FACILITATOR GUIDE

Enterprise Selection, Planning and Establishment

Level 2

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Title:		**Identify and Recognise Factors Influencing Agricultural Enterprise Selection** **Apply Layout Principles for Conservation and Infrastructure**					
Applied Title:		**Identify and Recognise Factors Influencing Citrus Agricultural Enterprise Selection** **Apply Layout Principles for Conservation and Infrastructure**					
Field:		Agriculture and Nature Conservation					
Sub-Field:		Primary Agriculture					
SETA (SGB):		AgriSETA					
Skills Area:		Enterprise Selection, Planning and Establishment					
Context:		Citrus Production					
US No:	116081 116127	**Level:**	2	**Credits:**	2 5	**Notional Hours:**	20 50
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citrus research international

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Unit standard alignment and assessment tool development:
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Table of Contents

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.

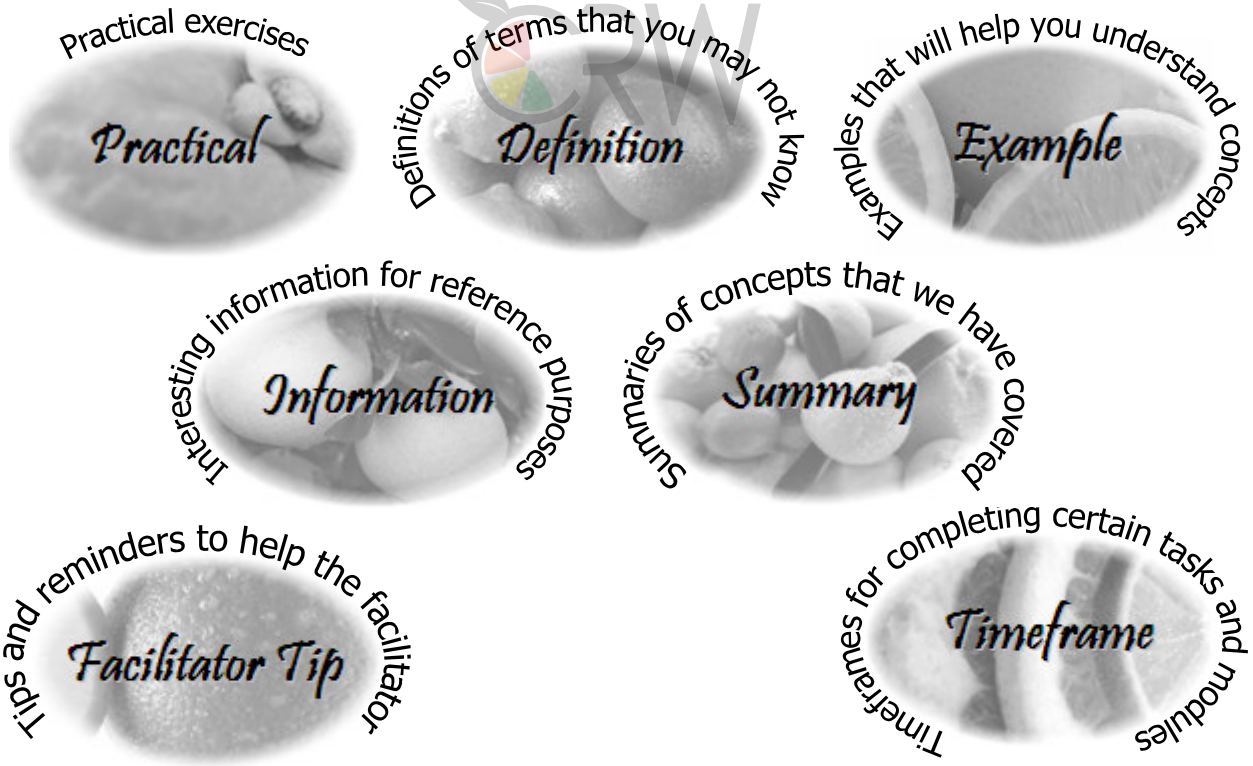
This set of learning material consists of the following guides:

- ***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)	**70h**	**40h**	**30h**	
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
Introduction to Skills Area	30min	30min		n/a
Session 1 (Chapter 1)	6h 15min	5h 15min	1h activities	1
Session 2 (Chapter 2)	6h 45min	5h 15min	1h 30min activities	2
Session 3 (Chapter 3)	7h 30min	5h 30min	2h activities	3
Session 4 (Chapter 4)	8h 30min	5h 30min	3h activities	4-5
Session 5 (Chapter 5)	6h 30min	5h 30min	1h activities	6
Session 6 (Chapter 6)	7h 15min	5h 30min	1h 45min activities	7-8
Session 7 (Chapter 7)	6h 30min	5h 30min	1h activities	9
Practical experience in enterprise selection, infrastructure placement and infrastructure maintenance	16h		16h	
Preparation for Assessment and Revision	2h 30min	30min	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

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

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.		

Preparation	*Yes*	*No*
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

You have to complete this section as follows:

Total time	*Theory*	*Practical*
60min	30min	30min

Take the time to introduce learners to each other, the program overview and the program expectations. Use icebreakers and allow sufficient opportunity for learners to ask any questions that they might have.

This is also an opportunity to identify learners who do not hold the required background or literacy level to enter this program. This will assist with strategising your facilitation time to concentrate on areas where learners might struggle or need additional help.

1. Purpose

1.1. 116081

Qualifying learners are able to demonstrate an understanding of the principles and factors influencing agricultural enterprise selection. They will be well positioned to extend their learning and practice into other areas of agriculture, specifically crop production and animal production systems. The profession will benefit from this training by learners being equipped with adequate skills to have input into enterprise selection and production to improve productivity and performance.

Learners will understand the importance of the application of business principles in agricultural production with specific reference to enterprise selection.

They will be able to operate farming practices as businesses and will gain the knowledge and skills to move from a subsistence orientation to an economic orientation in agriculture. Knowledge and skills will be gained by farmers to access mainstream agriculture through a business-orientated approach to agriculture.

1.2. 116127

A learner achieving this unit standard will be able to plan, layout and maintain conservation structures and prevention measures in an agricultural environment, report faults and where appropriate, repair them under supervision.

2. Learning Assumed to Be in Place

2.1. 116081

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	116158	Apply basic agricultural enterprise selection principles (crop selection, site selection, etc.)

2.2. 116127

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	116172	Apply elementary farm layout and infrastructure
1 (F)	116157	Demonstrate an understanding of the basic concepts of sustainable farming systems

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.

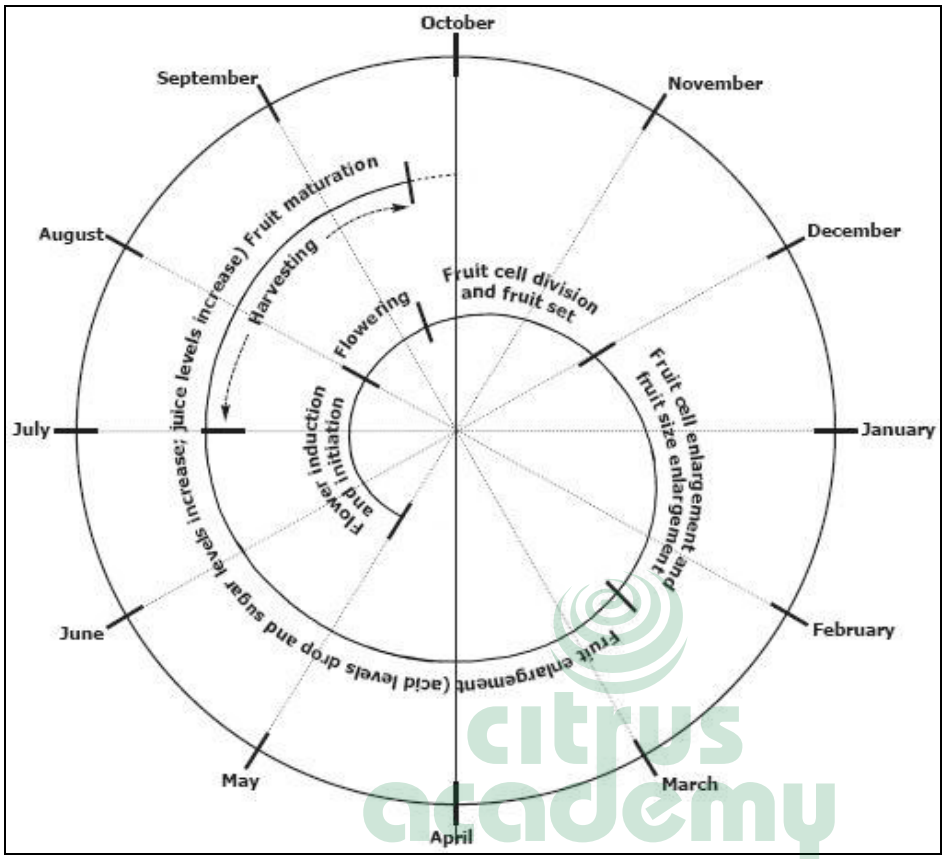
Phenology

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.

Skills Area	***Description***
Conservation	Considers the impact of farming practices on the environment, with reference to the measures required to minimise this impact and protect the environment.
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 Enterprise Selection, Planning and Establishment

You have to complete this section as follows:

Total time	*Theory*	*Practical*
30min	30min	

This section provides some basic background information. Allow learners to share experiences, make comments and ask questions during this introductory session to establish what they already know and to identify areas where additional attention and explanation might be necessary.

1. Introduction

A citrus farm is a business that has to be planned very carefully for it to succeed.

When planning a citrus planting, whether large or small, at the outset one has to start with the end in mind. Consider what has to be achieved, or what has to be delivered to the market, to result in a profitable outcome. The starting point should therefore be reliable market intelligence to determine which types of citrus fruit are in the greatest demand.

The different types of citrus cannot all be grown successfully in the same microclimate. The area which is earmarked for future plantings therefore has to be matched with a product or products which is in demand and can be produced successfully in that area.

Once the above has been established, the physical aspects of the area identified for the planting have to be examined carefully.

This learning material integrates two main fields of study. The first is the selection of enterprises and the planning that goes along with it. This field is about answering the questions:

- How do we decide what to plant?
- What natural resources do we need to grow the crop?
- What infrastructure do we need to grow the crop?
- What types and cultivars do we choose between for this crop?
- What production stock do we need to grow the crop?
- What is the production cycle for the crop?
- How is this crop harvested?
- How is this crop treated after being harvested?

The second field of study focuses on the physical layout of a farm. It is about answering questions such as:

- What are the environmental factors that must be taken into account when we decide how to layout the farm?
- How do we lay out the farm to cause the least possible environmental impact?
- What kind of infrastructure do we need to plan for and build on the farm?
- How do we construct the infrastructure that we need?

2. Classification and Characteristics of Citrus

The characteristics of citrus must be taken into account when planning a citrus planting. Citrus is a perennial, long-term, evergreen crop. It bears fruit in winter and does not have a cold requirement for blossom and setting a crop. Citrus grows well in most climates.

Fruit such as apples and pears are perennial long-term crops that bear fruit in summer. They are deciduous, meaning that they shed their leaves in autumn. Deciduous crops have a high cold requirement to blossom and bear well in the next season, and therefore have different climatic requirements from citrus.

Like most tree crops, citrus constitutes a long-term commitment, whereas other crops, such as vegetables, are annual crops with very short lifecycles. Citrus orchards have an average economic lifespan of eighteen to thirty years.

The most basic needs to produce an optimum citrus crop are:

- Healthy and stable plant material
- A micro-climate conducive to quality production
- A deep, well-drained, fertile soil with balanced nutrition
- Sufficient, clean irrigation water and a good irrigation system
- Good management

3. Market Demand

Market The market is a network in which buyers and sellers interact to exchange goods and services for money.
Market Demand Market demand is the total demand or request for a product by all consumers.

There are several points that prospective and existing growers need to consider carefully before deciding where and what to plant. Of these, the market and market demand for a specific product is amongst the most important. All decisions that are taken must be taken against the background of market demand.

The costs of production, packing, transport and marketing of fruit of a perishable nature, such as citrus, are high. High enough consumer prices therefore have to be realised to ensure a profitable return on the farm.

The location that has been chosen for planting must in itself have the potential to produce a product of the right quality. Market demand and preferences change all the time and it is important to have the most recent market intelligence at hand when deciding what to plant.

Chapter 1

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

Name and recognise natural resources required for the selection of the relevant enterprise

You have to complete this section as follows:

Total time	*Theory*	*Practical*
6h 15min	5h 15min	1h activities

Facilitate this program as much as possible on site, where the relevant areas under discussion can be pointed out. Learners will identify more easily and will be able to compare it better with their own work situation. Strive for participation from all learners. Where specific areas are discussed that are referred to again, summarise on poster paper and paste these in the facilitation venue.

1. Introduction

As custodians of much of a nation's land, the farming community has many responsibilities, including:

- To provide an immediate income from the farming enterprise
- To plan for a long-term income from the farming operation
- To consider the effects of the farming operations on the rest of the society today
- To use the land wisely so that it will still be able to produce for future generations

In the long run, the last responsibility is the most important. From the viewpoint of today's society, the third is most important, while the first and second may be of the greatest importance to the farmer and those dependent on the farming operation for their livelihood.

Realistically however, many decisions must necessarily be based on providing immediate income to the farming enterprise. The most obvious reason for operating any business is to make money and to provide income for owner and for the employees of the enterprise. This means that every decision cannot always serve all the responsibilities of the farmer. The reality is that the farming operation must generate enough income each year to pay operating costs, land lease costs, and machinery and equipment purchases, meet debt payments, cover insurance costs, and maintain farm infrastructure.

While the above costs must be covered each year if the enterprise is to stay in business, the other responsibilities must also be considered in making day-to-day decisions. Extensive investigation and planning has to form the basis of any new planting to ensure that all the responsibilities are considered.

2. Natural Resources

Lead a class discussion around the natural resources required for citrus production and identify why these natural resources are important to the success or failure of the enterprise in each case. Be sure to incorporate examples from other citrus producing areas and countries as well.

Natural Resources

Natural resources are the various elements in any given farming environment which will contribute to the production of a quality product on a profitable and sustainable basis, without detrimental effects on the environment.

Natural resources in the farming environment include:

- Soil
- Water
- Climate
- Indigenous vegetation
- Landscape and topography
- Infrastructure
- People

3. Climate

Climate is an integral part of the climate-soil-culture complex, and the factor that mostly determines the yield in citrus production. It is also the overriding factor influencing the type and quality of citrus that can be grown for export in a particular area.

Climate

Climate is the average weather, usually taken over a 30 year period, for a particular region and time period. Climate is not the same as weather, but is the average pattern of weather for a particular region. Climatic elements include precipitation, temperature, humidity, sunshine, wind velocity, phenomena such as fog, frost, and hail-storms, and other measures of the weather.

Weather

Weather is the specific condition of the atmosphere at a particular place and time. It is measured in terms of factors such as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather changes from hour to hour, day to day, and season to season.

Microclimate

Microclimate refers to the climate of a small site. It may differ from the climate large of the area due to aspect, tree cover (or the absence of tree cover), or exposure to winds.

3.1. Climatic Conditions

Worldwide, citrus is produced almost exclusively in the band between 20 and 40 degrees north and south of the equator, being in sub-tropical regions. Fruit of higher quality and better appearance are produced in environments that are more subtropical than tropical in nature. Fruit colour development tends to be a problem in tropical climates.

In South Africa, commercial citrus production is confined to areas with mild and almost frost-free winters and where temperatures seldom drop below -2 degrees Celsius. Factors limiting citrus production in some areas are:

- High spring or summer temperatures
- Low relative humidity
- Water stress during critical growth periods due to poor availability
- Hail
- Wind, which causes external blemishing

Climatic conditions that play a role in citrus production include:

- Temperature
- Wind
- Rainfall
- Hail

3.1.1. Temperature

Temperature is the most important factor that accounts for observed differences in vegetative and fruiting characteristics. It is, however, difficult to separate the influence of temperature from that of other factors.

Extreme heat during the blossom and fruit set periods can cause a severe drop of blossoms and fruitlets, which will have a direct effect on the crop yield. During the November drop period, severe heat can cause a moisture deficit in the tree which also leads to an excessive drop of fruitlets.

Very dry and hot periods during the early development stage of the fruit lead to smaller fruit and which will impact directly on income.

Very low temperatures which may include frost very seldom damages trees or cause crop losses in the citrus producing areas of Southern Africa.

3.1.2. Wind

In Southern Africa citrus is produced inland and near the coast in a variation of climatic regions, all with varying degrees of wind. Production for the export market demands high standards in terms of cosmetic appearance of the fruit. Wind blemish is one of the main cull factors and causes of losses, with as much as 70% having been recorded in more windy areas.

Extremely windy conditions also detrimentally affect tree growth, tree development and yield. Windy conditions hamper orchard management practices such as spraying and irrigation.

In the establishment of any production unit, prevailing winds and the possible effects thereof on orchard development and subsequent income has to be considered carefully.

3.1.3. Rainfall

Sufficient rain to ensure enough water for irrigation purposes is one of the main requirements for successful citrus production. The effect of too much or too little rain can, depending on the intensity, vary from negligible to catastrophic.

Prolonged dry periods, which occur in most of the citrus producing areas, can have a severe effect on yield and fruit size, and subsequently profitability.

Prolonged rainy spells in the summer rainfall areas during the spring and summer hampers spray programs and can result in heavy pest and disease infestations. Late summer or autumn rains can also have a negative effect on internal fruit quality, which in turn influences export pack-out percentage and shelf-life, and reduces income.

Rain during the harvest season, which occurs regularly in the winter rainfall areas, hampers harvesting, affects fruit quality, and increases the potential for postharvest decay.

3.1.4. Hail

Hail damage is a real threat in the northern production areas. Hail causes extensive damage to both the crop and trees.

It is prudent to examine the incidence of hail in any of the northern areas before developing a new production unit. The information on the incidence in the various areas is available from the crop insurance companies, who can also provide information on costs of insurance against hail damage.

3.2. Analysing Local Climatic Conditions

Where possible, show data from the website listed below or visit a weather station to show learners how climatic conditions are measured and monitored.

The Institute for Soil, Climate and Water has a central website for the weather station network in South Africa, where the climatic information collected throughout the country can be accessed. The web address is www.155.240.219.9/agric/ver1 and e-mail address is opsroom@arc.agric.za. To establish which weather station is the closest to the farm, the exact geographical position of the farm should be known.

The type of information which is required for enterprise selection and planning for as long a period as possible, is the following:

- Average rainfall
- Relative humidity
- Average, maximum and minimum evapotranspiration
- Average, maximum and minimum wind speed and direction
- Average, maximum and minimum temperatures

All the above are available on an hourly, daily, monthly and yearly basis and the information can be accessed at all times.

4. Indigenous Vegetation

It is a good idea to ask that learners pre-read this section and that they bring examples or photos of indigenous vegetation to class. Discuss why this vegetation is found in the area and why it is important to look at indigenous vegetation when planning a citrus farm.

South Africa is ranked as the third most biologically diverse country in the world, mainly due to the richness of plant life. It is important to know the indigenous vegetation of the area in which the farming enterprise is going to be established and identify the possible effects of such development on the environment.

There are two types of vegetation that one should be aware of when involved in agriculture, being **indigenous** and **invasive** vegetation.

Indigenous vegetation refers to trees, under-storey plants, groundcover and plants occurring **naturally** in a specific area. Examples of such vegetation in South Africa are proteas, fynbos, rhino veld, disas, a wide variety of succulents, afro-montane and coastal forests, broadleaved forests in the Lowveld, and grasslands.

Generally, the indigenous vegetation types in citrus production areas are as follows:

- Western Cape – Fynbos
- Eastern Cape – Grassland/Savannah
- KwaZulu-Natal – Savannah/Bushveld
- Mpumalanga – Savannah/Bushveld
- Limpopo – Bushveld

Invasive vegetation is alien plants that have been brought into South Africa for their beauty, economic value, or for an ecological purpose. Invasive plants often do not have natural enemies and therefore tend to proliferate, competing with indigenous vegetation for resources.

When planning a citrus planting, a careful study must be made of the naturally-occurring vegetation in the area, including a differentiation between indigenous and invasive vegetation. All land-users, and especially farmers, have a responsibility of maintaining indigenous flora as far as possible and eradicating invasive plants.

5. Topography

Topography is a difficult concept for some level 2 learners to understand. It is best demonstrated by letting learners walk up a hill and describe how the bottom and top of the hill differs, and point out why these differences occur. Visit the hill during the morning and afternoon, and point out the difference in temperature and other weather conditions on different sides of the hill. Also point out the plants that are found on the hill as opposed to those that are found on flat land.

Topography refers to the "lie of the land", or the physio-geographic characteristics of land in terms of elevation, slope and orientation, such as:

- The shape and lie of the land;
- Its relation to oceans and mountain ranges;
- Its climate;
- Its geographical history;
- Its slope and directions; and
- Its location in terms of longitude and latitude

An understanding of topography is critical for a number of reasons. In terms of environmental quality, agriculture, and hydrology, understanding the topography of an area enhances the understanding of watershed boundaries, drainage characteristics, water movement and water quality.

Understanding topography also aids in soil conservation, especially in agriculture. Contour ploughing, which is the practice of ploughing along the topographic lines, is an established practice of enabling sustainable agriculture on sloping land.

When planning orchards, an understanding of topography is important when deciding on placement of the orchard and row direction, keeping the effect of irrigation runoff and storm water management in mind. In the Western and Eastern Cape, the fruit in orchards on east-facing slopes will be earlier than on west-facing slopes. In windy areas, an orchard at the top a hill facing the prevailing winds will suffer much more wind damage than one on the lee side of the hill.

Topography is also important in determining weather patterns. Two areas in fairly close proximity may differ radically in climatic characteristics, such as rainfall, because of elevation differences or position relative to a nearby hill or mountain range. It is also well known that topography influences occurrence of hail with incidence of hail on two farms relatively near to each other differing greatly.

Knowledge of the possible effects of the topography on the development of a specific orchard or farm can therefore have a strong bearing on the eventual profitability of the plantings.

Although topography refers to a wide range of factors, the factors that are most important in terms of enterprise selection are the lie of the land, and its slope and direction.

The slope of a surface can be described as the degree of deviation from the horizontal. It can be nearly level, gently sloping, strongly sloping, undulating or rolling. Soils with similar texture can differ a lot with regard to water absorption and erosion as result of differences in slope. Danger of erosion normally increases as the slope of the land increases.

The relationship between slope and suitability of land for crop production is determined by the relative importance of surface drainage, erosion, infiltration, and cultivation. Other factors which influence the effect of slope on production potential are the type of crop, stability of the topsoil, intensity and duration of rainfall, as well as method and type of irrigation.

6. Water

Facilitator Tip

Most learners will be familiar with the need for water in agriculture, but some might struggle with conservation concepts and with maintaining high water quality. Where possible, look at the suitability of different water sources for citrus production while visiting farm sites. Emphasise the need for irrigation scheduling and the consequences of not irrigating according to schedules.

Irrigation in agriculture is dependant on water of a suitable quality. Water quality is judged by the potential problems which can develop as result of long-term use. The level of potential problems varies and is determined by soil, climate and crop, as well as skill and knowledge of the water-user. Judicial use of good quality water normally does not result in any problems.

The National Water Act (Act 36 of 1998) states that the government is the official protector of the country's water. Water is seen as a communal resource and access to water use is based on obtaining permission in the form of a permit. Farmers therefore have to register their water use with the Department of Water Affairs as an individual or through the local Water Users Association.

In practice however, a very large proportion of problems experienced in citrus production are directly related to water use and quality. The quality of the water used for irrigation can for instance vary greatly depending on the soluble salt content. Special management practices are necessary in this case to ensure acceptable yields.

In planning a citrus enterprise or orchard it is therefore most important to carefully assess the following aspects:

- The water source
- Irrigation capacity
- Water quality

6.1. The Water Source

There are three main sources of water, being rivers, dams and boreholes. The permanence of all three water sources depends on the natural rainfall in the specific area and the underlying geological formations. The water source must be secure and guaranteed to deliver a sustained and sufficient volume for citrus production.

Mature citrus trees require between 7,000m^3 and 10,000 m^3 of water per hectare per year, with a peak requirement during the summer months. The water source must be able to provide a large enough volume of water to sustain the hectares under production. It is also good policy only to develop to within the capacity of available water and build in a safety factor for water supply.

6.2. Irrigation Capacity

Irrigation capacity and the sustainability of the water source are one of the main factors in determining the potential size of the orchards or farm which can be developed. Enough water must be available at all times for optimum growth and production throughout the year.

According to the National Water Act (1998), the fair distribution of water is of extreme importance, and water measuring is applied to verify the extraction of water against an allocation. Most water sources are managed by Water Users Associations, which has to see to it that only the quantity of water allocated to each specific farm is pumped by or delivered to the farm for irrigation purposes. It is the farmer's prerogative to utilise the allocated amount to the best of his ability through choice of irrigation system and good management.

The microclimate of the area is a determining factor in the design of any irrigation system. This includes factors such as:

- Whether it is a summer or winter rainfall area
- The average monthly precipitation
- The average minimum and maximum temperatures
- The frequency, velocity and seasonal distribution of wind

The type of soil should be taken into consideration to ensure that the volume applied does not exceed the infiltration capacity of that particular soil. The rate of application must be calculated to supply in the crop requirement for optimal growth and production throughout the year.

Water measuring, or determining of flow rate, is an aid for the effective distribution of water and is usually applied for the sake of legal or management requirements, or both. A wide variety of measuring devices are available commercially and at the onset of implementation of water measuring, the following must be considered:

- What functions must the measuring equipment be able to perform?
- Which level of operation is required?
- How much are they prepared to spend?

Possible functions include the measuring of flow-rate in cubic meter per hour. A number of registering devices are available, ranging from very basic to highly sophisticated.

6.3. Water Quality

The quality of the water from water sources varies depending on origin and has to be tested before use. Irrigation water is either pumped directly from rivers or boreholes, or received from a central canal system for storage in the farm dams or for direct distribution in the orchard through an irrigation system.

Filtration of the irrigation water may be necessary, depending on the quality of the received water, and the irrigation system being used. The degree of filtration needed adds substantially to the initial cost of installation of a system.

Water quality should always be good enough to ensure production of acceptable volumes of high quality fruit. If obtained from sources like rivers or boreholes, the salt and / or pollution levels should never rise above acceptable norms, as this will inhibit good agricultural practices.

Water quality can be tested by a number of laboratories. Crops differ in their sensitivity to high salt concentrations in the irrigation water. Citrus is generally classified as a salt sensitive crop and water quality analyses should therefore always be included as one of the basic considerations in determining the potential of a farm for citrus production.

7. Soil

Soil is the result of soil formation processes over thousands of years. Soil types differ from one place on the surface of the earth to the other, as the result of the differences in the formation processes.

Selection of a farm or a land on which to develop citrus orchards should be preceded by a thorough exercise of land evaluation of the farm to determine which areas on the farm are suitable for citrus production. It should also include the potential for agricultural use of other areas on the farm as well as the management necessary to maintain and improve the immediately surrounding environment.

7.1. Soil Potential

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, specifically the soil texture. 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.

7.1.1. Soil Fertility

Soil Fertility

Soil fertility refers to the nutrient content of the soil and its resultant 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 simply be referred to 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: the higher the clay content, the higher the soil fertility. Clay particles tend to however bind nutrients strongly, making fewer nutrients available to the plant.

7.1.2. Plant Available Water

There is a considerable variation in the capacity of soils to store and release water for plant use. This is referred to as the water holding capacity of the 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.

The water absorption capacity of a soil must be taken into consideration at all times when preparing land for planting or planning an irrigation system.

7.1.3. Soil Permeability

The ease with which air, water and roots can penetrate soils 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. Such soils do 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 movement is much quicker.

As a result, the infiltration rate of water varies between soil types. The infiltration rate of sandy soils is relatively fast and could cause difficulty in ensuring even distribution with irrigation. The density of clay soils on the other hand slows down water penetration. Water movement within the soil is also closely related to the soil structure.

7.2. Soil Characteristics

The differences in soils are best described by seeing, feeling and experimenting with soils on site. Let learners tell you what they see and feel and how the soil reacts to water or drought. Let them tell you how the plant will experience this.

The differences in soils that are found in different areas are associated with suitability for crop production, mainly as result of differences in the following characteristics:

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

These factors determine to a large extent 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.

7.2.1. 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:

- The more difficult a soil is to work or till;
- The greater the water holding capacity;
- The slower water will enter and move through the soil profile;
- The more difficult plant root penetration;
- The more readily surface soil will crust; and
- The more nutrient rich the soil

7.2.2. 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 aggregation of all the various particles that can be separated from each other by weakness planes. The primary particles include the amount and type of clay and organic material, and sand, gravel and stones. Factors that determine the soil structure include factors such as absolute amounts and ratios between

exchangeable and soluble nutrient elements, wetting and drying cycles, soil depth, tillage practices and a number of other factors.

Structure is a characteristic of soil that can therefore be 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.

7.2.3. 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.

Determining the soil layers requires an intensive soil survey beforehand to ensure that all possible barriers to sub-surface water movement are addressed during soil preparation.

7.2.4. 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.

Chemical composition plays an important part in the production potential of soil. In irrigated areas, this characteristic can be viewed as adjustable as it can be altered through leaching and chemical supplementation.

7.2.5. Soil Depth

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.

The soil depth for optimal root development can be improved by deep ploughing during soil preparation or ridging in areas where subsoil layers cannot be utilised or in cases of poor drainage.

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

- Market demand and the physical properties of the potential site play the biggest role in planning a new citrus planting.
- Citrus is a perennial, evergreen, long-term crop and therefore constitutes a long-term investment.
- The successful production of citrus requires good plant material, a suitable micro-climate, suitable soil, good quality water and irrigation, and good management.
- Natural resources are the elements in the natural environment that are required for the production of a crop, and include soil, water, climate, indigenous vegetation, landscape and topography, infrastructure, and people.
- Citrus is grown in sub-tropical climates, where winters are not too cold and relatively frost-free, spring and summer temperatures are not too high, the relative humidity is not too low, water is fairly available, and there is no or little hail and wind. Temperature, wind, rainfall and hail are climatic conditions which most affect citrus production.
- Indigenous vegetation of the area must be known and taken into account when a planting is being planned.
- Topography refers to the lie of the land, also referred to as the physio-geographic characteristics of the land.
- The water source, irrigation capacity, and water quality must be considered when assessing the suitability of the water supply.
- Soil potential is determined by the soil fertility, plant available water and soil permeability.
- The suitability of soil for citrus production is determined by the texture, structure, layering, chemical and mineral composition, and depth.
- Soil erosion occurs when soil particles are removed by wind or water at a greater rate than it can be formed. The dangers of erosion must be taken into account when planning a planting.

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

Activity 1 – Ask an Expert

Ensure that learners have access to an expert and that they know to gain knowledge for the specific questions asked.

Timeframe: 1h

Chapter 2

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

Understand the design of farm lay-out according to agricultural, water catchment and environmental conservation areas
and
Recognise veldt and soil types, animal and human behaviour and demarcate appropriate areas for sustainable resource use in the lay-out of the farm

You have to complete this section as follows:

Total time	*Theory*	*Practical*
6h 45min	5h 15min	1h 30min activities

Throughout this section, ask the learners how does farming impact on the environment in which we farm, and what are the responsibilities of farmers and farm workers toward the environment.

1. Introduction

Land use, and therefore citrus farming, alters the natural environment and has already been the cause of tremendous environmental degradation in South Africa. A very small percentage of natural land areas are conserved in nature reserves and national parks, and the rest are on private land. Conservation of the environment, including indigenous vegetation, water sources, and the soil, is therefore largely dependent on landowners.

Prior to developing land it is important to survey the area to be planted to establish whether it may endanger the surrounding environment and what should be done to do an ecologically sensitive development.

2. The Impact of Citrus Farming on the Environment

Basic environmental patterns and processes have to do with local conditions and include soils, climate, water sources, topography, and ecosystems.

The environmental pattern for a specific land area therefore includes:

- The types of soils that are on the farm
- The microclimate of the area
- The water and water sources

- The types of animals that one might encounter naturally in the area
- How the land is formed in the area, including mountains, rivers and dams
- The types of people, buildings and activities that happen in this area

In the development of a farm or new planting the above factors must be managed and / or utilised in such a manner that production can be continued over a long period without a significant negative impact on the natural environment or its inhabitants.

Citrus cultivation has the potential to impact most significantly on soil, water sources and ecosystems. It is highly unlikely that citrus production will change the topography of the land, except where small areas may be levelled to construct roads or buildings. The most significant danger in this case is however still on the soil in terms of erosion.

3. The Impact on Soil

It is important to show learners examples of the different forms of erosion that is discussed in this section. If physical examples cannot be found, use photographs. Make sure that learners understand why this type of erosion happens, how to avoid it and why it would be detrimental to citrus farming in the long run.

Cultivation impacts on the soil both when a new farm or planting is established and on an ongoing basis. Production practices, such as fertilisation and irrigation, can change the physical and chemical properties of the soil. Irrigation with water that has a high salt content can for instance cause soil salinisation, which impacts negatively on the productivity of the soil.

The greatest danger that the establishment of a new farm holds for soil is causing or accelerating soil erosion. Soil erosion occurs when soil is removed through the action of wind and water at a greater rate than it is formed. It is often the result of farming practices that do not take the dangers of erosion into consideration. The establishment of a farm exposes soil to these elements to a greater degree, thereby increasing the risk of erosion.

When a raindrop hits the 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 removed first. The topsoil is the nutrient-rich layer and 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 respected. Soil is formed at a rate of only 1cm every 100 to 400 years and it takes 3,000 to 12,000 years to build enough soil to form productive land. For this reason, soil is considered to be a non-renewable resource and once destroyed, it is gone forever.

If we disregard this, a time will come when there would not be enough soil left to sustain life on earth, because the soil is a necessary growth medium for plants, a home for certain insects and animals, as well as a medium from which we get minerals. It is important therefore to treat soil, especially topsoil, as a living entity.

Cultivation has a marked effect on soils. In its natural state in any micro-environment, soil is covered and protected by natural vegetation. Removing the natural vegetation, for the purpose of cultivation for crop production, the establishment of infrastructure, or any other use, results in irreversible changes to the soil.

Utmost care must be taken in any such action that all the possible dangers are considered. Over-cultivation can destroy the topsoil structure, impeding movement of air, water and roots with a resultant decrease in soil potential. The dangers of cultivation vary, with sandy soils being more sensitive than clay soils.

3.1. Forms of Erosion

The most common forms of erosion are water erosion and wind erosion.

3.1.1. 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

3.1.1.1. Sheet Erosion

Sheet erosion is characterised by the down-slope removal of soil particles within 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.

3.1.1.2. Rill Erosion (Channel 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 are formed in the field.

3.1.1.3. Gully Erosion (Dongas)

Dongas 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.

3.1.2. 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 several consecutive days.

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.

3.2. Factors Determining Soil Erosion

There are various factors determining soil erodibility, of which the following are the most important:

- Slope
- Soil texture
- Soil structure
- Terrain unit
- Organic material
- Vegetation cover

3.2.1. Slope

The steeper the slope is, the greater the erosion will be, as a result of the increased velocity (swiftness) 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.

3.2.2. Soil Texture

As discussed in chapter 1, texture relates to the ratio between the different sized particles being sand, silt and clay in the soil. In combination with factors such as the slope of the land, vegetation cover and the intensity of precipitation during rain or irrigation, the soil texture determines 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. Vegetation cover will decrease erosion substantially. In the same situation clay soil will suffer much less and no erosion respectively.

3.2.3. Soil Structure

A soil with poor structure, meaning high sand fraction, and low clay and organic content, erodes much more readily than a soil with a well-balanced structure.

Structure can however also 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.

3.2.4. Terrain Unit

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.

3.2.5. 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 influences the infiltration capacity of the soil, therefore reducing runoff.

3.2.6. Vegetation Cover

The loss of protective vegetation through overgrazing, ploughing and fire makes soil vulnerable to being swept away by wind and water. Plants provide protective cover on the land and prevent soil erosion for the following reasons:

- 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.
- Plants break the speed of water drops or wind before it hits the soil, reducing its impact.

3.3. Preventing Soil Erosion

The following measures can be implemented to prevent soil erosion:

- 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.
- Ensure that the infiltration capacity of the soil is considered in the design of the irrigation system to prevent excess run-off.
- Use contour ploughing and windbreaks.
- Establish grass strips in the inter-row areas in orchards.
- Make sure that there are always plants growing on the soil, and that the soil is rich in humus.
- Allow indigenous plants to grow along riverbanks.
- Conserve wetlands.
- Employ minimum or no tillage.
- Encourage water infiltration and reduce water runoff.

4. The Impact on Water Sources

A good sustainable water source is one of the most important basic requirements for citrus farming. It is therefore important to develop the farm in such a way that it will not endanger water supply in any way. The highest priority should always be given to consideration of the possible negative impact of any orchard development or practise on the sustainability of the source and quality of the water.

Practices which will have a negative impact are as follows:

- Injudicious burning of indigenous vegetation
- Injudicious removal of indigenous vegetation in catchment areas for orchard development
- Over-cultivation leading to erosion
- Poor storm water management
- Exceeding the limitations of available water by over-developing
- Poor irrigation systems and irrigation management
- Polluting runoff water by over fertilisation and poor management of spray materials
- Polluting runoff water or water source by poor waste and sanitation management

5. The Impact on Ecosystems

Ecosystem

An ecosystem is a localised group of interdependent organisms together with the environment that they inhabit and depend on.

The indigenous veld types in the citrus growing areas are just a few of the more than 70 occurring in South Africa, all typical of the specific area where they are found and thriving in the environment and micro-climate of that area. The ecosystem supporting each of these veld types can easily be disturbed by injudicious actions in the development of a farm which would alter one or more of the basic elements supporting it.

An example is Renosterveld, which is a type of fynbos occurring only on the lowlands of the Western Cape. It is part of the Cape Floral Kingdom, the smallest of the world's six plant kingdoms. Of the total area originally covered by this unique vegetation, less than 4% remains today, virtually all on privately owned land.

Renosterveld is rich in plant species, many of which are endemic and occur nowhere else in the world. In addition, many species are extremely rare and threatened. The conservation of these plant species is a valuable contribution to the greater preservation of biological diversity. Renosterveld is of international botanical importance and the existence of this veld type and the habitat it provides is dependent on the preservation of sufficient areas thereof. The precarious conservation status of the threatened geometric tortoise, which occurs only in this veld type, is a good example of the close ties animals have with their habitat.

If a citrus farm is developed in an area where a specific veld type occurs, it is important to identify all actions which could endanger the natural ecosystem and to develop an action plan with the help of soil conservation committees or the Department of Agriculture, Forestry and Fisheries.

Measures which can be taken are the following:

- Use renosterveld for grazing and conserve it at the same time by leaving sections unploughed, preventing over-grazing, applying correct veld-burning practices, controlling invasive plants, and using fertilisers and poisons correctly.

- Identify sensitive areas and rare plant species on your property which ought to be conserved.

- Identify threats to sensitive veld and take measures to ensure its survival.

- Have threatened areas declared private nature reserves, natural heritage sites or sites of conservation importance. This will increase the conservation status of the land.

- Establish a conservancy with neighbours, allowing the farmer to take care of sensitive land areas without it being legally binding.

- In identifying the areas in which to establish the citrus orchards, ensure that the necessary actions will not endanger the ecosystem.

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

- Prior to developing land it is important to survey the area to be planted to establish whether it may endanger the surrounding environment and what should be done to do an ecologically sensitive development.
- The environmental pattern for a specific land area includes types of soils that are on the farm, microclimate of the area, water and water sources, types of animals that naturally occur, how the land is formed in the area, and the people, buildings and activities that happen in this area.
- Citrus cultivation has the potential to impact most significantly on soil, water sources and ecosystems.
- Cultivation impacts on the soil both when a new farm or planting is established and on an ongoing basis through production practices, such as fertilisation and irrigation.
- The greatest danger that the establishment of a new farm or planting poses to soil is causing or accelerating soil erosion, which occurs when soil is removed through the action of wind and water at a greater rate than it is formed.
- 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), and gully erosion.
- Wind erosion occurs when the land surface is left bare in regions that are arid enough to allow the soil to dry out, and flat enough to allow the wind to carry the soil away over several consecutive days.
- There are various factors determining soil erodibility, the most important being slope, soil texture, soil structure, terrain unit, organic material, and vegetation cover.
- It is important to develop the farm in such a way that it will not endanger water supply in any way.
- If a citrus farm is developed in an area where a specific veld type occurs, it is important to identify all actions which could endanger the natural ecosystem and to develop an action plan with the help of soil conservation committees or the Department of Agriculture, Forestry and Fisheries.

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

Activity 2 – Research and Report

Remind learners of the need to conduct independent research to answer this reference to any sources or literature used to answer the activity.

Timeframe: 1h 30min

Chapter 3

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

Describe and recognise infrastructural requirements for the selection of the relevant enterprise and
Construct the infrastructure and relate the physical and chemical characteristics of soil, landscape and local climate and land capability and demarcate areas for sustainable use

You have to complete this section as follows:

Total time	***Theory***	***Practical***
7h 30min	5h 30min	2h activities

It is vital that learners are able to distinguish between the different types of infrastructure and its purpose. Ensure that learners understand that all farming enterprises and all citrus farms do not have the same infrastructural requirements. Where possible, hold the discussions on a farm and identify the location of the infrastructure and why it would be found in this specific place.

1. Role and Function of Infrastructure

Infrastructure

Infrastructure refers to services and facilities that support day-to-day economic activity, in this case a citrus production unit.

The basis of a decision of whether to plant and develop a citrus farming unit in a specific area will always be the production potential of the farm, with climate, soil and water as the most important aspects. Infrastructure, although important, will always be a secondary element in the decision-making process. Although infrastructure will therefore not necessarily be a determining factor in whether to establish a citrus farm, it does play a very important role in the planning process.

Infrastructure supports the production process. The size of the farm or planned enterprise determines the type and extent of the infrastructure that will be necessary. A large farm will need a large internal infrastructure to support all the many activities in the production process, and even for instance warrant an own packhouse with all the necessary equipment and manpower. A small farm on the other hand

would need to make use of more external support, as the extent of its activities would not warrant too large expenditure on internal infrastructure.

Other factors are considered with establishment of a new or replacement orchard on an existing farm. Factors such as utilisation of existing infrastructure and whether the chosen cultivar will make a contribution to the current cultivar mix, are the main considerations.

2. External Infrastructure

External infrastructure depends on the location of the farming unit. The transport of supplies and produce over long distances from remote farming units is costly and has a negative impact on the efficiency of production management. The following factors must be investigated carefully:

- Access roads
- Locality
- Communication systems
- Availability of service providers
- Community services

2.1. Access Roads

Access roads refer to roads that lead to the farm, and are generally the concern of the local Department of Public Works or the local municipality. The quality of access roads must be considered when the decision is taken to develop a farming enterprise. These are the roads that workers must use to get to the farm, and over which fruit must be transported to the packhouse or the market.

2.2. Locality

The following is important in terms of locality:

- Surrounding production area
- Proximity to town
- Road and rail transport

Well-settled citrus production areas tend to develop a citrus culture over the years. This manifests itself in the products and services available, as well as local expertise regarding all production-orientated activities.

2.3. Communication Systems

Communication infrastructure refers to telecommunication and radio systems. In some areas, telephone connections are not available, which makes the management of a farming enterprise more difficult.

2.4. Availability of Service Providers

The availability of the following types of service providers must be taken into account:

- Suppliers of equipment and stock
- Maintenance services, irrigation design and installation
- Extension services
- Packhouse and cold-storage

Service providers to a large extent oil the wheels of an enterprise by providing support and production materials in the technical and maintenance fields. Ease of access to their services and goods therefore plays an important role. Day-to-day management becomes more and more demanding and costly with distance, and therefore availability, of service providers.

2.5. Community Services

The following community services play an important role:

- Shops
- Schools
- Medical services
- Churches

Farming enterprises in outlying areas has to make additional provision in remuneration and time for employees and their families to enable them to access the above services.

3. Internal (On-Farm) Infrastructure

The internal infrastructure, also referred to as on-farm infrastructure, is planned along with the orchard layout as part of the land utilisation plan. On-farm infrastructure includes:

- Fencing
- Farms roads
- Irrigation and water supply systems
- Electricity supply
- Boundary fencing
- Farm buildings

3.1. Fencing

A farm is private property and should therefore be well fenced off with limited access to ensure control of movement and security.

The most common types of fencing that is erected on and around a farm are security fencing, cattle fencing, and game fencing, which includes small game and large game fencing. The types of fencing vary in construction and cost depending on its purpose and where it is erected.

3.2. Farm Roads

Main roads on a farm should be positioned to serve all main action areas without causing too much farm traffic in and around the orchards. It is ideal to have the offices, packhouse, stores and housing area situated as near as possible to the farm entrance, so that movement in and around orchards is limited and only linked to production.

3.3. Irrigation and Water Supply Systems

The main aim in development of an irrigation reticulation system is to optimise the use of energy. Placement of dams and pump-houses will therefore be critical in determining the cost of electricity for irrigation purposes. Infield irrigation systems also differ with regard to energy requirement.

Irrigation infrastructure includes:

- Dams
- Main supply – pump-houses and pumps
- In-field irrigation system

3.4. Electricity Supply

A cost effective power supply system should be planned carefully to include possible future development of orchards and infrastructure. Installation of new power supply points is costly and careful attention to initial planning will save costs at a later stage.

Electricity infrastructure includes:

- Main supply – buildings, pump-houses and pumps
- Reticulation to in-field installations

3.5. Farm Buildings

Farm buildings include:

- Housing – permanent and temporary management and workers
- Stores – for vehicles, tractors, implements, chemicals, produce
- Offices
- Packhouses

Placement of the various buildings in relation to the other action centres and activities need to be considered carefully in developing a new farm. Offices, stores and a packhouse must be situated so that it will compliment the farm activities, as well as assist with management and control.

Farm buildings are normally grouped together for the sake of electricity supply, water supply, and access control. Noise factors must however be taken into account – the offices should for instance not be placed right next to the packhouse or maintenance shed.

The extent of housing needed on a farm depends on the size of the farm as well as the distance to the nearest labour source or town. The number of houses that are required increases with the distance from a town or labour source, and special provision must be made for management, middle management and supervisory staff.

Stores must be planned in such a way that access can be controlled to keep the equipment and stock items secure. Stores must however at the same time be easily accessible for authorised persons. There are also special requirements with regard to the design of stores for agrochemicals, and these requirements must be taken into account when planning is done.

Offices must be as close as possible to the main access road to the farm to limit on-farm traffic. The packhouse must however be easily accessible from the orchards to limit traffic during harvesting. The packhouse or loading platform should be situated equidistant from the furthest orchards to ensure minimum time lost in transporting the fruit to those areas.

4. Developing New On-Farm Infrastructure

4.1. Fencing

Boundary fencing must be erected according to the title deed for the farm. If it is unclear where boundary of the farm is, a survey must be done to ensure that the fences are put up in the right area.

The type of fencing erected is determined by location of the farm and the purpose of the fence. A boundary fence on a farm that is in a highly populated area near a town has to be much more secure, and therefore costly, than one in a sparsely populated area.

On citrus farms, security fences are sometimes erected around orchards if there is a danger of crop theft. Cattle fencing are also used to keep livestock out of the orchards, where they pose not only a physical danger to the trees, but also a danger of contamination which may compromise food safety. If the farm is located in an area where there is a lot of wildlife, wildlife fencing is used to protect the orchards.

Security fencing, especially if it is electrified, is considerably more expensive than other types of fencing. It is therefore rarely used for a boundary fence, and is more likely to be used to enclose farm buildings, especially housing.

4.2. Farm Roads

Farm roads have to be planned very carefully in relation to entrance roads and the location of farm buildings. Traffic to and on the farm are mostly the following:

- Light vehicles for transport and deliveries
- Heavy vehicles delivering items like fertiliser, cement or sand
- Heavy vehicles transporting bins with fruit to the packhouse
- On-farm traffic such as bakkies, tractors and trailers

Entrance to the farm from the main road should be secure to prevent unauthorised entry. The type of roads that are used, the off-loading and loading areas, and movement on the farm has to be considered very carefully, and especially in terms of safety of movement. The roads that are used most often must not run through or adjacent to orchards to minimise dust on the trees and fruit.

4.3. Irrigation and Water Supply Systems

The total volume of irrigation water available to a farm determines the size to which the citrus plantings can be developed. The way in which the water is managed will therefore determine the volume of fruit which can be produced and the ultimate profitability of the farming enterprise.

The source of water on a farm can vary from natural runoff into farm dams, rivers, boreholes and irrigation schemes.

The volume of irrigation water registered for any particular farm must be managed carefully to ensure that it is used in a sustainable manner. Proper planning of the water reticulation system to and on the farm is most important and should be done in collaboration with an experienced irrigation engineer.

4.4. Electricity

Electricity is supplied to farms by Escom or certain municipalities who sub-contracts to ESCOM. As service provider, they have to supply and maintain the service line up to the transformer. The connection from there to where the electricity is needed, such as a building or a pump, has to be installed by a qualified electrician according to prescribed legal standards.

Future needs for expansion of orchards, buildings and other structures must be taken into consideration in developing the electricity supply system. It must therefore form part of the overall development plan and it is important to include a representative of Escom in the planning phase.

4.5. Farm Buildings

Buildings are not erected regularly, and the investment is usually substantial when it is done. The farmer and workers have to live with and use the buildings for a long time. For this reason, careful planning is required to make sure that the building will fit the farm's needs. Buildings must be places strategically to fit in with daily management and control.

Buildings and other structures should therefore be designed to serve the farming enterprise. Buildings should be placed:

- To increase efficiency;
- To improve working conditions;
- To maintain quality of stored items;
- To provide or improve control;
- So that there is enough space to accommodate future expansion;
- So that they can be accessed without causing unnecessary traffic in and around orchards;
- With consideration of prevailing winds and weather patterns.

All buildings must also comply with local and national regulations with regard to construction, safety and environmental matters. For certain buildings, such as agrochemical stores, there are very specific requirements and the farmer must be aware of these when the building is planned.

5. Evaluating Existing Internal Infrastructure

When a farm is being purchased as a unit, the existing internal infrastructure must be evaluated to ensure that repairs or redevelopment of infrastructure will not lead to high additional costs.

5.1. Fencing

Determine whether the fences around the farm have been erected according to the title deed of the farm. This is easiest done by having the farm surveyed. All fences should also be in a good condition and effective for what is required, for example a cattle fence will not control movement of game or be effective as security fence around a citrus orchard. Having to erect new fences is costly and should be considered at purchase.

5.2. Housing

If there is insufficient housing on an existing farm, developing additional housing is a major factor to be considered as it requires substantial capital outlay. Good and sufficient housing on a farm is therefore a positive factor. Even with enough housing, the placement of the houses in relation to the workplace, farm entrance and water courses can pose problems with regard to transport, security and pollution.

The quality of the housing with regard to water supply, electricity, ablution and runoff has to conform to health, safety and GlobalGAP requirements.

5.3. Water Supply

Water supply has to be sufficient for both farming activities and domestic purposes, and water sources must be tested for quality. Ensure that the sources are sustained throughout the year and that enough water is available in dry seasons. A good reticulation system for current and planned orchards, as well as to the housing, offices and packhouse must exist.

5.4. Electricity

Electricity supply to housing, offices, pump-houses and other structures is required. The quality of the reticulation system, as well as wiring in all existing structures, must conform to local governmental standards and safety regulations in the Occupational Health and Safety Act.

5.5. Roads

The two points to consider are access onto the farm and access on the farm to offices, workshops, orchards and other structures like stores and a packhouse.

Access onto the farm should be secure and entrance controllable. Access on the farm to the various work stations and orchards should be such that there is very little movement past orchards by the daily traffic on the farm.

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

- Infrastructure is the support structure necessary for successful establishment of a citrus farm or planting.
- Infrastructure is not a determining factor when a decision is taken to develop a citrus farm, but it plays a very important role in the planning process.
- For external infrastructure, access roads, the locality of the farm, communication systems, and the availability of service providers and community services must be investigated.
- Internal infrastructure includes fencing farm roads, irrigation and water supply systems, electricity supply, and farm buildings.
- The most common types of fencing are security fencing, cattle fencing and game fencing. The type and location of fencing depends on the needs of the farming enterprise.
- Roads must be located to provide easy access to the main buildings on the farm while limiting movement in and around the orchards.
- Irrigation infrastructure includes dams, pumps and pump-houses, and in-field irrigation, and the system must designed and installed by a qualified irrigation engineer.
- Electricity infrastructure includes the main supply and the reticulation system and must be designed and installed by a qualified electrical person.
- Farm buildings includes housing, stores, offices and, in some cases, packhouses. Buildings must be placed so that they can be easily accessed but still provide security and control.
- When an existing farm is purchased, the infrastructure must be evaluated against the planned activities on the farm.
- Existing infrastructure that must be evaluated includes fencing, housing, water supply, electricity, and roads.

Complete activity 3 in the **Learner Workbook**.

Activity 3 – Group Discussion

Allow time for groups to discuss the questions and then record their findings. Conclude the overall conclusions on poster board and paste it up in the facilitation room for future reference.

Timeframe: 2h

Chapter 4

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

Identify and recognise stock required for the relevant enterprise

You have to complete this section as follows:

Total time	*Theory*	*Practical*
8h 30min	5h 30min	3h activities

1. Introduction

The stock that is required in a citrus production enterprise refers to two types of stock. Firstly, it refers to the different cultivars of citrus fruit, and secondly to the production stock that is required.

2. Citrus Cultivars

Ask learners to identify the various types of citrus that they come across and to identify specific characteristics of the types, such as colour, size and taste. Bring examples to class if possible.

Cultivar research and development is an ongoing process with numerous new selections constantly being tested. Only those that meet all the production and market requirements are eventually recommended to be planted commercially.

Choosing the correct cultivar, or cultivar mix, is essential to the success of a citrus farm. The choice depends mostly on the conditions, of which the climate is the most important, and on the market demand for the cultivar.

In table 4.1 is information regarding the commercially recommended cultivars grown in South Africa, and an indication of the major production regions of South Africa in which they are grown. The characteristics of the cultivars are also described.

Please Note

This list of cultivars is not in any way exhaustive as new cultivars are constantly being developed.

The split between the regions also change from year to year as trees are removed and replaced in different proportions with different selections. The aim is to provide an idea of the classification of cultivars, the major cultivars in each group, and the major production areas for each.

In table 4.1 we refer to the weeks numbers in which fruit is marketed. The week numbers can be found in any standard diary. As an example, and for the sake of easy referencing, a calendar with week numbers for 2006 is provided at the end of this chapter.

Cultivar	***Description***	***Origins***	***Harvest Period***	***Marketing (Week No.)***
Oranges				
Production Areas	**Navels** • Eastern Cape: 30% • Limpopo Province: 25% • Mpumalanga: 20% • Western Cape: 25% **Valencias** • Eastern Cape: 20% • KwaZulu-Natal: 3% • Limpopo Province: 50% • Mpumalanga: 17% • Western Cape: 10% **Midseasons** • Limpopo Province: 70% • Mpumalanga: 30%			
Navels	Medium to large seedless fruit with small embedded navel at the stylar end of the fruit. Easily peeled with soft fibred segments. The worlds' premier dessert fruit.	Originally from China. The Washington navel was the first commercially recognised navel. Many selections now exist.	March to June	15-30
Late Navels	Late ripening selections of navels.	Selections derived from the Navel	End May to end July	22-35
Tomango	Small but good quality fruit. Largely seedless with tender juicy flesh.	Unknown	May and June	22-32
Shamouti	Medium to large size. Oval in shape. Distinctive fragrance and flavour.	Israel	June and July	25-35
Midknight	Large fruit and virtually deedless. Good internal quality. Bears more fruit inside the tree canopy.	Sundays River Valley in the Eastern Cape, South Africa	Mid July to mid August in hot areas, and from August to mid September in colder areas	33-43
Delta Seedless	Medium-sized, seedless fruit of good quality with a smooth rind.	South Africa	Mid July to end August in hot areas and end July to early September in colder areas	30-42

Cultivar	*Description*	*Origins*	*Harvest Period*	*Marketing (Week No.)*
Valencia	Medium to large fruit, roundish in shape with a well-coloured, moderately thin rind of smooth, sometimes finely pebbled texture. The relatively high acid content and high sugar content to produce a delicious taste. This variety is ideal for juicing.	Portuguese Azores	July to end September in hot areas and mid July to mid October in colder areas	30-49
Soft Citrus (Mandarins)				
Production Areas	• Eastern Cape: 43% • Western Cape: 50% • Other: 7%			
Satsumas	Earliest ripening of all soft citrus varieties. They are seedless and very easily peeled. Flavour can only be described as average to poor.	Japan	March to end April	12-20
Novas	Medium to large fruit, with a rind that does not peel easily and has a distinctive aroma. The flesh is deep orange. The segments are juicy, tender and sweet.	Florida	April to mid May in hot areas and May to Mid June in colder areas	15-25
Clementine	The world's premier mandarin. They are easy to peel and, if grown in single blocks away from other cross-pollinating varieties, the fruit are seedless. When mature, the peel turns bright orange. The fruit has a distinctive sweet taste and flavour.	Thought to be China. Numerous selections have been discovered or developed in Spain, Corsica, Italy and Morroco.	Mid April to end June	17-34
Minneola	A hybrid of grapefruit and tangerine, they tend to have big fruit with a distinctive nipple at the stem end of the fruit. The mature fruit turns a deep orange colour. It is juicy, aromatic and has a good tangy flavour.	Florida	Mid May to end June in hot areas Mid June to end July in colder areas	24-36
Tambor	Generally difficult to peel, the pulp is tender and extremely juicy. The fruit is of medium size and slightly flattened at the stylar-end, where a small navel often forms.	Jamaica	End June to early August	28-40

Cultivar	*Description*	*Origins*	*Harvest Period*	*Marketing (Week No.)*
Nadorcott	Easily peeled, the rind turns deep orange at maturity. Seedless when grown in separate blocks away from other cross- pollinating varieties. Late maturing. Internal quality is excellent with high sugar levels.	Morocco	June-August	26-43
Grapefruit				
Production Areas	• Eastern Cape: 3% • KwaZulu-Natal: 12% • Limpopo Province: 15% • Mpumalanga: 35% • Swaziland: 35%			
Marsh	The fruit is large, white and virtually seedless. Marsh is suitable for fresh consumption in segments and for juicing.	Lakeland, Florida	End March to mid June	17-35
Rosé	This fruit has a pale-pink flesh, and the skin is yellow with a red blush.	Texas	Mid April to end June	19-35
Star Ruby	Rind is this and a deep golden yellow to red. The flesh is deep red and the fruit rarely has more than one or two seeds. Very high juice content and sweet flavour. Well suited to those who find other grapefruit too sharp in taste.	Weslaco, Texas	Mid April to end June in hot areas	19-35
Lemons				
Production Areas	• Eastern Cape: 35% • Western Cape: 15% • KwaZulu-Natal: 3% • Limpopo Province: 15% • Mpumalanga: 30% • Swaziland: 2%			
Eureka	The rind is smooth and has a thin to medium thickness. This lemon has a high acid level and high juice content. It rarely has more than 5 seeds per fruit and is often seedless.	California in 1858	Mid February to mid July in hot areas and mid March to mid August in colder areas	12-44

Table 4.1: Commercial Citrus Cultivars of South Africa

3. Production Stock

Visit the store rooms on a citrus farm with the learners and identify what is found on the farm and what the stock items are used for. Remind learners that this varies between enterprises, and encourage them to think of items that may be required that they do not see.

The production stock that is required on a citrus farm is as follows:

- Plant material
- Agrochemicals, including plant protection products and fertilisers
- Tools, machinery and equipment
- Maintenance items
- Fuel
- Other consumables

3.1. Plant Material

Although plant material as such is not really a stock item, the process of buying and handling is – as in the case of the other items – prescribed in the Good Agricultural Practices (GAP) for fresh fruit production. Registration for GAP, of which GlobalGAP is the most important, is a requirement for entry into most fruit markets and will be dealt with where applicable in the following chapters.

GlobalGAP sets out a framework for Good Agricultural Practices (GAP) on farms and defines essential elements for development of best agricultural practice for global production of horticultural products.

The correct choice of cultivar is one of the most important decisions that a grower must make. Producing high quality fruit, which will satisfy consumer preference in the various markets, is of utmost importance in achieving and maintaining profitability.

Choice of the best rootstock also forms an integral part of the planning of any new orchard development. The rootstock directly influences tree performance and fruit quality, and this means that rootstocks can be used to partially offset the effect of limiting soil or environmental factors. Some of the factors which influence the choice of cultivar and rootstock include:

- Locality, in terms of the microclimate
- Soil and water quality and availability
- The need to produce good yields of fruit of good quality and size
- Market demand for a specific cultivar
- Existing cultivar spread on the farm
- Packhouse capacity and its effective utilisation

Trees can be purchased from any of a number of accredited citrus nurseries. Before ordering, it is important to establish whether the nursery is accredited by the Citrus Improvement Programme (CIP), and to ensure that the nursery will supply trees that are true-to-type and of a high quality.

Orders must be placed at least 18 months prior to planting. On ordering, it must be specified that only certified bud-wood from the Citrus Foundation Block (CFB) should be used, and that the trees must conform to the minimum standards specified under the CIP. The physical requirements for certification of citrus nursery trees are as follows:

- All trees must be healthy with a good nutritional status.

- The trees must be free of pests and diseases.
- The stems of all trees must be straight.
- The bud union must be at least 200mm above soil level.
- Trees must have healthy, well-developed root systems, free of any harmful pathogens and nematodes.
- Trees must comply with the basic tree size standards as specified in the CIP scheme.

The above requirements should be discussed in detail and agreed to by both the buyer and seller on ordering the trees. The nursery should be visited periodically during the period that the trees are being grown to ensure that the correct practices are being applied.

At delivery, certificates issued by the CIP should accompany each consignment of trees, certifying both the health as well as the origin of the bud-wood. This is a requirement for GlobalGAP registration.

3.2. Agrochemicals

Agrochemicals

Agrochemicals are all chemical substances utilised in pre- and postharvest processes to produce horticultural products for fresh consumption. Agrochemicals include substances for soil preparation, fertilisers, and crop protection and postharvest chemicals.

GlobalGAP requirements for handling agrochemicals are explicit and most compliance criteria are not considered as negotiable. All chemicals must be handled according to the parameters set out under the registration certificate. Chemicals banned in the European Union cannot be used on crops destined for sale in the European Union.

Recommendations for the use of agrochemicals must be made by technically responsible persons able to demonstrate competence to determine types and quantities to be applied. All products must be applied appropriately for the target recommended on the product label. Persons handling the products must be trained in the correct and safe handling procedures

Application of all chemicals must be recorded indicating crop name and variety, application date, product trade name and active ingredients, as well as that the required pre-harvest interval (PHI) has been observed. Residue testing must be carried out prior to shipment to ensure that the maximum residue restrictions of the target markets are met.

Chemicals must be stored in a safe place in such a manner that no contamination will take place. The stock of chemicals must be controlled carefully and records must be kept from which the current stock levels can be easily determined. Empty containers must not be re-used and must be disposed of in a manner that avoids exposure to humans and contamination of the environment.

3.3. Tools, Machinery and Equipment

The type and quantity of the tools, machinery and equipment that is needed on a citrus farm depends on the production practices that are employed and the size of the farm.

Tools, machinery and equipment must be stored in a secure facility and proper control and management is required to ensure that these items are not lost or mislaid. A maintenance plan is required to ensure that the items are properly maintained and that their lifespan is prolonged as far as possible.

Tools, machinery and equipment must never be used for a purpose that they are not designed for, and only authorised, trained personnel should be allowed to use it.

3.4. Maintenance Items

Maintenance items include lubricants, spare parts, tyres and other equipment held in a workshop to maintain vehicles and equipment on the farm. It also includes pipes, fittings and micro-jet or drip emitters to maintain the irrigation system and water supply to the farm structures and housing.

Holding too many of these items constitutes dead capital lying in the stores and it is important to maintain a good balance of the quantities held without jeopardising the farming operation.

All these items must be stored safely on shelves in secured stores with proper control on issuing for maintenance to avoid misuse and to have ongoing information on the level of items in the stores.

3.5. Fuel

Fuel refers to the diesel and petrol that are required to operate the vehicles and equipment on the farm. Most farms have fuel tanks on the farm, to which fuel is delivered in bulk from time to time. Tractors and other vehicles are filled from the storage tanks.

Fuel must be stored in appropriate containers to ensure that it is secure, and to prevent contamination of the environment. Preventative measures must be in place to ensure that any spillage can be handled in an ecologically sensitive manner.

Records must be kept of the fuel that is dispensed to all vehicles and machinery, and provision must be made to ensure that sufficient fuel is available at all times, especially during times of high production activity, such as during harvesting or spraying.

3.6. Other Consumables

Other consumables include items as protective clothing, cleaning material, and items that are used in the administration and management of the business. The types and quantities of consumables that are required depend on the size of the production unit. Consumables are usually purchased from local suppliers.

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

- Two types of stock are required on a citrus farm, being the plant stock, meaning the type and cultivar of citrus that is being planted, and production stock.
- Citrus are classified in four groups being oranges, soft citrus (mandarins), grapefruit, and

lemons.

- The production stock required on a citrus farm is plant material, agrochemicals, tools, machinery and equipment, maintenance items, fuel, and other consumables.
- The choice of cultivar and rootstock is one of the most important decisions that must be taken when planning a citrus planting.
- Plant material must be purchased from nursery that is accredited by the Citrus Improvement Program (CIP) and that can supply trees that are true-to-type and of high quality. Each consignment of trees must be certified in terms of GlobalGAP requirements.
- The tools, machinery and equipment required depend on production practices and the size of the farm.
- Agrochemicals are chemical products that are used in pre- and postharvest agricultural production processes and include chemicals for soil preparation, fertilisation and crop protection, and postharvest processes.
- Maintenance items include lubricants, spare parts, tyres, irrigation emitters, pipes, and other items that are needed to maintain the vehicles and equipment and the irrigation system on the farm.
- Fuel refers to the diesel and petrol that is required to operate the vehicles and equipment on the farm.
- Other consumables include items such as protective clothing, cleaning material, and all other items required for the management and administration of the business.

Complete activities 4 and 5 in the **Learner Workbook**.

Activity 4 – Ask an Expert

Ensure that learners have access to an expert to interview. Remind learners that the objective of the interview is to get answers to the questions in the activity. Remind learners to rephrase answers as per their own understanding.

Timeframe: 1h 30min

Activity 5 – Worksheet

Allow time for learners to complete the activity individually. Encourage them to use their own words and interpretation, and to use their own practical experience as much as possible while answering the question.

Timeframe: 1h 30min

2011 Calendar

	So	Mo	Tu	We	Th	Fr	Sa	Week
							1	
January	2	3	4	5	6	7	8	1
	9	10	11	12	13	14	15	2
	16	17	18	19	20	21	22	3
	23	24	25	26	27	28	29	4
	30	31	1	2	3	4	5	5
February	6	7	8	9	10	11	12	6
	13	14	15	16	17	18	19	7
	20	21	22	23	24	25	26	8
	27	28	1	2	3	4	5	9
March	6	7	8	9	10	11	12	10
	13	14	15	16	17	18	19	11
	20	21	22	23	24	25	26	12
	27	28	29	30	31	1	2	13
April	3	4	5	6	7	8	9	14
	10	11	12	13	14	15	16	15
	17	18	19	20	21	22	23	16
	24	25	26	27	28	29	30	17
May	1	2	3	4	5	6	7	18
	8	9	10	11	12	13	14	19
	15	16	17	18	19	20	21	20
	22	23	24	25	26	27	28	21
	29	30	31	1	2	3	4	22
June	5	6	7	8	9	10	11	23
	12	13	14	15	16	17	18	24
	19	20	21	22	23	24	25	25
	26	27	28	29	30			26

	So	Mo	Tu	We	Th	Fr	Sa	Week
						1	2	26
July	3	4	5	6	7	8	9	27
	10	11	12	13	14	15	16	28
	17	18	19	20	21	22	23	29
	24	25	26	27	28	29	30	30
	31	1	2	3	4	5	6	31
August	7	8	9	10	11	12	13	32
	14	15	16	17	18	19	20	33
	21	22	23	24	25	26	27	34
	28	29	30	31	1	2	3	35
September	4	5	6	7	8	9	10	36
	11	12	13	14	15	16	17	37
	18	19	20	21	22	23	24	38
	25	26	27	28	29	30	1	39
October	2	3	4	5	6	7	8	40
	9	10	11	12	13	14	15	41
	16	17	18	19	20	21	22	42
	23	24	25	26	27	28	29	43
November	30	31	1	2	3	4	5	44
	6	7	8	9	10	11	12	45
	13	14	15	16	17	18	19	46
	20	21	22	23	24	25	26	47
	27	28	29	30	1	2	3	48
December	4	5	6	7	8	9	10	49
	11	12	13	14	15	16	17	50
	18	19	20	21	22	23	24	51
	25	26	27	28	29	30	31	52

Chapter 5

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

Recognise and describe production cycles within the relevant enterprise

You have to complete this section as follows:

Total time	*Theory*	*Practical*
6h 30min	5h 30min	1h activities

The citrus production cycle would be something that the learners are familiar with in terms of practical experience and through the introductory part of this program. Ask the learners to pre-read this section and answer any questions that they might still have.

1. The Citrus Production Cycle

The production cycle for citrus is a year-round process, and is closely related to the annual growth cycle of the citrus tree. This cycle is discussed shortly in the introduction to this learning material. The production cycle is designed to provide the tree with what it requires to optimally support the current growth stage.

Using the annual cycle in the introduction, the production cycle is related to the growth stages of the tree as set out in table 5.1. Please note that the approximate phenology of a valencia orange tree was used to develop the production cycle that is reflected in this table, and that the phenology of various types and cultivars of citrus fruit can differ slightly.

Month	*Cell Processes*	*Fruit and Flower Development*	*Production Processes*					
			Fertilisation	Pest and Disease Control	Irrigation	Pruning	Harvesting	Packing
July	Flower Initiation	Flowering						
August	Cell Division							
September								

Month	*Cell Processes*	*Fruit and Flower Development*	*Production Processes*					
			Fertilisation	Pest and Disease Control	Irrigation	Pruning	Harvesting	Packing
October		Fruit Set						
November								
December	Cell Enlargement							
January		Fruit Growth and Maturation						
February								
March								
April								
May								
June								

Table 5.1: The Annual Production Cycle for a Valencia Orange

2. Reporting and Recording Observations and Actions

Facilitator Tip

Lead a class discussion around the following points and questions and summarise the conclusions on poster board to paste up in the facilitation room as reminder:

- How do you know when what goes on with the citrus crop?
- Why do you need to know what is going on with the citrus crop?
- How do you know when to perform certain actions on the citrus crop?
- How do you know if your farming activities are working?
- How do you know if the crop that you produce makes the consumer happy?

The size and quality of the fruit at harvest is determined by a large number of factors. Each of these can cause a poor size or quality fruit which will eventually result in lower income.

It is therefore important to observe and record all factors which can influence the outcome. A system of recording all these factors must exist on every citrus farm. Recordkeeping is a way of monitoring external and internal factors, as well as procedures which can influence the outcome of the production process.

It is important to develop a formal recordkeeping system which is kept up to date and can be referred to at any time. It should be designed in such a way that the information will also conform to GAP norms.

GAP certification and registration has become a requirement for exporting fruit to most countries. In order to be certified and registered farmers should be able to demonstrate their commitment to:

- Maintaining consumer confidence in food quality and safety.

- Minimising the detrimental impact of farming practices on the environment, whilst conserving nature and wildlife.

- Reducing the use of chemical crop protection products.

- Improving the efficiency of natural resource use.

- Ensuring a responsible attitude towards worker health and safety.

The recordkeeping system must be such that it is possible to trace back fruit received on the market to its origins, meaning to where it was produced in the orchard. All the production processes and actions employed in the production of the fruit must be open to scrutiny.

It is important that all employees are aware of the importance of recording all the necessary actions and observations during the production process, as well as why the information is necessary. Actions and observations that must be recorded include the following:

- Blossom dates of all cultivars
- Weather data
- Irrigation scheduling
- Details of fertiliser applications
- Details of pest and disease control application

2.1. Blossom Dates

Blossom dates vary from year to year and influences phenological development of fruit up to the time of harvest. Comparing the date of full blossom with those of previous years is an indication of the picking date relative to the previous years and can be utilised in planning the harvesting and picking process. Spray recommendations quite often also refer to days after full bloom.

2.2. Weather Data

Weather data includes:

- Rainfall
- Daily maximum and minimum temperatures
- Humidity
- Evaporation

Analyses of trends in weather data are used to determine fruit growth patterns, which indicate the fruit size spectrum at harvest. This information is used in crop prediction and plays an important role in marketing, as the markets vary in their fruit size preferences.

2.3. Irrigation Scheduling

The irrigation manager prescribes the irrigation scheduling. The actual implementation of the planned scheduling must be recorded to ensure that scheduling was complied with. Irrigation reports also include details of problems that may have been encountered with the irrigation system.

2.4. Fertiliser Applications

This information is utilised in combination with production statistics to formulate the fertiliser recommendations for each year. It must also be available for inspection for qualification under the GlobalGAP system. All instructions to employees indicating time of application and quantities must be given in writing and the actual application per orchard must be recorded as one of the requirements for traceability.

2.5. Pest and Disease Control Application

All details of the pest and disease control program must be recorded for GlobalGAP qualification. This should include verification that the person recommending the program is qualified, all instructions to employees, safety precautions, and training records.

3. Marketing

Marketing of citrus can be done by the producer himself, through a cooperative, or through market agents in both the local and overseas markets. The fruit can also be sent directly to juice processing factories. The fresh fruit markets generally yield the highest income and only the sub-standard fruit are juiced.

The local and export markets for fresh fruit, as well as buyers within each marketing sphere, have different standards for the internal and external quality of the fruit. Knowledge of the market requirements for the specific kinds of citrus fruit, as well as individual cultivars, is most important to ensure maximum proceeds and a profitable farming enterprise.

Having established the target markets and the various standards to which the fruit must comply, the producer must ensure that the final product conforms to these standards.

It must be possible to produce the desired fruit quality of the chosen cultivar in the specific micro-climate in which the farm is situated. Choice of cultivar is therefore one of the most important decisions to ensure profitable returns on the farm. It is for instance not possible to produce quality grapefruit in the colder Mediterranean climate of the Western Cape, or navels in the Lowveld of Limpopo or Mpumalanga.

Most markets insist on traceability of all processes to which the fruit was subjected from the orchard up to the point of sale. This can only be achieved through constant quality management and recording throughout the production process in the orchard, harvesting, packing process and the rest of the supply chain.

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 5

- The citrus production cycle is closely related to the growth cycle of the tree, and is designed to provide the tree with what it needs during each stage for optimal growth.
- Recordkeeping monitors internal and external factors that can influence the outcome of the production process.
- A recordkeeping system should be such that it is possible to trace the origins of any fruit, even back to the orchard.
- Actions and observations that are to be recorded include blossom dates of all cultivars, weather data, irrigation scheduling, details of fertiliser applications, and details of pest and disease control applications.

- Marketing of fruit is done either by the grower directly, or more likely by a marketing agent. It is essential that the grower should be aware of the requirements of the markets that he intends selling his fruit in.

Complete activity 6 in the **Learner Workbook**.

Activity 6 – Group Discussion

Allow time for groups to break away for discussion regarding the activity and encourage each member of the group to make contributions, and to record their own findings.

Timeframe: 1h

Chapter 6

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

Identify and recognise harvest practices within the relevant enterprise

You have to complete this section as follows:

Total time	*Theory*	*Practical*
7h 15min	5h 30min	1h 45min activities

If the program is presented outside of the harvest season, class discussions will have to be held during this session that follow. If the program is delivered during harvest, spend time observing and commenting about actual harvesting with the learners. Pay special attention to harvesting procedures, how they impact on the decisions that are made in an enterprise and how these would influence the set-up of a new enterprise.

1. Basic Preparation Requirements

The harvesting of citrus fruit is the final process in the production cycle, and one of the most important. If the harvest is not well-planned and well-managed, it may lead to damage to fruit that have been produced at high cost.

The basic requirements for preparing of the harvesting process are:

- Crop estimates
- Management
- Equipment
- Work force

1.1. Crop Estimates

The basis for calculating the management, equipment and labour needed to harvest the crop within the normal picking period of each cultivar is an accurate crop estimate.

The estimate must, apart from crop volume, also indicate projected fruit size spread per cultivar, external quality and time of ripening. Internal quality development towards harvest must be monitored from about six to eight weeks before estimated harvesting date to confirm or adjust earlier predictions.

1.2. Management

1.2.1. Training

All supervisors and workers must be trained before harvesting to ensure that the correct methods are used during the picking process. It is important that both the supervisors and workers are at the same level of understanding of why the picking process must be done in a certain manner and what the negative effects of deviation would be.

1.2.2. Quality Management

Systems must be devised to monitor that the fruit is harvested with the correct internal and external quality standards. This dictates that fruit samples must be taken and analysed from well before harvesting, and the quality standards must be monitored up to picking.

The **internal** quality parameters that are measured are juice percentage, total soluble solids (TSS), acid content and TSS/acid ratio. Picking can only commence once the minimum levels stated in the market specification are reached, as they generally do not change after picking. Colour development is the main **external** quality factor monitored at this stage.

The actual picking process must be done as prescribed and must be carefully monitored.

1.3. Equipment

All the equipment needed for the picking process must be checked beforehand to ensure that it is in good condition and that it is sufficient. Equipment includes:

- Tractors
- Picking trailers
- Bins
- Ladders
- Clippers
- Picking bags
- Picking gloves

Care must also be taken to ensure that sufficient ablution facilities are available for the additional workers that are employed during the harvesting period.

1.4. Work Force

The number of harvest workers and supervisors required is calculated on the basis of the crop estimate, taking into account the period in which the harvesting must be completed for each cultivar.

2. Harvest Practices

2.1. Harvesting Systems

Two harvesting systems are commonly used in the South African citrus industry, being bulk bins (400kg capacity) and picking trailers (1.6 – 2.5 ton capacity).

Both systems have advantages and disadvantages. The decision on which type to use is usually based on the production area within which the farm is located and the variety being picked.

2.2. Pre-Harvest Actions

The pre-harvest actions include the following:

- Final estimate of total crop per cultivar as well as fruit size spectrum
- Comparing internal and external fruit quality with marketing standards
- Sourcing and training of supervisors and pickers
- Medical examination of all workers to be involved in the picking operation
- Issuing protective clothing to all pickers
- Preparing and cleaning picking equipment

2.3. Picking Process

The following actions are involved in the picking process:

- Decide which picking method to use, being clippers or snap-picking.
- Inspect the cleanliness and condition of ladders, clippers and picking bags daily.
- Inspect the fingernails of pickers, which must be short to prevent injuries to fruit.
- Ensure that enough drinking water is available.
- Monitor hygiene standards, for instance washing of hands after meals and ablutions.
- Ensure that fruit that are wet are not picked to prevent pressure bruising, called oleocellosis.
- Monitor of general picking and handling of fruit from tree to bin or trailer by supervisors.
- Ensure that picking bags are emptied carefully so as not to cause injuries to the fruit.
- Ensure that fruit do not have long stems after picking.
- Ensure that bins or trailers are not overfilled before transporting.
- Monitor the removal of all fallen and decayed fruit from orchards after picking.

2.4. Transport to Accumulation Point or Packhouse

In preparation for harvesting, all orchard roads must be graded. Rough roads cause unnecessary wear and tear on transport vehicles and equipment, and can lead to injuries and bruising to the fruit.

Fruit must be transported from the orchard and to packhouse at a moderate speed to prevent injuries or bruising. Transport at high speeds on gravel roads also causes dust to settle on the fruit, which leads to injuries. At high speeds, fruit in the top layers moves up and down, which also cause injuries. These small injuries can lead to infection by pathogens and result in decay.

3. Health and Hygiene Principles

3.1. Health and Safety

The Occupational Health and Safety Act of 1993 (OHSA) provides for the health and safety of persons at work and when using plant and machinery. It also provides for protection of persons other than those at work against hazards to health and safety arising out of activities of persons at work.

3.1.1. Employers

According to the OHSA, employers have the basic duty towards employees to provide and maintain a working environment that is safe and without risk to the health of the employees.

The matters to which these duties refer include the following:

- Providing and maintaining systems of work, plant and machinery that are safe and without risk to health;

- Taking steps to eliminate or diminish any hazard or potential hazard to the safety or health of employees;

- Identifying the hazards to the health or safety of persons attached to any work which is performed, and devising and applying any necessary precautionary measures;
- Providing such information, instruction, training and supervision as may be necessary to ensure the health and safety of his employees;
- Not permitting any employee to do any work unless the precautionary measures which may be prescribed have been taken;
- Ensuring that the work is performed under the general supervision of a person trained to understand the hazards associated with it and who has the authority to ensure that the precautionary measures taken by the employer are enforced.

3.1.2. Employees

Employees also have a responsibility under the OHSA, as follows:

- Take reasonable care for the health and safety of himself and of other persons who may be affected by his / her acts or omissions;
- Cooperate with his / her supervisor to comply with any health and safety measures;
- Carry out any lawful order given to him / her in the interest of health and safety;
- If any unsafe or unhealthy situation comes to his / her attention, report it as soon as possible to the supervisor and / or employer;
- If he / she is involved in any accident which may affect his / her health, to report the incident as soon as possible;
- Cooperate with safety committees whenever required.

Complete activity 7 in the **Learner Workbook**.

Activity 7 – Ask an Expert

Ensure that learners have access to an expert to interview and that they understand that the objective of the interview is to obtain answers to the questions in the activity.

Timeframe: 45min

3.2. Hygiene

A hygiene risk analysis encompassing, amongst others, harvesting procedures, should be carried out prior to harvesting and processing.

All identified actions should be communicated to all persons involved in the harvesting process through training, and must be strictly enforced by supervisors and management. All such actions must be documented and monitored throughout.

The following applies:

- Only healthy people must be involved in the harvesting process.
- Workers must have access to clean toilets and hand washing facilities in the vicinity of their work area.
- Basic verbal and written instructions in hygiene must be given before handling fruit, including personal cleanliness, washing of hands after meals and ablutions, wearing of jewellery, fingernail-length and personal behaviour.
- Workers must be made aware of the importance of wearing and caring of protective clothing.
- All subcontractors and visitors must be aware of the relevant demands on personal hygiene.
- A trained person in first aid must be available whenever on-farm activities are carried out.
- The accident and emergency procedures must be clearly understood by all workers.

4. Quality Standards

4.1. Internal Quality Standards

Harvesting fruit at optimum maturity is an important factor that determines the shelf-life of the final product. Each cultivar has a unique set of internal standards, which develops with ripening and reaches optimum levels at its normal picking time. The length of the normal picking time can vary from four to ten weeks between cultivars.

A number of parameters, including rind puffiness, rind-colour, and acid and sugar levels, are used to measure fruit maturity. The parameters are monitored from about four to six weeks before the anticipated date of harvest to confirm that the predicted fruit maturity coincides with the packing period indicated on the crop estimate.

It is essential that the internal fruit quality complies in all respects with the export requirements before harvesting. The packhouse has no control over internal fruit quality and non-conforming fruit has to be discounted at much lower prices to inferior markets.

4.2. External Quality Standards

External standards at the time of harvest refer to rind colour, skin blemishes, deformed fruit and insect damage and diseases. Injured fruit – sustained during picking and transport process – are also monitored and removed at the packhouse.

Rind colour develops further after picking and can be enhanced through de-greening or delaying the fruit before processing at a higher temperature. Practices like these will however detract from shelf-life and marketing potential. It is therefore best practice to only harvest fruit with fully developed rind colour.

Blemishes are caused by wind, hail and insects and are normally more severe at an early stage of fruit development. A certain level of blemishes is allowed on export and local market fruit, but obviously non-conforming fruit must be graded out and sent for juicing.

4.3. Pests and Diseases

Blemishes caused by insects like bollworm and thrips are caused long before harvest. Such fruit are culled at the packhouse. Numerous postharvest diseases often result from pre-harvest infections. This can be reduced or eliminated by the following orchard practices prior to harvest:

- Spraying trees with fungicides
- Removal of dead wood inside trees
- Pruning trees to prevent fruit contact with soil
- Removal of fallen fruit
- Control of fruit fly, false codling moth, mealy bug and other insects which may damage fruit

The level of postharvest decay is also influenced by picking and transport practices, fruit maturity, pruning of trees, fertilisation and irrigation practices. Correct management of these practices is therefore of primary importance to deliver a highly marketable fruit to the packhouse for processing.

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 6

- The basic requirements for preparing for the harvesting process are crop estimates, management, equipment, and the work force.
- The crop estimate must include the expected crop volume, projected fruit size spread per cultivar, external quality, and expected time of ripening.
- Management preparations must be made by ensuring that all supervisors and workers are properly trained, and that systems are in place to monitor the quality of the fruit and the overall picking and packing process.
- The harvesting equipment that is required includes tractors, picking trailers, bins, ladders, clippers, picking bags, and picking gloves.
- The crop estimate is used to calculate the number of workers needed for the harvest.
- Two harvesting systems are commonly used, being bins and picking trailers.
- Before the harvest commences a final crop estimate must be made, the internal and external fruit quality must be compared with market standards, the workforce must be secured and equipped, and equipment must be prepared and cleaned.
- The picking process must be monitored constantly to ensure that quality and cleanliness standards are maintained.
- Fruit must be transported to the packhouse in such a manner that injury to the fruit is prevented and the fruit quality is not compromised.
- The Occupational Health and Safety Act of 1993 must be adhered to in order to ensure that the health and safety of workers is protected.
- A hygiene risk analysis must be carried out prior to the harvesting process to ensure that prescribed standards are maintained.
- The internal and external fruit quality must adhere to the market standards, and the residue levels of crop protection products must be monitored carefully to ensure that it adheres to international minimum residue levels.

Complete activity 8 in the **Learner Workbook**.

Activity 8 – Worksheet

Encourage learners to answer the worksheet according to their own observations of harvesting and the practical environment that they are exposed to.

Timeframe: 1h

Chapter 7

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

Describe and recognise postharvest practices within relevant enterprise

You have to complete this section as follows:

Total time	*Theory*	*Practical*
6h 30min	5h 30min	1h activities

Some learners may not have had exposure to and experience in postharvest practices. Where possible, create scenarios where the learner has to play different roles, thinking from the perspective of the worker, the business owner, and the consumer.

Where possible, arrange for site visits to packhouses. Also pay a visit to a supermarket to determine how fruit was handled and packed and why it might have been done in this way.

1. Basic Requirements for Postharvest Processes

1.1. Packing Material

Packing material includes a variety of cartons, wrappers, labels, bags, trays, and so on. The packing material used for packing specific fruit destined for a specific export market is determined by the requirements of that market.

Packing material must conform to the required quality standards to ensure that the fruit are safe and protected from injury. Packing material should be checked on delivery to the packhouse.

1.2. Postharvest Treatment Chemicals

The chemicals required for postharvest treatments depend on the requirements of the market for which the fruit is destined. Chemicals must be stored and handled in accordance with GAP and health and safety standards.

1.3. Employees

A safe and healthy environment must exist at all workstations and all employees must wear appropriate protective clothing. All employees must be adequately trained for their specific job and must be aware of all the rules, regulations and hazards.

2. Packhouse Practices

Once fruit has left the orchard, it is subjected to a number of processes, being:

- Receiving fruit at packhouse and product identification
- Decay control practices
- Wash line
- Grading
- Labelling
- Sizing, packing and marking
- Palletisation

2.1. Receiving and Product Identification

Fruit arriving at the packhouse, and at any subsequent point, should be traceable back to the particular orchard, picking team and date of harvest. Each trailer or bin received should be clearly identified, indicating:

- Grower name
- Orchard
- Variety
- Date picked
- Supervisor's signature

2.1.1. Monitoring and Verification of Receipt

Time and date of arrival from the orchard as well as tipping on the packing line must be recorded as proof of receipt. Quality checks are done to ensure that the fruit comply with export requirements.

2.1.2. Cull Factor Analysis

Analysis of cull factors provides information about the extent and nature of external quality defects, presence of phytosanitary pests, and the decay potential arising from mechanical or insect damage to the fruit. From this and estimated export percentage can be determined.

A random sample of the consignment is inspected for the following:

- Harvest defects, such as injuries, long stems, plugged and buttonless fruit. Buttonless fruit are fruit from which the little structure where the fruit meets the stem, called the button, has been removed during harvesting. Plugged fruit are fruit where white flesh can be seen under the skin where the button has been removed. Buttonless and plugged fruit are more susceptible to disease and infection, and therefore pose a food safety hazard.
- Other decay factors, such as false codling moth and fruit fly damage
- Blemish factors, such as wind, thrips and red scale
- Internal quality

2.2. Decay Control

Packhouse treatments cannot eliminate all postharvest decay and effective pre-harvest control measures are also prerequisite for successfully controlling postharvest decay.

It is not possible to totally exclude injuries in the picking process. The fruit must therefore be delivered to the packhouse for treatment as quickly as possible after picking. If the fruit is not going to be packed on arrival at the packhouse, it is advisable to drench the load with chlorinated water before storage.

The entire packing line should be checked regularly for sharp objects which may damage the fruit. Graders and packers should wear gloves.

Pressure injuries (oleocellosis) to the fruit in the packing line should be eliminated through careful management of areas where it could occur, for instance in the high pressure de-scaling unit, with too high temperature in hot water baths, with high roller speeds, and wax accumulated on conveyer belts, guides and aluminium rollers.

The most effective fungicide treatments must be applied, and the concentration must be correct and be monitored and recorded on a regular basis. Fruit which has been washed or dipped in a water bath must be properly dried before entering a fungicide tank or the area where fungicide is sprayed on in water or in wax.

Low temperatures stop or delay the development of fungi. The packed fruit must therefore be placed in cold storage as soon as possible after packing.

2.3. Wash Line

The wash line is defined as the area encompassing all the processes from tipping the fruit (wet or dry) at the entrance of the packhouse to after the wax drying tunnel. The effectiveness of these treatments only becomes apparent once the product has left the packhouse and has arrived at the market place. Careful monitoring of the following key points on the wash line must therefore be carried out on a regular basis:

- Wet or dry dumping area
- High pressure de-scaling area
- Brushes
- Drying tunnels
- Fungicide application area
- Waxing area

2.4. Grading

This operation is the most difficult to control because it is entirely dependent on the human element. Many factors influence the effectiveness of grading, including the following:

- External fruit quality
- Design of the grading table
- Fruit colour and size, because poor colour can for instance mask blemishes
- Presence of developing factors such as oleocellosis and black spot
- Level of training and capability of graders
- Number of fruit handled per minute by graders
- Shift duration and rest intervals
- Supervision and commitment of personnel to quality

The monitoring and verification of grading is the most specialised quality control function in the packhouse. It requires trained and experienced personnel who have intimate knowledge of both local and export standards for all categories of fruit.

Monitoring is done by drawing random samples of fruit from the line at regular intervals after each grading operation. Each sample is then graded to the applicable standard to which the product must comply.

The findings are documented and if necessary, changes or training of graders immediately implemented.

2.5. Labelling

The following aspects of the labelling process must be controlled:

- The correct labels must be used for variety and size
- Sufficient fruit of the desired counts must be labelled
- Only one label must be applied per fruit

2.6. Sizing, Packing and Marking

In most packhouses, machinery is used for automated sizing of fruit. The type of packing material in which the fruit is to be packed determines sizing requirements. Within each count or size category, carton-fill and mass are in turn determined by the actual size of the fruit.

The type of controls required is determined by the equipment in use. It is nevertheless important to measure fruit of all sizes from randomly drawn samples throughout the packing day.

Packed cartons are weighed on a regular basis, assessed for carton fill and the packing patterns checked. Detail of the monitoring process must at all times be recorded for regular inspection by the packhouse management and supervisors.

Cartons are stored and erected in a separate area. Three aspects of carton erection affect quality or acceptability of the end product, being:

- Inadequate gluing and loose flaps
- Damage to carton components by the sealing machine
- Non-compliance with carton manufacture specifications

All three must be monitored throughout the packing day and non-conformance or problems must be documented.

2.7. Palletisation

The following aspects require attention to ensure that pallets are stable and can withstand the handling required to reach the final destination:

- Compliance with pallet specifications
- Application of spot glue where appropriate
- Stacking pattern
- Strapping

The frequency of monitoring the palletisation process is determined by the daily volume of fruit packed. All inspection results must be recorded and corrective action must be taken where necessary.

3. Health and Hygiene Principles

The general health, safety and hygiene principles discussed in the previous chapter are also applicable for all postharvest activities.

Transport of fruit and empty bins or trailers to and from the orchards should not expose any person to possible injury. The tractors, vehicles and forklifts must all be in good condition and the drivers and operators must be well trained and licensed.

4. Quality Standards

The quality standards set out in the previous chapter must be maintained during the picking operation to be verified on arrival at the packhouse. The general appearance of the fruit in the bins or trailers should be checked on arrival at the packhouse for dust and / or other external damage in order to monitor the transport and give feedback to the orchards if any adjustments should be made.

Documentation regarding the load must also be correct to ensure accurate product identification and traceability.

A well-developed cull factor analysis for fruit delivered to the packhouse is essential for two reasons:

- To provide feedback to the orchards regarding fruit quality as well as the standard of the picking operation. Feedback to the orchards should be as soon as possible after receiving each load.
- To provide packhouse personnel with an early warning should they be required to give attention to a particular cull factor or quality deficiency.

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 7

- Proper packing material and well-trained employees are essential for postharvest practices and packing.
- Postharvest practices include receiving fruit, product identification and traceability, decay control, the wash line, grading, labelling, sizing, packing and marking, and palletisation.
- It is essential that all fruit must be traceable to its origins, and therefore each trailer or bin should be clearly marked with the name of the grower, the orchard, the variety, the date picked, and must carry the supervisor's signature.
- Care must be taken to ensure that fruit is not damaged during the picking process. Other measures and treatments are used to control postharvest decay.
- The wash line includes wet or dry dumping, high pressure de-scaling, brushing, drying, and fungicide application.
- Grading is dependent on the human element and can be influenced by a number of factors, and must be monitored very carefully.
- The correct labels must be used to comply with market requirements.
- Carton erection must be monitored to ensure that the cartons are not damaged and that sufficient glue is used.
- The packing of fruit must be monitored regularly to ensure compliance to market requirements.
- Cartons must be palletised in such a way that the pallets are stable and can withstand handling.
- Health and hygiene principles must be applied carefully in the packhouse, while quality standards must be maintained at all times.

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

Activity 9 – Flow Diagram

Explain to learners what a flow diagram is and how to approach this activity in sequence of the practices they observe in their practical environment or as per the research they have done.

Timeframe: 1h

Remind learners to arrange for attending practical at a citrus farm to serve as testimonial for specific participation in enterprise selection activities or infrastructure planning, placement or maintenance. This serves as part of the learner's summative assessment. The time devoted to this should be at least two 8-hour work days.

Bibliography

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

Soil Science 314, Department of Soil Sciences, University of Stellenbosch

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