and the planning required for this purpose.
Crop Protection	Looks at the practical application of crop protection agents through various methods, with specific reference to tools and equipment used, and health and safety requirements.
Food Safety	Concerns the requirements in terms of health and safety, and environmental control for ensuring food safety and hygiene.
Harvesting	Looks at the process of determining fruit maturity through maturity indexing, the harvesting of fruit, and the tools and equipment used for this purpose.
Conservation	Considers the impact of farming practices on the environment, with reference to the measures required to minimise this impact and protect the environment.

Skills Area	***Description***
Marketing	Concerns the factors influencing citrus marketing, and the development of an effective marketing plan.
Production Management	Concerns the actions and processes involved in effective production management, with specific reference to the coordination of the various production tasks and processes and the creation of a strategic plan for the enterprise.
Industry Overview	An overview of the citrus industry and the various institutions involved.
Packhouse Practices	Concerns the specific principles and practices that are employed in the packhouse environment, and specifically: • Citrus Product Characteristics • Understanding Citrus Fruit Markets • Health and Safety in the Packhouse • Personal Hygiene Requirements for Packhouse Personnel • Understanding and Maintaining the Cold Chain • The Role of Quality Checks in the Packing Process • The Application of Fruit Treatments • The Application of Pre-Sorting Prior to Packing • Receiving Fruit into the Packhouse • Grading Fruit in the Packhouse • Packing and Packaging Materials • Palletisation of Packed Fruit • Storage of Fruit • Dispatch and Transportation of Packed Fruit • Understanding Automated Packing Solutions

Introduction to Crop Establishment

Use this opportunity to ascertain what learners already know about crop establishment. Lead a class discussion during which learners are allowed to share personal experiences.

A number of factors have to be considered before establishing an orchard to ensure that the capital that is invested yields the necessary income to result in a profitable planting.

The main factors are the following:

- Is the climate of the area suitable for citrus production?
- What types of citrus can be grown successfully in the specific micro-climate where establishment is planned?
- What is the market demand of the specific planned cultivar and will it yield a high enough income?
- Is there any weather phenomena that would limit production and that could influence total and marketable yield, such as strong winds, hail or excessive cold, and how often do these conditions occur?
- What is the general support infrastructure in the area and specifically on the farm?
- Is there a sufficient workforce available in the area?

Once these questions have been answered and the decision has been taken to proceed, a preliminary study is done of the area for which the orchard is planned, including the following actions:

- An environmental study to ensure that the establishment of orchards will not have a negative impact on the surrounding area.
- Orientation of the orchard with consideration of slope and controlling run-off water to curb erosion. Ideally, a 10° to 30° south-east facing slope with a north-south row direction or rows along the contour of the slope should be used to avoid erosion.
- Establishing the availability, quantity and quality of water for irrigation.
- A soil study to determine the physical and chemical composition for proper soil preparation.
- Provision for sub-surface and surface drainage.
- Determining the necessity of windbreaks.

Once all these preparatory actions have been taken, and all the studies have been made, planning for the orchard layout is finalised. Based on these plans, the trees can now be planted.

Chapter 1

After completing this chapter, the learner will be able to:

Monitor the handling of planting material for successful establishment according to required procedures for a specific crop

You have to complete this section as follows:

Total time	*Theory*	*Practical*
5h	3h	1h activities 1h plant inspection and pre-planting care of plants in nursery or farm environment

1. Plant Material

Planting an orchard is a long-term investment which, if the trees are of a good quality and all the pre- and post-plant actions are done properly, will only become profitable 7 to 10 years after planting.

Plant material is ordered from a certified nursery at least one-and-a-half to two years in advance of the intended planting date. The cultivar and rootstock are specified when the trees are ordered.

The nursery is visited periodically during the nursery period to ensure that the plants are true to type, that nursery practices adhere to the norms for certification, and that proper pest and disease control measures are followed.

The nursery trees must not be delivered to the farm too long before actual planting. Ideally, the trees must be inspected in the nursery before delivery to make sure that the trees are in a good condition before being transported.

Trees that have been grown in containers can theoretically be planted at any time during the year. In most areas, the normal planting period is between mid-August and the end of November, being after the soil has warmed up after the winter and before the worse heat of the summer. This also provides the newly planted trees with the best opportunity for rapid development and growth during the warm summer months.

Complete activity 1 in the **Learner Workbook**.

Activity 1 – Worksheet

Allow time for groups to break away and discuss the activity to draw conclusions. Learners have to conclude all the things to remember when planting and plant material.

Timeframe: 1h

2. Selection of Healthy Plants

Ensure that learners understand that healthy plants will ensure a higher survival rate and holds economic benefit when orchards last longer.

It is very important to be able to recognise healthy plants. When the plants are delivered from the nursery they should comply with the requirements for certification, as follows:

- All trees must be healthy in all respects without physical damage.
- The trees must be free of pests and certified to be free of root rot (Phytophthora).
- The stems of all trees must be straight.
- The bud union must be at least 200mm above soil level.
- The trees must have a well developed root system.
- Trees must be 21 months or younger after budding and 30 months or younger after seed germination.

Any tree that does not comply with the above standards should be rejected as it would affect the development potential of the orchard. Trees should ideally still be in rest when planted, because actively growing trees require more care following planting.

3. Safekeeping of Plant Material

Safekeeping of plant material needs to be explored, from obtaining the plants from the nursery, to working with it and taking care of it after planting.

Most trees received from nurseries are grown in plastic bags in a pathogen-free growth medium in a controlled environment. The young tree should at no stage experience moisture stress during the period leading up to planting. This is most important in ensuring that the tree will start to develop feeder roots and grow well as soon as possible after planting.

The plants are watered well before leaving the nursery to ensure that the growth medium does not dry out during transport to the farm. Great care must be taken during transport that the trees are not

exposed to hot, dry or windy conditions. Trees should ideally be transported in an enclosed vehicle. Damage to or loss of leaves during transport will detract from the growth potential of the tree.

On arrival at the farm, the trees must be watered and then kept moist in their bags until they are planted. The roots of the plants must not be allowed to dry out at any time. Dried out roots severely affect development of new roots after planting, and therefore the rapid growth required of the newly planted trees.

A few nurseries produce bare-root trees. Bare-root trees are trees from open ground nurseries that are removed, or lifted, from the soil just prior to transport to the farm for planting. This is not common practice, because it is much easier to control all the factors affecting the development of nursery trees and produce quality trees in containers. Extra care should be taken with bare-root trees after removal from the soil at the nursery to prevent drying out of the roots.

To prevent drying out, bare-root trees are normally bundled in multiples of 25 or 50 just after being removed from the soil, and the roots are immediately covered in an absorbent material such as hessian, which is then kept moist until planting. Bare-root trees must be transplanted immediately, prior to the first spring flush which, depending on the area and cultivar, can be between the beginning of September and the end of October.

If it is not possible to transplant bare-root trees immediately, the main challenge is to prevent the roots from drying out. In this undesirable situation, the trees should be removed from the protective packaging and layered in a trench with the roots completely covered with soil to keep them in a moist environment. If kept like this for too long, feeder roots will start to form and the trees will start to grow. The carbohydrate reserves of the young tree are used in the process and when eventually planted, this loss in reserves will result in poor growth.

In chapter 3 the care for plants immediately prior to planting is discussed in detail.

4. Preparation of Planting Areas

Ensure that learners understand the need for soil preparation in particular. Emphasise other considerations by looking at the requirements of the plant and evaluating the climatic and environmental conditions.

The planting area is prepared for planting well in advance of planting. Preparations include the following:

- Soil preparation
- Windbreaks
- Irrigation supply lines

4.1. Soil Preparation

The preparation of the soil for planting is normally done about three to nine months prior to planting, depending on the moisture status of the soil.

Physical and chemical soil preparation is aimed at optimising conditions for root development. A good physical soil condition promotes a favourable air and water balance in the soil and the growth and functioning of plant roots. With good management, this leads to proper and rapid tree development as well as early and sustainable production.

4.1.1. Chemical Soil Preparation

Chemical imbalances, such as soil acidity and other nutrient element, such as phosphorous and potassium deficiencies, are normally addressed and rectified during soil preparation. Determining the chemical imbalances that need to be addressed is a specialised field that requires soil samples to be taken and analysed when the site is initially selected. The soil analyses report is interpreted, and recommendations are made and implemented during soil preparation.

4.1.2. Physical Soil Preparation

Soil is prepared by either ripping or ploughing to a depth of between 60cm and 100cm to encourage effective root development and increase effective soil depth. It also assists in breaking up hard structures within the soil that might limit root development or cause build-up of water tables.

Ridging soil from the inter-row area towards the area in the row where the trees are to be planted is sometimes done to increase the soil depth in the tree rows. Some growers also prefer to ridge even on deeper soils to ensure that orchard machinery only move in a restricted inter-row area to prevent soil compaction by the machinery. Ridging also improves surface drainage.

During planting, tractors and trailers have to move onto the area which has been prepared for planting to perform tasks such as the removal of stones and transport of trees and pipes. This should however be limited wherever possible as it compacts the soil again after it has been ripped or ploughed. It is good practice to accurately measure and peg out the orchard before vehicles are allowed in and to clearly mark the rows with agricultural lime. The vehicles can then stay on the paths that will eventually become the inter-row areas.

4.2. Windbreaks

Windbreaks are trees that are planted to provide protection for the orchard against wind, especially in very windy areas. If orchards are exposed to wind, small fruit can be damaged by surrounding twigs and leaves causing external blemishes that can render the fruit not suitable for export. Water loss is also higher because of higher evaporation, and the tree can suffer physical damage from very strong winds.

Trees, such as certain types of pine trees or Beefwood, are planted around orchards for this purpose. Windbreak trees should, if possible, be established well before planting to afford the necessary protection to the young trees from the start.

4.3. Irrigation Supply Lines

Components of the irrigation supply system include mainlines, sub-mainlines and mother-lines. These must be installed before planting so that the aboveground reticulation pipes and emitters can be installed immediately after planting.

Summary

This is an opportunity to check the progress that learners have made.

Allow time for the learners to read through the summary and to gauge their own progress. Make sure that each and every learner gets and opportunity to ask questions.

Chapter 1

- Citrus trees are normally planted between mid-August and the end of November.
- Plant material must be ordered from a certified nursery one-and-a-half to two years in advance.
- Trees must comply with certification requirements when they are delivered from the nursery.
- Trees must never be allowed to suffer water stress before being planted, especially bare-root trees.
- Preparations of the planting area include soil preparation, windbreaks and the installation of the irrigation supply system.
- Soil preparation includes chemical and physical soil preparation.
- Windbreaks are trees that are planted around an orchard to protect the citrus trees against strong winds. They are planted well in advance.
- The irrigation supply system includes mainlines, sub-mainlines and mother-lines. These are installed before the orchard is planted.

Chapter 2

After completing this chapter, the learner will be able to:

Select, use and care for the appropriate tools and equipment used in the planting of a specific crop

You have to complete this section as follows:

Total time	*Theory*	*Practical*
7h 30min	4h	1h 30min activities 2h site visit seeing tools for orchard layout in use; time in tool shed of farm maintaining and storing tools or shadowing the tool store man

1. Selection of Tools and Equipment

Show as much of this equipment as possible, preferably on site and in practice. If possible, arrange site visits where learners see the equipment being used by trained personnel.

Two types of tools and equipment are used for planting tree crops like citrus, being:

- Measuring equipment
- Planting aids
- Other tools and equipment

1.1. Measuring Equipment

Measuring equipment is used to lay out the orchard and ensure that the trees are planted in the exact position prescribed by the design, and with the planting distance that has been decided on.

Measuring equipment and tools include:

- A theodolite or dumpy level;
- Measuring tape
- Plant line or cable
- Stakes

Theodolite and dumpy levels are generally used to mark out straight lines and to determine right angles. While planting a citrus orchard, the theodolite or dumpy level, if available, is used to determine the position of the plant rows and to ensure that the rows are parallel to each other.

Figure 2.1: Using a Theodolite to Lay Out a New Orchard

A measuring tape is used to measure the distance between rows and between trees. Plant lines or cables are used to mark the positions of the rows. The plant line or cable can be notched to indicate the position of the tree inside the tree row. If it is not notched the measuring tape must be used to determine the tree spacing in the row. The position of each tree is marked with a stake.

Figure 2.2: Measuring Tape

1.2. Planting Aids

Planting aids are used when the trees are being planted. Planting aids include a planting board, spades, forks and a water-cart.

1.3. Other Tools and Equipment

Other tools and equipment that is used during planting and in immediate post-planting care include pruning shears, stakes, twine, and stem covers.

Pruning shears are used to remove any unwanted growth or prune back damaged shoots immediately after planting.

After planting, trees are normally fastened to a stake with twine. The stake is inserted next to the stem and stabilises the tree against wind during the first year after planting. The twine used should be biodegradable.

Various types of stem covers are used to cover the lower part of the stem to prevent suckers from developing in that area, and to protect the tree from herbicide applications.

2. Using Tools and Equipment

The theodolite and dumpy level are sophisticated equipment, and should be handled with care by a trained person.

When using a measuring tape, do not stretch the tape excessively, as this can cause the tape to be inaccurate. The use of a fibre type tape is recommended, because steel tapes can expand during the heat of the day. Some plant lines are made of wire and also tend to expand during the heat of day, affecting accuracy in same way as for steel tape.

A planting board is about 150mm wide with a V-notch at each end. The board is exactly the length of the in-row planting distance. When planting holes are dug, the stake that has been used to mark the tree position is removed and the planting board is used to plant the tree in the correct place.

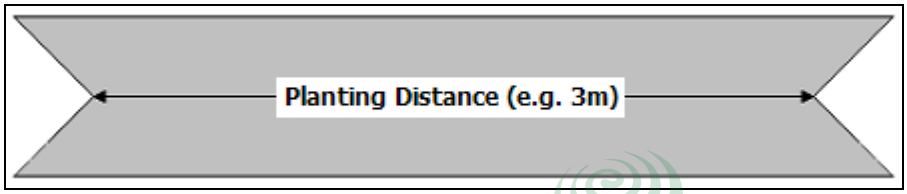


Figure 2.3: Planting Board

Spades and forks are used to make the planting holes. Forks are preferable to spades, as spades can smear slightly too wet soil on the insides of holes and compact the soil.

Trees are watered immediately after planting to ensure good contact between the roots and the soil. The water-cart is used for this purpose, and moves carefully only in the inter-row spaces to prevent compaction of the soil in the plant rows.

3. Maintaining Tools and Equipment

Tools such as theodolites and dumpy levels are sensitive measuring equipment and must be stored in special carry cases. They must always be kept dry and clean, and must be stored in a cool, dry place. Shocks and bumps to the equipment must be avoided. The tripod that the equipment is mounted on must be washed separately.

General maintenance of tools and equipment include cleaning and proper storage. Hand tools are washed and left to dry and stored in a proper and secure storeroom. Measuring tapes are wiped down with a damp cloth and rolled up. Be careful not to roll up the tape too tightly. Never use a measuring tape as a winch to reel in objects or to pull out stakes.

Summary

This is an opportunity to check the progress that learners have made.

Allow time for the learners to read through the summary and to gauge their own progress. Make sure that each and every learner gets and opportunity to ask questions.

Chapter 2

- Three types of tools and equipment are used during the establishment of an orchard, being measuring equipment, planting aids and other tools and equipment.
- Measuring equipment is used during the layout of the orchard and includes a theodolite or dumpy level, measuring tape, plant line or cable, and stakes.
- Planting aids are used when the trees are planted and include a planting board, spades, forks, and a water cart.
- Other tools and equipment include pruning sheers, stakes, twine, and stem covers.
- A theodolite or dumpy level is used to determine straight lines and right angles, and should be used by a trained person.
- Measuring tape is used to measure the inter-row and inter-tree spacing, and plant lines and stakes are used to mark row and tree positions.
- A planting board is used to measure the inter-tree spacing, and spades and forks are used to dig planting holes.
- A water cart is used to wet the tree immediately after planting.
- Pruning sheers are used to remove any unwanted growth or damaged twigs immediately after planting.
- Young trees are usually tied to a stake with twine to support it and stabilise it during the first year of planting.
- Stem covers protects the young tree against the development of suckers and against herbicide applications.
- Tools and equipment must be cleaned and dried properly after use, and stored in a safe place.

Complete activity 2 in the **Learner Workbook**.

Activity 2 – Worksheet

Lead a class discussion after learners have compiled a list of tools, along with their uses and application, in which the cleaning, maintenance and safe storage of tools are discussed.

Timeframe: 1h 30min

Chapter 3

After completing this chapter, the learner will be able to:

Understand the impact of environmental conditions on the successful establishment of crops

You have to complete this section as follows:

Total time	*Theory*	*Practical*
9h	6h	3h activities

1. Planting Conditions

Discuss the need to consider planting conditions and adapting to different conditions.

Transplanting a tree from a bag or any other medium causes a shock to the tree, from which it must recover and adapt to settle in the new growth environment. The more tree-friendly the conditions are under which the transplanting takes place, the less stress on the tree and the quicker it will settle and grow.

Planting conditions that play a marked role in the subsequent development of the plant are:

- Weather conditions
- Soil conditions

A number of actions can also be taken before and during planting to limit the stress on the tree, including:

- Arrange to plant only in the mornings.
- Keep the trees awaiting transport to the land in a cool, shady area.
- Transport only enough trees to the land that can be planted within 30 minutes after arrival.
- Water the tree immediately after planting from a water cart.
- Fasten the tree immediately after planting to a stake.

Complete activities 3 and 4 in the **Learner Workbook**.

Facilitator Tip

Activity 3 – Worksheet

Encourage learners to design colourful and creative posters and discuss the impacts of all environmental conditions on the plants and planting.

Timeframe: 1h

Activity 4 – Worksheet

Allow time for learners to do research about favourable soil conditions for citrus trees. Encourage learners to look for resources in literature, online and through consulting experts.

Timeframe: 1h 30min

1.1. Weather Conditions

Temperature is the single most important factor influencing the growth and production of a citrus tree after being planted, and is closely related to humidity. The effect of temperature on a newly planted tree therefore has to be carefully considered in deciding when to plant in the different citrus producing areas.

Extreme temperatures should be avoided when planting an orchard. Air temperatures above 39°C are considered to be detrimental to the tree and it is generally believed that 13°C is the minimum temperature at which growth takes place. For this reason, planting is preferably limited to the mornings. Planting should be suspended immediately if temperatures rise to unacceptable levels.

The air temperature influences the soil temperature, which plays a major part in nutrient and moisture uptake of the plant. The physical environment of the root system, including temperature, is in general far more stable than that of the canopy as it does not change as rapidly or have such large daily or seasonal fluctuations.

The impact of rain during planting is mostly positive, except if the soil becomes saturated. Planting should be stopped and the soil must be allowed to dry out. Flooding soon after the establishment of an orchard can also lead to the plants being dislodged and washed away.

1.2. Soil Conditions

The regions suitable for commercial citrus production have soil temperatures which range between 6°C and 16°C during the winter and between 24°C and 36°C during the summer.

Planting should not start before the soil has warmed up sufficiently after winter to ensure good root growth and uptake of water and nutrients. Too high temperatures on the other hand should also be avoided as it could severely affect establishment of the tree and cause moisture stress resulting in root shock and poor growth.

At planting the soil should be:

- Moist enough to ensure that the roots do not suffer root shock, while being dry enough to prevent clods from forming when compacted around the roots;
- Warming up after winter and above a temperature of 20°C;
- Well drained;
- Well prepared up to a depth of at least 600mm;
- At optimum pH and nutrient status.

2. The Effects of Root Shock

Spend extra time in explaining the concept of root shock, its effects and methods to counter or limit it.

Root shock is the result of transplanting a tree from a medium in which conditions for growth is optimal to another medium, such as when a tree is removed from its container and planted in the soil.

The extent of the root shock increases if the tree is subjected to stress during transplanting. The more root shock can be avoided, the quicker the plant will adapt to the new growth environment.

In most instances, root shock is caused by poor moisture conditions that cause roots to dry out during the transport and pre-planting period. The feeder roots dry out first and could even die in extreme cases. The plant then has to use energy to revitalise the root system which leads to poor new root development. The resultant vegetative growth is below expectations and can even result in dying of the severest affected plants.

Complete activity 5 in the **Learner Workbook**.

Activity 5 – Worksheet

Explain the concept of a mind map and allow learners to complete the activity.

Timeframe: 30min

Summary

This is an opportunity to check the progress that learners have made.

Allow time for the learners to read through the summary and to gauge their own progress. Make sure that each and every learner gets and opportunity to ask questions.

Chapter 3

- The more favourable the conditions are under which a tree is transplanted, the more rapidly it will settle into its new environment and grow.
- Certain steps are taken to ensure that the conditions are favourable for transplanting, including planting only in the mornings, keeping trees in a cool, shady place before being transplanted, watering trees immediately after planting, and tying them to stakes for support.
- The conditions during planting that play a role in the subsequent development of the tree is the weather conditions, of which temperature is the most important, and soil conditions.
- The air temperatures must not be higher than 39°C and not lower than 13°C during planting.
- If it rains during planting, planting must be stopped if the soil becomes saturated.
- During planting, the soil should be moist but not saturated with water, above 20°C, well drained, well prepared, and at an optimal pH and nutrient level.
- Root shock is the result of the transplanting of a tree from one medium to another, and can be avoided by creating optimum growing conditions in the new growth medium.

Chapter 4

After completing this chapter, the learner will be able to:

Monitor the planting of plant material at correct spacing between rows, and individual plants, and at the correct depth for specific plant species

You have to complete this section as follows:

Total time	*Theory*	*Practical*
12h 45min	3h 30min	4h 15min activities 5h participating in orchard layout and physical planting

1. Introduction

The necessary preparation for planting has now been made. We have the necessary equipment at hand, we have quality plant material that has been well cared for, we have prepared the planting area in the prescribed manner, and we have ensured that the ideal conditions exist for planting. We have also been informed on the dangers of root shock and the steps that are required to avoid this condition. The orchard can now be planted in line with the design, and with the correct tree and row spacing.

2. Spacing

Spacing refers to both the tree and row spacing. The spacing of the orchard is decided on when the orchard is planned, and depends on the type of soil and the growth habits of the cultivar to be planted. Cultivars with a prolific growth habits that are planted in good soil will therefore be planted with a wider tree spacing than weaker growers on poorer soil.

Spacing is for example expressed as 6x3, meaning that the rows will be 6m apart with trees planted every 3m within the row. The number of trees planted per hectare can be determined by the spacing.

Calculating Trees per Hectare

Using the example above, the trees per hectare can be calculated as below. Remember that:

1ha = 10,000m^2 = 100m x 100m

100 / 6 = 17 rows per hectare
100 / 3 = 33 trees per row
17 x 33 = 561 trees per hectare

3. Orchard Layout

An orchard block has to be measured and laid out very precisely. The exact position of each tree is marked with a stake before planting starts to ensure that the orchard will be planted exactly as planned. Using the orchard plan or the irrigation plan, the steps below are followed:

- Mark out the position of the longest row in the planting direction, whether it is along the side or through the middle of the block that is being planted.
- Using a theodolite or a dumpy level, mark out a line at 90°, either at the end of a rectangular or through the middle of an irregularly shaped block.

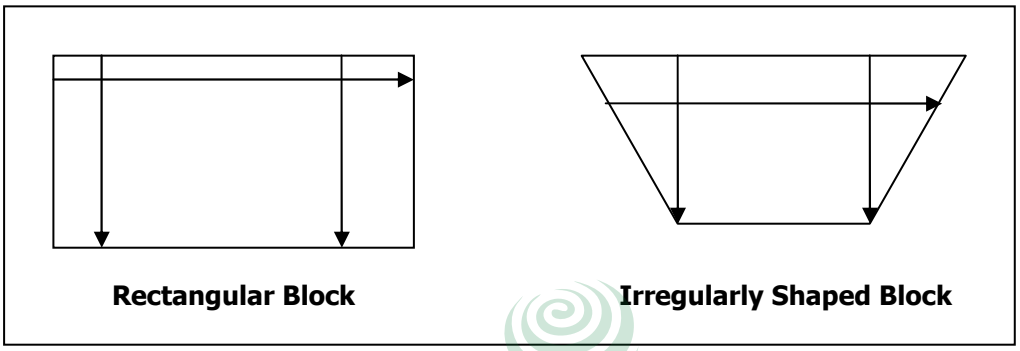


Figure 4.1: Orchard Layouts in Differently Shaped Blocks

- Working from these two lines, stake out the rows and the tree positions as prescribed by the basic plan. Mark the rows with planting lines and the position of each tree with a stake.
- Always ensure that the row and tree position lines are at 90°.
- Once all the stakes are in place, ensure that the stakes are aligned in the rows, across the rows and diagonally.

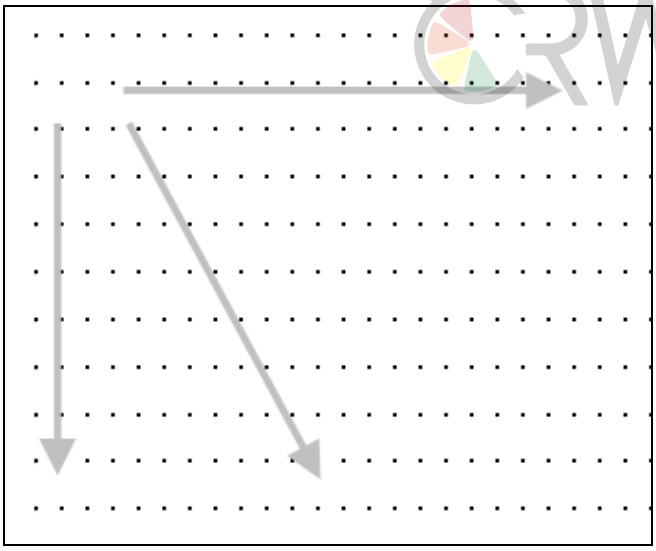


Figure 4.2: Alignment in Planted Blocks

4. Planting Procedure

Once the orchard has been staked out the trees can be planted, using the following procedure:

- Dig planting holes just prior to planting using a garden fork or spade. It is better to use forks to make the holes, as spades may smear the insides of holes if the soil is slightly too wet, making it

difficult for roots to penetrate the surrounding soil. Planting holes should be just large enough to accommodate the roots. In the case of bare-rooted trees, the planting hole is dug to the depth of the roots, but the width of the hole should extend beyond the roots.

- Remove the tree from the container. If a bark medium has been used in the bag, shake about 25% of the medium from the roots to ensure that at least a third of the roots are in direct contact with the soil after planting. In this way, root disturbance will not be excessive and the trees will not show any negative effects, such as root shock, after being transplanted into the soil.
- If a knot of roots has developed at the bottom of the plastic bag of container trees, spread these roots out to give the tree a larger root-zone.
- Position the tree on a pile of soil placed in the bottom of the hole, and backfill the hole with soil.
- To avoid any air pockets around the roots and to keep the tree firmly embedded in the soil, gently agitate the trunk to ensure that the soil moves evenly around the roots. This will ensure that the moisture in the soil will be available to all the roots.
- Gently compact the soil by treading on the soil around the root-zone. This also ensures that the soil is not heaped around the trunk, which may cause water to run away from the root-zone.
- The base of the tree stem must be slightly higher than the surrounding soil surface so that once the tree have settled no part of the stem is below ground level. Ideally, the place where the first roots grow from the stem should just be visible above the soil surface. In this way, the possibility of infection of the stem with Phytophthora (collar rot) is reduced. A slight ridge of approximately 20cm in height assists with drainage of water from the stem area after irrigation or excessive rain, and helps to avoid continuous moistness.
- Good contact between soil and roots is very important. It is common practice to water the trees immediately after planting from a water cart.
- To support and stabilise the tree against the wind, plant a stake of about 1.5m next to the tree with 1m of the stake extending above the ground level. Tie the tree to the stake with twine. This stake will remain in place during the first year of the development of the young tree.
- Fasten a stem cover around the bottom part of the stem. The manner in which the stem cover is fastened will depend on the type being used.

Complete activities 6, 7 and 8 in the **Learner Workbook**.

Activity 6 – Worksheet

Explain the concept of a flow diagram and allow learners to complete their own flow diagram.

Timeframe: 45min

Activity 7 – Worksheet

This activity is to be completed individually by each learner. Encourage the to use their own words and answer according to their own interpretation.

Timeframe: 1h

Activity 8 – Worksheet

Allow time for learners to complete this activity individually according to their own strategies and based on their practical experience with post-planting procedures.

Timeframe: 30min

5. Watering Newly Planted Material

Start facilitation of this section by posing the question: "What will happen if the tree is not watered after planting?"

Newly planted trees are immediately watered by a water-cart, after which the irrigation system should take over. In the absence of a permanent irrigation system, a basin which can hold 30 to 40 litres of water should be constructed around each tree immediately after planting.

Irrigation in the newly planted orchard must be installed immediately after the trees are planted and be operative within the same week. Irrigation must be applied directly to the root area at least once a week for the first four to six weeks.

It is important to supply water to the root-zone area without over-irrigating. With a permanent micro-irrigation system, the starter spreaders are used to supply water to the root-zone area, which is very small at this stage. It is not advisable to wet too large an area initially, as this could lead to water-logging outside the root-zone, which will inhibit lateral root development. The starter spreaders are replaced with permanent spreaders six to eight months after planting once root development has taken place.

In the case of drip irrigation, one must ensure that the drippers deliver the water to the root-zone only in the required quantities. The volume delivered is increased as the roots grow and increase in volume.

6. Post Planting Care

Encourage learner participation in post-planting procedures and encourage learners to conclude the "why" behind the procedure.

- At planting, the root volume of the young tree is small relative to the leaf area. Pruning the canopy to leave two or three well spaced framework branches of 20cm to 30cm in length is therefore usually done to reduce transpiration.

- In windy areas, growers remove all framework branches by topping the trees, thus giving the stem time to thicken as the new framework branches are formed.

- Using stem protectors of paper or straw, or painting stems with whitewash (diluted PVA), are common practices used to protect the stems of young trees from the sun.

- New growth, referred to as suckers, which develop lower down on the stem and particularly at ground level, should be removed at regular intervals. Care should however be taken not to tear them off, but to use pruning sheers. Tears in the bark at that level could be entry points for pathogens. Stem protectors also inhibit the growth of suckers.

- A well managed weed, pest and disease control program and an effective fertilisation programs must be followed to ensure optimum conditions for tree development.

7. Replacement of Unhealthy or Poorly Developing Trees

If the soil has been well prepared for a new planting and healthy trees were planted correctly and cared for well, a very small percentage of the trees will have to be replaced as a result of not developing well.

Poor tree development can be due to one or a combination of many factors, including:

- Poor water supply
- Inadequate staking
- Inadequate protection against wind
- Ring-barking by stake fasteners
- Insect damage
- Root rot (Phytophthora)

Newly planted trees that are not developing well or that are dying should be examined carefully to identify the cause so that one can prevent any of the other seemingly healthy trees to be effected.

Replacing trees in a new planting, also referred to as infilling, should be done within the first three years after planting. The older the orchard, the more difficult it is to develop the in-filled trees to fill the space of the trees it is replacing and produce equally to the others. To achieve this in the shortest possible time, special attention must be paid to the soil in which the tree has to be planted, the irrigation after planting, nutrition, and insect and disease control.

The actions should include the following:

- Dig a hole at least five times the size of the original planting hole;

- Fill the whole with new, healthy soil which has been treated against root rot and nematodes. The soil texture should not differ too much from the surrounding soil;

- Mix in organic fertiliser to encourage root growth;

- Plant the new tree in the new soil, as prescribed above;

- Water properly after planting;

- Water the in-filled tree in addition to the regular irrigation schedule to keep the moisture in the root-zone around the newly planted tree at optimum;

- Apply a well-balanced soil and foliar nutrition program to boost growth of the newly planted tree;

- Control pests and diseases;

- Regular monitor the development of the tree.

8. Basic Hygiene Standards: Preventing Cross-Contamination

Be alert to learners that do not understand the concept of cross-contamination. Ensure that hygiene procedures are very well understood and that the application is not seen as impractical.

Trees obtained from an accredited citrus nursery are free from known virus diseases which could have a negative effect on tree development and production of quality fruit. It is important that production practices in the newly planted orchard should be aimed at maintaining that status.

Pruning citrus trees to shape them for optimum production has become a standard practise. Many old orchards are infected with viral diseases which can be transmitted with pruning equipment to the young trees.

It is therefore important to establish a culture to disinfect pruning equipment such as saws, pruning shears and loppers when moving between orchards, or even from tree to tree. Any of a number of disinfectants can be used, but it will be prudent to get a formal recommendation for the product to use.

When pruning in an orchard of trees of the same origin, pruning equipment must be sterilised at least in the morning before starting, after lunch and in the afternoons after work. Sterilisation when moving from one orchard to another is the norm.

This practice should be stressed at training and requires strict supervision throughout the pruning operation. Mechanical pruning equipment should also be sterilised between orchards.

Summary

This is an opportunity to check the progress that learners have made.

Allow time for the learners to read through the summary and to gauge their own progress. Make sure that each and every learner gets and opportunity to ask questions.

Chapter 4

- Spacing refers to tree and row spacing, and is expressed as for example 6x3, meaning rows are 6m apart with trees planted every 3m in the rows.
- The orchard is laid out before planting starts, and the position of each row is indicated by a planting line or cable and the position of each tree with a stake.
- Stakes must align in the rows, across the rows and diagonally before planting starts.
- Planting holes are dug immediately prior to planting, the tree is removed from its container, the roots are spread if required, the trees is placed on a pile of soil at the bottom of the planting hole, and the hole is backfilled with soil.
- The tree is agitated gently to ensure that all the roots are in contact with the soil, after which

the soil is compacted gently around the root-zone. The base of the tree stem must be slightly above the soil level.
- Trees are watered immediately after being planted, after which irrigation system takes over.
- Sufficient water must be supplied to the root-zone without over-irrigating. Special micro-jets are used and the amount of water delivered by drippers is carefully controlled.
- Trees are pruned to reduce transpiration until the tree is well-established.
- Tree stems are wrapped or painted to protect them from the sun.
- Suckers must be removed regularly.
- Weed, pest and disease control and fertilisation must be optimum to ensure good tree development.
- Poor tree development can be as a result of a number of factors.
- Trees can be replaced in a new planting in the first three years after the orchard is established. Such trees must be well cared for to ensure rapid growth and development.
- Cross contamination is prevented by ensuring that pruning tools and equipment is sterilised.

Complete activity 9 in the **Learner Workbook**.

Activity 9 – Worksheet

This activity contains more information than the information that was given in the section before the activity. Encourage learners to attempt answering this activity as a "what do I know" attempt and then consulting their learner guide or searching for additional help.

Timeframe: 2h

Bibliography

Integrated Production Guidelines for Export Citrus: Volume 1, Research and Extension Services, Citrus Research International