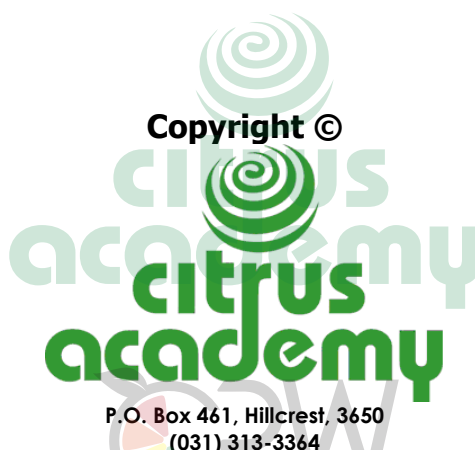


LEARNER GUIDE

Enterprise Selection, Planning and Establishment

Level 3



Title:		Identify and Recognise Factors Influencing Agricultural Enterprise Selection Assist in Farm Planning and Layout for Conservation and Rainwater Harvesting					
Applied Title:		Identify and Recognise Factors Influencing Agricultural Enterprise Selection Assist in Farm Planning and Layout for Conservation and Rainwater Harvesting					
Field:		Agriculture and Nature Conservation					
Sub-Field:		Primary Agriculture					
SETA (SGB):		AgriSETA					
Skills Area:		Enterprise Selection, Planning and Establishment					
Context:		Citrus Production					
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Based on the Production Guidelines of:



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Unit standard alignment and assessment tool development:

Cabeton Training and Development

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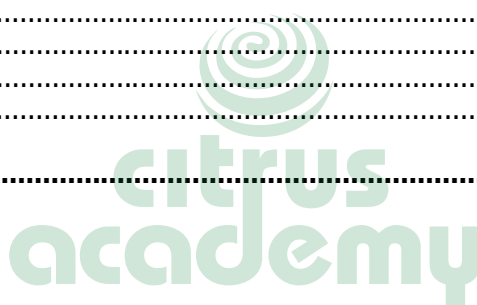
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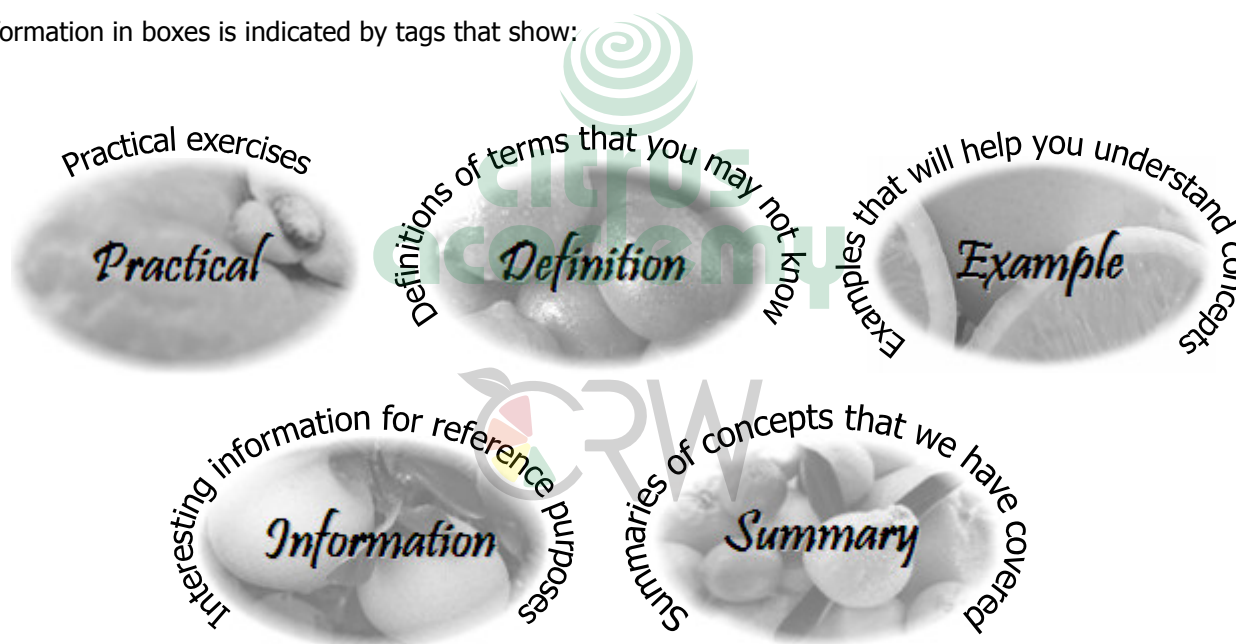
This learning material has been developed to assist the learner wishing to complete this unit standard. The guide contains all necessary learning to ensure that the learner will attain the competencies required by the unit standard.

The learner guide is accompanied by a Learner Assessment Guide. Please ensure that you have access to this guide as well.

The learner guide was designed to be used by a learner during the presentation of a skills program based on the unit standard, and to be kept afterwards by the learner for reference purposes. The learner assessment guide was designed to be completed during and after the presentation of the skills program, and forms part of the assessment process.

Although this learner 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:



Introduction

1. Purpose

1.1. Unit Standard 116214

Qualifying learners are capable of interpreting the factors influencing agricultural enterprises and enterprise selection and production, and of planning accordingly. In addition, they will be well positioned to extend their learning and practice into other areas of agriculture, specifically crop production and animal production systems. This training will benefit the profession by equipping learners with adequate skills to have input into the interpretation of factors influencing enterprise selection and to production planning to improve productivity and performance. Learners will understand the importance of the application of business principles in agricultural production with specific reference to enterprise planning. 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. Farmers will gain the knowledge and skills to access mainstream agriculture through a business-orientated approach to agriculture.

1.2. Unit Standard 116274

A learner achieving this unit standard will be able to plan, lay out and develop a maintenance program for conservation and infrastructure development and will have the ability to design, construct and maintain resource use practices that include, but are not restricted to, soil and water erosion prevention measures in an agricultural environment. Learners will gain an understanding of sustainable agricultural practices as applied in the animal, plant and mixed farming sub-fields. This unit standard focuses on the application of conservation and rain harvesting practices. They will be able to participate in, undertake and plan farming practices with knowledge of their environment. This unit standard instils a culture of maintenance and care for both the environment as well as towards farming infrastructure and operations.

2. Learning Assumed to Be in Place

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

2.1. 116214

<i>NQF Level</i>	<i>Unit Standard Number</i>	<i>Unit Standard Description</i>
NQF2		Literacy and Numeracy
2	116081	Identify and recognise factors influencing agricultural enterprise selection

2.2. 116274

<i>NQF Level</i>	<i>Unit Standard Number</i>	<i>Unit Standard Description</i>
NQF2		Literacy and Numeracy
2	116127	Apply layout principles for conservation and infrastructure

Revision of Level 2

1. Natural Resources

- 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.

2. Environmental Conservation

- 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.

3. Infrastructure

- 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 be 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 include 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.

4. Cultivars and Production Stock

- 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.

5. Production Cycles

- 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.

6. Harvest Practices

- 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.

7. Postharvest Practices

- 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.



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.

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.

Ecosystem

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

Infrastructure

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

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.

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.

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.

Soil Fertility

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

Soil Potential

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

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.

2011 Calendar

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

Chapter 1

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

Interpret and categorise natural resources required for the selection of the relevant enterprise. Assist in a land capability analysis to serve as the basis for development of an area or an enterprise selection for the farm.

1. Introduction

Information on a wide range of matters concerning the natural resources in the area where establishment of the enterprise is planned has to be considered carefully. Apart from the inherent production potential of the land, the effects on the natural environment of the establishment of citrus orchards have to be determined and evaluated.

A risk assessment has to be undertaken to determine whether the site or area in question is suitable for food production with regards to crop quality, food safety, worker health and safety, and the environment. Where risks are identified, a corrective action plan with strategies to minimise such risks must be prepared. Sustainable development requires consideration of all relevant factors, including:

- Avoiding or minimising the disturbance of natural ecosystems
- Avoiding the pollution and degradation of the environment
- Minimising and disposing of waste in a responsible manner
- Using natural resources responsibly, taking into account the consequences of resource depletion
- Anticipating and preventing negative impacts on the environment and people's environmental rights

When planning new developments, it is necessary to have a thorough knowledge of the requirements for the production of quality citrus fruit, in combination with the information acquired through a thorough land capability and environmental analysis.

2. Natural Resources Required for Citrus Production

Natural resources required for citrus production can be described in short as those that would result in optimum yields of quality, marketable fruit to maximise on-farm income per hectare.

Climate plays the most important role in what can be produced in any specific area. World-wide, citrus is produced in a band lying roughly between 20° and 40° north and south of the equator, referred to as subtropical regions. The other basic natural resources that are required for production of all types of citrus are a **well-drained soil** and an adequate, good quality **water supply**.

A land capability analysis is used to assess the suitability of the land for crop production.



Definition

Land Capability

Land capability classification is a system of grouping land primarily on the basis of their capability to produce common cultivated crops and pasture plants without deteriorating over a long period of time. Land capability classification is subdivided into capability class and capability subclass.

Land capability depends primarily on **climate**, a number of **soil properties**, for example depth and stoniness, **wetness**, **erosion risk** and **slope**. Also included is the overall **pattern and variability** and **vegetation cover**. When assessing potential for citrus production, a land capability analysis is used in combination with an environmental analysis.

3. Climate

The main climatic requirements for citrus often form the basis of the decisions regarding area and cultivar to be planted. Citrus of higher quality and better appearance are produced in environments that are more subtropical than tropical in nature.

In tropical regions, the lack of a well defined summer / winter seasonality results in blossoming over an extended period which can complicate spray programs and result in uneven fruitlet development in orchards. Colour development also tends to be a problem in tropical climates, because it depends on the differentiation between day and night temperatures in the winter – cold nights initiate good colour development.

The diversity in climate between the citrus production regions of Southern Africa results in the ability to produce a wide range of citrus fruit for world-wide marketing. Growers must however ensure that cultivars most suited to their climatic conditions are planted.

3.1. Climatic Factors Influencing Citrus Production

The climatic factors that play the most important role in enterprise selection are:

- Temperature
- Day length and light
- Rainfall and humidity
- Wind
- Hail

Although rainfall and wind can be augmented and managed to a certain degree through irrigation and windbreaks, climatic factors are generally a given and play a major role in deciding what type of citrus to produce.

3.1.1. Temperature

Temperature is the single most important factor influencing citrus production, and interacts with moisture and various other external and internal factors to influence all growth processes. Extremely high temperatures can cause excessive moisture loss through transpiration, dry out the soil and cause a lowering in humidity. This can lead to damage to plants as a result of dehydration.

Extremely low temperatures are associated with frost which causes cold damage. Older trees are often able to recover from cold damage with only the loss of leaves or a few branches. If the trees were bearing at the time, all the fruit will be lost. Young trees are especially vulnerable and cold damage can lead to the death of the entire plant.

The concept of **heat unit summation** is a broad measure of the energy budget available to plants. Heat units are an index of degree day summations above a 13°C base temperature, which is the minimum growth temperature for citrus. Heat unit accumulation is strongly correlated to growth rate and fruit quality, provided that water and nutrients are sufficiently available.

One method of calculating heat units (HU) is by adding the difference between the mean monthly temperature and the base temperature (13°C) over a selected period, as follows:

$$\text{HU} = (\text{mean monthly temperature} - 13) \times \text{days/month}$$

The heat units of different areas can be compared with known criteria for various cultivars, thereby helping to determine the climatic suitability of a specific area.

The criteria for the main cultivars are as follows:

<i>Cultivar</i>	<i>Period</i>	<i>Heat Units (HU) (Monthly Average)</i>
Navels	Nov-Dec	1,600-2,950
	Jan-Apr	1,000-1,250
Lemons	Jan-Apr	1,100-1,500
Satsumas / Clementines	Nov-Dec	1,600-2,200
	Jan-Apr	1,000-1,150
Valencias	Jan-Apr	1,200-3,500 (wide tolerance)
Grapefruit	Jan-Apr	2,900-4,550

Table 1.1: Heat Units Criteria for Main Citrus Cultivars

The period between January and April is the most critical for citrus fruit growth. This is when the fruit enters the second growth phase that involves cell enlargement.

The heat unit concept has limitations and cannot be used in isolation, but forms a useful guideline in determining suitability for citrus production.

3.1.2. Day Length and Light

Light plays an important role in photosynthesis of all plants. Citrus responds to day length in that the longer the daylight period, the greater the total vegetative growth. The ideal sunshine requirement in mid-summer is 7.5 to 8.5 sunshine hours per day, while the minimum for export quality production is 5.8.

Flowering and fruiting behaviour of citrus is not influenced by day length, but is temperature and water-stress dependant.

3.1.3. Rainfall and Humidity

Rainfall in South Africa is not sufficient to provide for the water requirements of commercial citrus production. As a consequence, citrus plantings are irrigated and not dependant on rainfall, except where severe droughts cause restrictions in the water that is available for irrigation.

Warm and humid conditions favour the development of fungal diseases such as black spot, *Alternaria* brown spot and *Phytophthora*, complicating the spray programs and adding to production cost. In areas with generally high humidity, provision must be made for additional expenditure to control these diseases.

3.1.4. Wind

The frequency, velocity and seasonal distribution of wind influence suitability of a climate to citrus production. The major effects of wind are threefold:

- Hot winds cause excessive moisture loss through transpiration and can even cause the death of exposed leaves through dehydration.
- Hot winds cause slower development of young plantings than the norm.

- Wind cause mechanical damage, where tissues are bruised and fruit become scarred. Approximately 95% of wind blemishes occur within the first twelve weeks after petal fall, from September in the early areas to January in the late areas. Blemishing occurs from a wind speed threshold of 24 km/hr blowing for at least one hour.

3.1.5. Hail

Hail occurs mostly in the northern production areas in South Africa, and causes blemishes and damage that may render fruit unsuitable for export.

3.2. Evaluating the Suitability of Climate for Citrus Production

As stated before, the diversity of climate in the citrus production areas in South Africa results in the ability to grow a wide range of cultivars. Apart from ensuring that an area is principally suitable for growing the selected cultivar, the climate during the growing and picking season must also be conducive to producing the maximum percentage of export fruit, which impacts directly on income and profitability.

Certain climatic features are distinctive to each area and can impede the production, harvesting and packing process. These add to the risks of citrus production and sustainable profitability. Some examples of distinctive climatic features are:

- Continuous rains the Lowveld in the early part of the growing season can hamper spraying operations resulting in poor control of citrus black spot.
- Extreme cold that brings about black frost in the Northern Cape causes cold damage to trees and crop losses.
- Hail can result in a low export pack-out.
- Warm conditions during ripening in autumn in sub-tropical regions result in poor fruit colour development.
- Rain during harvesting in winter rainfall areas of the Western and Eastern Cape can delay harvesting and lead to poor quality and disease-prone fruit.

There are therefore, apart from the general climate, a number of other climatic factors specific to an area that has to be considered when deciding where to develop and what to plant.

3.3. Obtaining Information on Ambient Weather Conditions

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. Accurate positioning of individual points on the earth's surface is made possible by reference to the geometrical system of latitude and longitude. Latitude parallels are drawn west-east around the earth and numbered by degrees north and south of the equator, which is designated as 0° latitude. Longitude meridians are drawn north-south and numbered by the degrees east and west of the prime meridian at 0° of longitude, which passes through Greenwich in England.

By referring to these coordinates and their sub-divisions of minutes, which is 1/60th of a degree, and seconds, which is 1/60th of a minute, any place on earth can be located to within a few hundred yards. For example, Bien Donne Research station in the Western Cape is situated at minus 33.84° latitude and 18.98° longitude and is 119 metres above sea level.

The type of climatic 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; and
- 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. Long-, medium- and short-term weather forecasts are also available for each area. Forecasts are updated on a daily basis.

There are also private agencies that provide weather forecasts. Such agencies are often focussed on the control of specific diseases, which means that their forecasts will be adjusted to ensure that the information that is relevant to the development of the target disease is available.

3.4. Interpreting Information on Ambient Weather Conditions

Apart from the information that can be accessed on the above resources, the Weather Bureau supplies forecasts on a one to four day basis in the daily papers as well as on television. A wide base of information is therefore available to the citrus producer to use for planning production activities like irrigation and spraying as well as harvesting.

Interpretation of long-, medium- and short-term weather forecasts plays an important role in planning production activities on a citrus farm, for example:

- The projected effect of global warming on the various citrus production areas may for instance influence the investment decision on where to develop a citrus production unit.
- Long term forecasts on yearly weather patterns and rainfall are normally used for planning and allocation of water for irrigation.
- Medium term forecasts for one to two weeks are used to plan spraying, which cannot be done while it is raining or when it is extremely hot.
- 7 to 10 day forecasts, provided by certain agencies, are focused on control of diseases such as *Alternaria* and black spot and are used to make decisions on specific preventative spray applications.

4. Topography

In the level 2 learner guide topography and its importance in enterprise selection and planning was discussed in detail. To summarise the pertinent points:

- Topography is important for enterprise selection and planning in terms of the lie of the land, and its slope and direction.
- The slope of a surface is the degree of deviation from the horizontal. Slope influences the water absorption and predisposition to erosion (danger of erosion increases as the slope 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.
- Understanding the topography of an area enhances the understanding of watershed boundaries, drainage characteristics, water movement and water quality.
- Understanding topography aids in soil conservation, as practices such as contour ploughing can be used to enable sustainable agriculture on sloping land.

- Understanding of topography is important when deciding on the orchard and row direction, keeping the effect of irrigation runoff and storm water management in mind.
- Topography influences weather patterns.

Commercial citrus production requires the use of fairly heavy machinery, such as spray carts and picking trailers. During soil preparation, the tractors and implements used to prepare the soil must also be able to drive safely. The slope of the ground must therefore not be so severe that workers and equipment are put in danger. A flat surface with a slope of less than two degrees is however also not suitable, as surface drainage of rain water will be too slow.

The slope of the surface is also important for row orientation, surface drainage and erosion. Planting on contours is no longer done and if the slope poses any potential problems with surface drainage and / or erosion, orchard layout should be adapted accordingly.

The orchard roads and vehicle paths between rows are usually protected by grass-cover. If the orchard layout facilitates water movement at a moderate speed, erosion can be avoided. Row orientation is more important in the southern parts than in the northern parts of Southern Africa and can be changed to either slow or increase surface drainage.

5. Natural Vegetation

The establishment of a citrus production unit has serious implications for the biodiversity of the natural environment.

Biodiversity

Biodiversity means the range of organisms present in a particular ecological community or system, and is measured by the numbers and types of different species.

Commercial farming introduces a predominant species of animal or plant into an ecosystem. In the case of citrus farming, for instance, naturally-occurring vegetation is replaced with citrus trees, meaning that the biodiversity of the ecosystem is disturbed by design.

It is however essential to retain and protect natural vegetation where possible. Vegetation assists with erosion control by slowing water runoff and protecting the soil surface from wind. Natural vegetation also provides a haven for beneficial insects in the orchard.

When planning a citrus production unit, a careful study must be made of the natural vegetation in the area and the conservation of natural vegetation must be taken into account when the farm layout is planned. Special attention must be paid to the conservation of protected indigenous species, while invasive alien species must be identified for eradication.

Indigenous Species

Indigenous species are fauna and flora that originated from and that are typical of a region or country. Certain indigenous species are considered endangered.

Alien (Exotic) Species

Alien species, also referred to as exotic species, are fauna and flora that did not originate from the region or country, but that was brought to that region or country by humans.

Invasive Species

Around 1% of alien species become problematic to the local ecosystems into which they are introduced. These plants are referred to as invasive species.

5.1. Indigenous Species

Planning is the single most important factor for the sustainable management of natural resources. This is especially true when it comes to the protection of indigenous species when a new citrus production unit is established.

Most indigenous species will be found growing in low lying areas that forms a natural drainage way. In most cases these areas are topographically unsuited for the planting citrus trees. Extra care should be taken to preserve these areas, especially areas in close proximity to citrus orchards, as beneficial insects will in most cases use these areas to live and breed in.

Destruction of all indigenous habitats will have a severe influence on the number of natural enemies in and around the orchard and thus increase the cost of chemical pest control to the farmer.

5.2. Invasive Species

Invasive plants have been categorised by the Botanical Society of South Africa and the Agricultural Research Council (ARC) into three categories, depending on the threat that they hold for indigenous plant and animal species.

Category 1 – Invasive plants that have been identified as weeds and are prohibited by the Department of Agriculture, Forestry and Fisheries (DAFF). If these plants are found on a farm one is obligated by law to eradicate them.

Category 2 – Invasive plants that have the potential to become harmful but have certain beneficial properties that warrant their continued presence under certain circumstances. There are strict control measures for where category 2 plants are grown, including:

- The land user must obtain a water use license
- The plants may not be planted within 30m of the 50-year flood-line
- The plants are only allowed in demarcated areas under controlled conditions
- The plants have to primarily serve a commercial or utility purpose, such as a woodlot, windbreaks, building material, animal fodder, soil stabilisation, medicinal use or own consumption
- All reasonable steps must be taken to curtail the spreading of seeds or vegetative reproductive material outside the demarcated area
- All specimens outside the demarcated area must be eradicated
- The conditions under which the plants are cultivated must be controlled
- Plants may only be sold by permit holders

Category 3 – Invasive plants that have the proven potential of becoming harmful, but most of them are popular ornamentals or shade trees that will take a long time to replace. A few of them were placed into this category instead of category 1 or 2, because they do not cause problems in all situations. Reproductive material from these plants, such as seeds and cuttings, may no longer be propagated, imported, bought, sold or traded in any way. Category 3 plants may only be planted with special permission and may not be planted within 30m of the 50-year flood-line. It is legal to trade in the wood and other products that do not have the potential to grow or multiply.

 Information

Invasive Plants Used in Citrus Production

It is interesting to note that there are two invasive plant species that are commonly used as windbreaks on citrus farms, this being *Casuarina cunninghamiana* – *River Oak* (category 2) and *Grevillea robusta* – *Silky Oak* (category 3).

Grevillea is no longer recommended for use, but is still found on some farms. *Casuarina* is still widely used, in line with the regulations for category 2 plants, being that they are planted for a specific commercial purpose in controlled, demarcated areas. It is very important to be aware of the status of the plant, so that one can ensure that it is not planted within 30m of the 50-year flood-line and that it is not allowed to spread outside the demarcated area.

Any control programme for alien vegetation must include the following three phases:

- **Initial control** — Drastic reduction of existing population
- **Follow-up control** — Control of seedlings, root suckers and woody growth
- **Maintenance control** — Sustain low alien plant numbers with annual control

6. Status of Soil

As part of planning a new citrus enterprise, soil maps are prepared that indicate the soil types over the area earmarked for development. Land preparation techniques are selected with the aim of maintaining the soil structure and to avoid soil erosion.

6.1. Soil Survey

The first step in determining the suitability of land for citrus production is a soil survey to examine the physical characteristics of the soil. The aim of a soil survey is to determine the degree to which a given profile deviates from the requirement, what must be rectified, and how this can be done.

For a soil survey, profile pits are dug on a grid pattern to cover all the various soil types present in the area identified for development. The more heterogeneous the soil, meaning the more the soil changes across the area, the more pits must be dug in the area. One profile pit should not represent more than one or two hectares.

The following are noted and recorded when studying the profile:

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

- Compaction; and
- Structure

The soil survey is normally done by experienced soil scientists. The report and soil map include a recommendation on soil preparation for planting.

Soil samples for chemical analysis are taken in conjunction with the soil survey for further evaluation and to establish its nutritional status. From this analysis, it can be determined whether any chemical ameliorants should be applied during soil preparation to optimise the soil for tree development and production.

6.2. Soil Preparation

Soil preparation, or profile modification, is an expensive process that can only be justified by an increase in production and the extension of the economic life of an orchard. The success of soil preparation is measured by the health and volume of the root system, the size of the leaf canopy, and the volume of the crop.

The volume of the root system is directly related to the size of the leaf canopy. Proper soil preparation will therefore ensure that the trees in a newly planted orchard will fill its allotted space in the orchard in the shortest possible time.

6.2.1. Aims of Soil Preparation

Chemical and physical profile modification during soil preparation includes elements such as homogeneity, depth, bulk density, air content, pH, phosphorous and cations. The soil profile must be modified in such a way that a homogenous layer is created. Differences in texture must be removed by mixing, and differences between consecutive layers can be made more acceptable for root penetration through partial mixing.

The cultivation depth should be between 60cm and 70cm so that the effective root depth will be at least 50cm after the soil has settled again. The chemical conditions in the profile can also be rectified most effectively during soil preparation. A chemical analysis will indicate how much fertiliser, such as lime, gypsum, super phosphate and potassium, should be added.

6.2.2. Soil Preparation Methods

The method of soil preparation depends on the occurrence of factors which will restrict root penetration. The most important factors are:

- Sequence of layers;
- Depth of restrictions;
- Nature of the restriction;
- Internal drainage;
- Texture of the layers;
- Structural stability; and
- Compacted layers

The most commonly used soil preparation methods are mixing and loosening, or ripping.

6.2.2.1. Mixing

Mixing is used when the soil survey indicates that a mixing action is required to render a homogeneous rooting zone. The other reason to mix the profile is to incorporate the required chemicals and fertilisers to optimise the chemical composition of the soil. This can be done by any implement with a mixing action, because specific layers in the soil are in this case not being mixed, but the whole profile.

6.2.2.2. Loosening

When the properties of the profile indicate that the soil needs only to be loosened, almost any ripper-type plough is used. Loosening is sometimes also referred to as ripping because of the use of a ripping tine.

6.2.3. Environmental Conditions for Soil Preparation

Water content of the soil at preparation is very important and should be at about 50% of free water capacity. If the profile is too wet, the tine or shear of the implement will only slice the soil and cause undesirable compacted clods along the contact area with the shear, referred to as smear action. If the profile is too dry, the soil will break up into large clods, which is also undesirable. Sandy soil should be prepared in slightly drier conditions.

6.2.4. Soil Preparation Machinery and Equipment

There have been a lot of developments in suitable implements for soil preparation. The machinery was developed to either mix and loosen, or only loosen the soil, depending on the specific requirement. The requirements for these implements are that they must be able to cultivate to at least 60cm depth and that the tractor must run on the unprepared soil.

Other aspects which must be borne in mind in selecting implements are:

- 20% of the tine length must be deducted to determine the effective working depth of the implement.
- The lower tip of the tine or share almost invariably creates a sharp, compacted transition.
- The deeper the cultivation, the deeper the roots will penetrate, but the higher the cost.
- If a wheel must run on prepared soil it must be followed by a tine to rectify the compaction caused.
- Crawler tractors transfer approximately 90% of the tractors mass to the drawbar, 2x2 wheel tractors approximately 75%, and two-wheel tractors only 50%.
- A triangular wing fixed to the tip of the ripping tine will assist in lifting the soil, thereby improving the loosening process.

6.3. Chemical Soil Properties

In the level 2 learner guide the physical properties of soil was discussed. Chemical soil properties include those associated with its nutritional status, the soil salinity and the soil pH, meaning the degree of acidity. In practice, it is easier and cheaper to add something to the soil than to remove anything in order to improve the chemical properties. It is for example much cheaper to add nutrient elements through fertilisation than to leach out excess salts.

Soils are seldom chemically homogeneous and also often change with depth. It is therefore essential to determine at what depth an undesirable chemical condition occurs. This applies particularly to the pH of the sub-soil. The closer to the surface any chemically undesirable layer occurs, the less suitable the soil is. It is for this reason that soil samples are taken at various depths in the profile pit when a soil survey is conducted.

6.3.1. Total Salt Content

The total salt content is expressed as the resistance, in ohms per cm (Ω/cm), of a soil paste, or the specific conductivity, in milli-siemens per meter (mS/m), of a saturated sample. The table below shows the general norms for the evaluation of the total salt content of soils for citrus production.

Clay Content (%)	Suitability					
	Good		Fair		Poor	
	Resistance (Ω/cm)	Conductivity (mS/cm)	Resistance (Ω/cm)	Conductivity (mS/cm)	Resistance (Ω/cm)	Conductivity (mS/cm)
Less than 10%	>700	<60	450-700	60-90	<450	>90
10%-20%	>600	<80	350-600	80-130	<350	>130
20%-30%	>500	<90	250-500	90-150	<250	>150

Table 1.2: General Norms for Evaluation of Total Salt Content of Soils for Citrus Production

If soil is considered fairly suitable it is important to establish why the salt content is high, as it may be possible to improve it at a relatively low cost. Being aware of the causes will also assist in developing production practices that will take this into account. Sometimes suitability can be improved by relatively cheap methods, but even if it is possible, it remains a risk to plant citrus in such soil, unless it can be economically improved. To reclaim saline soil is usually very expensive.

6.3.2. pH

The acidity or alkalinity of soil is measured on a pH scale, ranging from 1 to 14, and the lower the pH value, the more acid the soil. In practice, citrus soil with a pH value of 6.0 to 7.5 when water is used for a suspension, are classified as neutral. Soils with a pH value above 7.5 is classified as alkaline and those with a value below 6.0 as acid. Citrus can be grown successfully in soils with a wide range of pH values. However, the ideal pH is about 7.0.

The conditions in acid soils are favourable for heavy metal toxicity and phosphate fixation. Such soils contain high concentration of aluminium and manganese in solution. Aluminium in particular is very phytotoxic, meaning toxic to plants and detrimental to root growth. Acid soils are normally well-leached, containing small amounts of basic cations such as calcium, magnesium and potassium.

Acid soils can be reclaimed by liming. Liming materials must be thoroughly mixed with the soil and incorporated as deep as possible into the root-zone during soil preparation before planting. At the other end of the pH scale, we find alkaline soils. High pH values are normally associated with high salt concentrations. Alkaline conditions result in a complex chemical situation with reduced availability of metal elements such as zinc, manganese, copper and iron.

Acidification of alkaline soils is possible, but seldom economically feasible. It can be accomplished commercially by applying acidifying nitrogen fertilisers such as ammonium sulphate, or sulphur, iron sulphate and aluminium sulphate, but this is an expensive process. It is far better to adapt cultivation practices to prevent an increase in pH and an accumulation of salt.

6.3.3. Chloride, Boron and Sodium

Apart from the influence of total salts, high concentrations of elements such as chloride, boron and sodium interfere with the absorption of other elements and may become phytotoxic.

Chloride is the main form in which chlorine occurs in the soil. Although it is a nutrient element, it is of greater significance in practice for the detrimental effect of high concentrations on plant nutrition and soil properties. Fertilisers that contain chloride must be applied with due regard to the type of crop and the condition of the soil.

Boron is an essential element, but easily reaches toxic levels. Fertilisers that contain boron must also be applied with care.

Sodium is a plant nutrient which, like chloride, is of greater significance on account of the problems it causes when concentrations in the soil and water reach excessive levels. High concentrations of sodium in the soil interfere with the absorption of other cations, weaken the soil structure, and bring about high pH levels. The side-effects of poor soil structure and high pH levels can be devastating and could render production practically impossible. Sodium accumulation in soil is brought about by poor drainage and the use of water with high sodium content. Reclamation of sodium salinised soils is expensive and impractical in most cases.

7. Water Quality

Aspects of water quality that influence crop production include the concentration of specific ions and their ratios relative to each other. The following have the most decisive influence on water quality:

- Total dissolved salts;
- Sodium absorption ratio;
- Concentration of boron and chloride; and
- Bicarbonate concentration in relation to calcium and magnesium

7.1. Total Dissolved Salts (TDS)

All natural water contains a certain quantity of salts in solution. The quantity can be measured in terms of mg per litre, but also indirectly by means of the specific electrical conductivity (EC).

Crops differ enormously in their sensitivity to high salt concentrations in the irrigation water. Citrus is generally classified as a salt sensitive crop.



Information

Influence of Salt Concentration on Citrus

In the table below, the influence of salt concentration in water on leaf drop and scorch is shown for Ruby Red grapefruit.

Total Dissolved Salts (TDS) (Mg/l)	Electrical Conductivity (EC) (mS/m)	Sodium Chloride (NaCl) (Mg/l)	Incidence of Leaf Scorch	Number of Leaves Dropped / Tree
1,000	156	500	Slight	1,000
1,600	250	1,000	Reasonable	1,800
2,300	360	1,500	Bad	5,800
3,500	550	2,000	Very Bad	7,000

The more salts in the water, the more will be applied during irrigation and the greater is the possibility of soil salinisation. The salt content of soil is closely related to the salt content of water and to leaching. During irrigation a certain amount of salts is also applied as evaporation and water absorption by plants concentrates the salts in the soil. If the subsequent irrigation does not remove some of the salts through leaching, a situation can develop in which the high salt concentration restricts production.

 Information

Leaching Requirement Against Salt Content

In the table below, the leaching requirement is given against the salt content of water for 90% and 100% production. For instance, it will be necessary to apply 17% more water than required to wet the soil profile in order to maintain 100% production if the EC of the water is 125mS/m.

Electrical Conductivity (mS/m)	Leaching Requirement (LR) (% water extra to be applied)	
	100% Production	90% Production
75	10	7
100	13	9
125	17	12
150	21	15
175	26	18
200	31	21
225	36	24
250	42	27
275	48	31

It is absolutely essential that the quality of the irrigation water must be known so that the leaching requirement can be determined, and provision must be made for an additional volume of water to accommodate leaching. Leaching is a necessary loss, and management can influence the production of citrus appreciably. This aspect is also crucial in the case of fertigation, where fertiliser is applied through the irrigation water and mismanagement can cause high salt concentrations. In the table below guidelines are given for the evaluation of irrigation water. It shows the values for total dissolved salts and electrical conductivity in terms of the possibility of soil salinisation.

Total Dissolved Salts (TDS) (Mg/l)	Electrical Conductivity (EC) (mS/m)	Possibility of Salinisation
0-150	0-25	None
151-500	26-75	Small
501-1,500	76-225	Reasonable
1,500+	225+	Big

Table 1.3: Guidelines for Evaluation of Irrigation Water

7.2. Sodium Adsorption Ratio (SAR)

An excess of sodium has a harmful effect on soil structure, and also adversely affects water infiltration, aeration and root growth. It is necessary to determine the ratio of the concentration of sodium to that of calcium and magnesium, which is the sodium adsorption ratio. The more sodium there is the higher the sodium adsorption ratio and therefore the possibility of salinisation. The sodium adsorption ratio and total dissolved salts are used jointly to classify water with regard to its suitability for use for irrigation.

7.3. Boron, Chloride and Iron

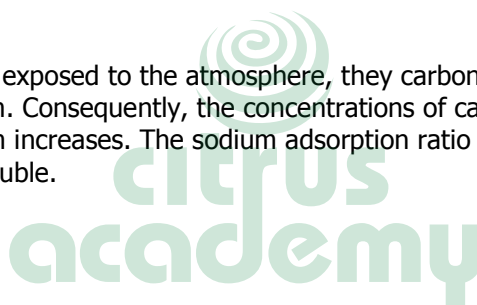
Boron toxicity is experienced if the irrigation water contains more than 1mg boron (B) per litre. Chloride levels are assessed as follows:

- Less than 1.5me/litre for chloride-free farming such as tobacco, beans, peas and lettuce
- Less than 3.0me/litre for most crops including citrus
- Less than 5.0me/litre for chloride resistant crops such as lucerne, barley and beetroot

Another dissolved mineral in water which can create problems is iron (Fe). At the relatively low concentration of 0.5 mg/litre, iron can cause blockages of small jets and drippers.

7.4. Bicarbonates

When bicarbonates are exposed to the atmosphere, they carbonate and form insoluble salts with calcium and magnesium. Consequently, the concentrations of calcium and magnesium fall and the concentration of sodium increases. The sodium adsorption ratio therefore increases because sodium carbonate is soluble.



Chapter 1

- When a new citrus planting is planned, the inherent production potential of the land and the effects on the natural environment of the establishment of citrus orchards has to be determined and evaluated.
- Sustainable development requires consideration of all relevant factors, including avoiding or minimising the disturbance of natural ecosystems, avoiding the pollution and degradation of the environment, minimising and disposing of waste in a responsible manner, using natural resources responsibly, taking into account the consequences of resource depletion, and anticipating and preventing negative impacts on the environment and people's environmental rights.
- Natural resources required for citrus production can be described in short as those that would result in optimum yields of quality, marketable fruit to maximise on-farm income per hectare.
- Climate plays the most important role in what can be produced in any specific area, in addition to a well-drained soil and an adequate, good quality water supply.
- Land capability classification is a system of grouping land primarily on the basis of their capability to produce common cultivated crops and pasture plants without deteriorating over a long period of time.
- Land capability depends primarily on climate, a number of soil properties, for example depth and stoniness, wetness, erosion risk and slope. Also included is the overall pattern and variability and vegetation cover.
- The main climatic requirements for citrus often form the basis of the decisions regarding area and cultivar to be planted and the climatic factors that play the most important role in enterprise selection are temperature, day length and light, rainfall and humidity, wind, and hail.
- The concept of heat unit summation is a broad measure of the energy budget available to

plants.

- Citrus responds to day length in that the longer the daylight period, the greater the total vegetative growth.
- Rainfall in South Africa is not sufficient to provide in the water requirements of commercial citrus production and citrus are therefore an irrigation crop.
- The frequency, velocity and seasonal distribution of wind influence suitability of a climate to citrus production.
- Hail occurs mostly in the northern production areas in South Africa, and causes blemishes and damage that may render fruit unsuitable for export.
- Apart from the general climate, there are a number of other climatic factors specific to an area that has to be considered when deciding where to develop and what to plant.
- 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 type of climatic information which is required for enterprise selection and planning for as long a period as possible is average rainfall, relative humidity, average, maximum and minimum evapotranspiration, average, maximum and minimum wind speed and direction, and average, maximum and minimum temperatures.
- Topography is important for enterprise selection and planning in terms of the lie of the land, and its slope and direction.
- The establishment of a citrus production unit has serious implications for the biodiversity of the natural environment.
- Planning is the single most important factor for ensuring the protection of indigenous species when a new citrus production unit is established.
- Invasive plants have been categorised by the Botanical Society of South Africa and the Agricultural Research Council (ARC) into three categories, depending on the threat that they hold for indigenous plant and animal species.
- Any control programme for alien vegetation must include initial control, follow-up control, and maintenance control.
- Soil maps are prepared that indicate the soil types over the area earmarked for development as part of planning a new citrus enterprise.
- The first step in determining the suitability of land for citrus production is a soil survey to examine the physical characteristics of the soil.
- Soil preparation, or profile modification, is an expensive process that can only be justified by an increase in production and the extension of the economic life of an orchard. The most commonly used soil preparation methods are mixing and loosening, or ripping.
- Chemical soil properties include those associated with its nutritional status, the soil salinity and the soil pH, meaning the degree of acidity.
- Aspects of water quality that influence crop production include the concentration of specific ions and their ratios relative to each other.


 Practical

Complete activities 1 and 2 in the **Learner Workbook**.

Chapter 2

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

Categorise and maintain infrastructure for the selection of the enterprise.
Design and construct prevention structures and infrastructure necessary for the farm area or the farm enterprise applying sustainable resource use principles.

1. Introduction

Infrastructure has a bearing on the practical implementation of all the day-to-day activities on a farm, and is the bare essentials required to operate a commercial farm. Infrastructure can be either external or internal (on-farm).

External infrastructure is mostly the responsibility of other people or bodies beside the farmer, such as Eskom, Telkom, cellular networks, and national and local government. External infrastructure includes electricity supply, access roads, and roads and railways to towns, cities and harbours.

Internal infrastructures include structures built, erected or bought on or for the farm to ensure profitable production of high quality crops. Examples are stores and sheds, housing, water storage dams and tanks, roads on the farm, irrigation systems, fencing, vehicles and equipment. Internal infrastructure will also include any conservation constructions that are made in order to ensure sustainable farming practices. These constructions can include bunds, gabions and wetland protection contours.

2. The Role and Function of Infrastructure

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 the most important factors. 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 as development of a cost effective infrastructure can require a large capital outlay. The medium- and long-term demands in terms of the cost of infrastructure development to produce and handle crops produced by new and replacement plantings, must always be considered carefully. It plays an important role in the cash flow and profits generated by the farm.

Infrastructure supports the production process. The size of the farm or planned enterprise determines the extent of the infrastructure that is required. A large farm needs a large internal infrastructure to support all the many activities in the production process – it may for instance warrant an own packhouse with all the necessary equipment and manpower. A small farm on the other hand needs to make use of more external support, as the extent of its activities may not warrant high expenditure on internal infrastructure.

Infrastructure can also be used to minimize the impact that farming has on the environment. Protections walls can be build to maintain the integrity of wetlands and bunds or dykes can be building to channel the run-off of water in order to recycle and re-use water thereby ensuring sustainability.

Other parameters are used when new or replacement orchards are established on an existing farm. Factors like utilisation of existing infrastructure, and whether the chosen cultivar will make a contribution to the current cultivar mix, are the main considerations.

3. Infrastructure Maintenance

Proper maintenance and repair of infrastructure on any farm is a prerequisite for success. It is important to develop a culture of neatness and care around infrastructure and all production aids within the ranks of management and employees. This is easier said than done, as it requires ongoing attention to detail, training, encouragement, and monitoring from senior management through to supervisors to all employees.

Maintenance and repairs to external infrastructure has to be done by formal requests or applications to relevant service providers through their regional representatives or through official organisations such as farmers associations, and local and national government. This process can be streamlined though good management, by ensuring that all the relevant contact details are on hand, and that the correct person or department has been identified so that delays can be avoided once a breakdown has occurred.

Internal infrastructure must be maintained according to a well-prepared, ongoing maintenance plan. It should account for all structures, roads, pumps and motors, electrical equipment, as well as vehicles and other farm equipment. The plan must also indicate whether maintenance and monitoring actions must be done on a daily, weekly, monthly, yearly or pre-seasonal basis.

A formal monitoring system indicating actions per item, dates performed and responsible employee must be in use to ensure that all actions are carried out in good time. Below is an example of a preventative maintenance plan for internal infrastructure.



Infrastructure Preventative Maintenance

<i>Infrastructure Item</i>	<i>Preventive Maintenance Checks</i>	<i>Recommended Action in Case of Deterioration</i>
Access Roads	- Storm water-drains are clear and sufficient - Potholes and other faults in the roads are repaired - Cracks in paving are marked and repaired	Report faults and deterioration to local road authority
Farm Roads	- Storm waterways are clear - Potholes and other faults in the roads are repaired	- Clear storm water ways - Repair faults and cracks as soon as possible before the condition of the road deteriorates further
Irrigation and Supply Systems	See Irrigation System Maintenance Plan	
Electricity Supply	- Annually: qualified person to inspect distribution boxes - Periodically: test earth-leakage and circuit-breakers - Periodically: inspect lightning arrestors	- Repair all problems and faulty equipment without delay - Lightning arrestors and earth spikes are at risk of theft, replace as necessary
Communication Systems	- Test communication lines - Test batteries, power packs, etc.	- Report broken or poor lines - Replace battery and power packs with a short standby time

Boundary Fencing	- Visually inspect fence for broken lines, droopy wires and unwanted plant growth. - Test electrical fences for proper voltage on wires and the correct working of energisers.	- Repair the fence as needed. - In the case of electric fences, the cause of voltage drop must be investigated and rectified. - Look out for droopy wires and vegetation 'earthing' the fence.
Buildings and Housing	Annually inspect: - Roof sheeting for leaks - Gutters for blockage - Plumbing for leaks - Interior / exterior surfaces for cracks and peeling paint - Doors and windows to lock and close properly	Repair faults as necessary (use qualified artisans for plumbing, electricity, building repairs, etc.)
Vehicles	Follow detailed service plan as recommended by the manufacturer, including servicing intervals and preventative maintenance.	Repair in line with the manufacturers recommendations.
Equipment	Follow detailed service plan as recommended by the manufacturer, including servicing intervals and preventative maintenance.	Repair in line with the manufacturers recommendations.

Some infrastructure items are made up of a number of components, and require a maintenance plan of its own. Below is an example of a maintenance plan for the irrigation system.

Irrigation System Maintenance Plan

Frequency	Task	Action
Daily	Check block pressures	Must be within prescribed limits
	Check emitter operation	Look for clogged, broken or misplaced emitters. Repair, replace, unclog or reposition emitters.
	Check for leaks and water wastage	Repair if found
	Flush primary filter	Flush filters as prescribed
	Check fertigation application	Must be within specifications
Weekly	Flushing of laterals	Flush lines as prescribed
	Flushing of secondary filters	Flush filters as prescribed
	Check the system pressure and flow	Must be as per design
	Check the pump operation parameters	Must be within prescribed parameters
	Check block pressures for automated valves	Must be as prescribed
	Check pump oil levels	
	Inspect fertigation plant	

Monthly	Visually inspect valves, water meters, and gauges	Look for damage and / or vandalism
	Open and inspect filters	As prescribed
	Check for leaks at pump pipe work	Check for leaks losing water and for leaks through which the pump can suck air
	Grease pump motor	As prescribed
	Perform CU tests	
Annually	Service valves and physically check correct operation	
	Thoroughly clean filters and replace sand in sand filters	
	Change oil in pump	
	Take a water sample at the end of lateral lines	
2-10 years	Replace bearings and wearing on pump and motor every five years.	
	Replace diaphragms on hydraulic valves every three years.	
	Replace poly pipe and nozzles every seven to ten years.	

4. **Conservation Infrastructure**

Infrastructural elements that must be taken into account when planning the layout of farm includes structures that are built to conserve the environment, such as:

4.1. **Bunds**

Bunds

Bunds, also called bund walls, are small earthen barriers on agricultural land or dirt roads with slopes ranging from 1 to 6 percent.

Bunds make the effective length of the slope shorter and thereby reduce the speed gain of runoff water. This prevents gullies from forming. (Think of how speed bumps on tar roads slow down traffic – bunds on dirt roads look the same and are there to slow down water.) Bunds are normally constructed with a grader. Because bunds direct and slow down water flow, they are handy for controlling soil erosion. Building bunds can however be quite damaging to the environment, and this must be kept in mind when planning construction.

4.2. **Gabions**

Gabions are cages made from wire mesh filled with, for example, rocks. They are used as retaining walls to lessen soil erosion. Gabions can also be used to line channels and can act as weirs to slow water run-off.

4.3. Mulching

Mulching is when the top soil is covered to slow erosion.

5. Regulations and Legislation

There are a number of laws that apply to infrastructure on farms. As far as the internal infrastructure is concerned, the employer must provide for the health and safety of persons at work and with regard to the use of plant and machinery, in accordance to the Occupational Health and Safety Act.

This implies that the employer must ensure that infrastructure utilised in the production process is in good condition and well maintained at all times, including the following:

- Dams must be approved and registered with the Department of Water Affairs.
- All buildings must conform to building regulations.
- Electrical installations must conform to regulations and be constructed and connected by qualified electricians.
- All vehicles must be licensed and their operators suitably qualified and licensed.

To export fruit to Europe and some other countries, the farm must be registered for Global GAP which, amongst others, prescribe measures which has a bearing on infrastructure, including:

- Inorganic fertilisers must be stored separately from other crop protection products, in covered, clean and dry areas, and in a way that prevents contamination of water courses.
- Crop protection products must be stored in a location which is sound, secure, fire-resistant, well-lit and away from other chemicals.
- The crop protection product store must have facilities for measuring and there must be facilities for dealing with spillage.
- The crop protection product store must be locked and access to the products must be limited to workers with formal training in handling them.
- Adequate ablution and washing facilities must be available for workers within a realistic distance from their workstations.



Chapter 2

- Infrastructure has a bearing on the practical implementation of all the day-to-day activities on a farm, and is the bare essentials required to operate a commercial farm.
- External infrastructure is mostly the responsibility of other people or bodies beside the farmer.
- Internal infrastructures include structures built, erected or bought on or for the farm to ensure profitable production of high quality crops.
- Infrastructure is not necessarily a determining factor in whether to establish a citrus farm, but it does play an important role in the planning process as development of a cost effective infrastructure can require a large capital outlay.
- Proper maintenance and repair of infrastructure on any farm is a prerequisite for success.
- Maintenance and repairs to external infrastructure has to be done by formal requests or applications to the relevant service providers through their regional representatives or through official organisations.

- Internal infrastructure must be maintained according to a well-prepared, ongoing maintenance plan.
- A formal monitoring system indicating actions per item, dates performed and responsible employee must be in use to ensure that all actions are carried out in good time.
- The employer must provide for the health and safety of persons at work and with regard to the use of plant and machinery, in accordance to the Occupational Health and Safety Act.
- To export fruit to Europe and some other countries, the farm must be registered for GlobalGAP which, amongst others, prescribe measures which has a bearing on infrastructure.
- When designing infrastructure for the new farm environmental protection structures must be taken into account and planned. These are structures such as bunds, gabions and mulching.

A circular inset image showing a close-up of hands working with soil or mulch, with the word "Practical" written in a cursive font over it.

Practical

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



Chapter 3

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

Determine stock required for the relevant enterprise

1. Introduction

Stock required for citrus production refers to two different types of stock, being the crop that is produced and the production stock items that are required to produce the crop. The crop that is produced refers specifically to the cultivars that can be produced on a farm. Production stock that is used on a citrus farm is plant material, agrochemicals, tools, machinery and equipment, maintenance items, fuel, and other consumables.

2. Cultivar Selection

The main types of citrus, as discussed at level 2, are:

- Oranges
- Soft citrus (Mandarins)
- Grapefruit
- Lemons

The decision on which type of citrus to plant is based primarily on the natural resources of the area that has been identified for development. Certain types of citrus grow well in conditions that other types will not adjust to at all.

Under each of these citrus types, there are a number of cultivars that can be selected. Cultivars are selected mostly on the basis of marketability. For instance, a cultivar such as Delta Valencia may be selected on the grounds of it being seedless, as opposed to other Valencia varieties that have pips and may therefore be less desirable for the consumer.

Production practices also play a role in the decision. To use the previous example, Delta Valencia requires careful tending, because seedless oranges tend to fall from the tree much easier than seeded varieties, and are therefore a lot more sensitive to for instance water stress.

Having a thorough knowledge of the characteristics and requirements of the various cultivars is very important in making the final decision on what to plant. In the level 2 learner guide is a table of common citrus cultivars. At the end of this chapter is a table with more detailed information about all the citrus types and cultivars grown in South Africa, in a format that is easily accessible and that can be used for reference purposes. It is however important to keep in mind that new cultivars are continuously being developed. Please consult the Integrated Production Guidelines for Citrus: Volume I published by Citrus Research International for up to date information.

3. Production Stock Requirements

In many cases, the production stock required for specific operations are quite simple to calculate. For instance, when a new orchard is established the plant material that is required can easily be determined by multiplying the number of trees per hectare with the size of the orchard, available on the orchard plan. Similarly, the tools and equipment, irrigation equipment, soil preparation chemicals and equipment, and other requirements can be determined from the orchard plan and is usually calculated when the planning for the establishment of the orchard is done.

Determining the stock requirements for ongoing production is not as simple. The stock requirements depend greatly on the production practices and the production volumes. The ability to accurately predict stock usage and determining stock requirements is often only perfected over time and with experience, but having effective systems in place greatly enhances the chances of success.

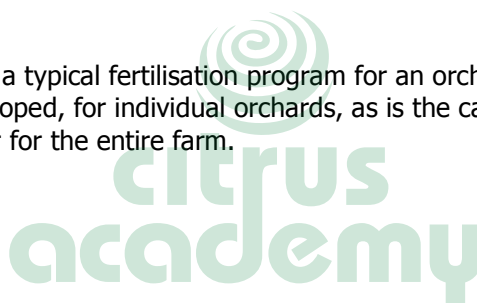
The various production reports and programs are handy tools in determining the requirements for a wide variety of production items. These reports include:

- Plant protection program
- Fertilisation program
- Weed control program
- Maintenance plan
- Production report

3.1. Agrochemical Stock Requirements

Agrochemicals include soil preparation chemicals, fertiliser, plant protection products, and herbicides. Determining the stock required for soil preparation is part of orchard establishment planning. The type and quantities depend on the method of soil preparation and the nutritional status of the soil. Once the orchard has been established, the ongoing agrochemical requirements can be determined from the approved plant protection and fertilisation programs. The programs are also used to determine the date on which items must be ordered to ensure that it will be delivered in good time.

Below is an example of a typical fertilisation program for an orchard on a citrus farm. Fertilisation programs may be developed, for individual orchards, as is the case in the example, for certain sections of the farms or for the entire farm.




Typical Fertilisation Program

FERTILISATION PROGRAM – CITRUS			
Orchard:	Orchard 10	Size:	3.0ha
Cultivar/Variety:	Delta Valencias	Trees per ha:	316
<i>Fertiliser</i>		<i>Quantity</i>	<i>Time of Application</i>
Soil Applications		g per tree	
Limestone Ammonium Nitrate (LAN)		500g	July
LAN		250g	August
LAN		250g	September
Potassium Chloride (KCL)		500g	September
Dolomitic Lime		4000g	October
Foliar Sprays		g per 100l water	
Low Biuret Urea		1000g	July
Manganese Sulphate		200g	October
Solubor®		150g	October
Remarks:			

The fertiliser requirements can now be calculated as follows:

<i>Month</i>	<i>Stock Item</i>	<i>Calculation</i>	<i>Total Requirement</i>
July	LAN	500g x 316 trees /1,000	158kg
	Low Biuret Urea	* 2,500l x 3.0ha = 7,500l 7,500l / 100 x 1,000g / 1,000	75kg
August	LAN	250g x 316 trees /1,000	79kg
September	LAN	250g x 316 trees /1,000	79kg
	KCL	500g x 316 trees /1,000	158kg
October	Dolomitic Lime	4,000g x 316 trees /1,000	1,264kg
	Manganese Sulphate	* 2,500l x 3.0ha = 7,500l 7,500l / 100 x 200g / 1,000	15kg
	Solubor®	* 2,500l x 3.0ha = 7,500l 7,500l / 100 x 150g / 1,000	11.25kg

* The amount of spray material required per hectare for foliar applications varies, and is usually between 2,000 and 2,500 litres per hectare for mature trees. The fertilisation manager will be able to accurately indicate the amount required per hectare.

A system, possibly in the form of a spreadsheet, can be developed to calculate the fertiliser requirements for all the orchards in the above manner. Once the information has been consolidated, orders can be placed for the total fertiliser requirement for the farm. The fertiliser will normally be ordered for delivery in the month before the application must be made to ensure that the items are delivered on time.

Plant protection products refer to all the chemicals that are used in the pest and disease control program. The requirements for these stock items are calculated from this program.

The pest and disease control program typically indicates the amount of chemical required in grams per 100l. The volume of mixed spray material required per hectare depends on whether a light, medium or heavy cover spray will be applied, which the pest and disease control manager will be able to indicate. The volume of chemical required is calculated using the same method as above.

Recommendation for herbicide applications is given in litres per hectare or per square meter. The surface area that is to be sprayed is normally a percentage of the planted hectares, which is then used to calculate the quantity that has to be purchased.



Herbicide Requirements

Recommendation: 5 litres herbicide per hectare

Planted area of 130ha, weeds on 20% of planted area

Volume herbicide required: 130 x 20% = 26ha x 5 = 260 litres

A system must be in place to calculate the requirements for the entire farm, and stock must be ordered in good time.

3.2. Tools, Machinery and Equipment Requirements

Machinery and equipment include items such as tractors, spray machines, herbicide carts, trailers, grass slashers, and so on. The type and quantity of machinery and equipment that is required depends on the size of the farm and the production practices that are employed, and is normally determined when the original planning for the farm is done. Machinery and equipment is not normally purchased on a regular basis, but may need to be replaced over time.

The type and number of tools that is required also depends on the production practices and size of the farm. It will however include:

- Maintenance tools and equipment
- Gauges, metres and other measuring equipment
- Harvesting tools and equipment
- Plant manipulation tools and equipment



Harvesting Equipment Requirements

As an example of how tools requirements are calculated by using production records, we will look at the calculation of harvesting tool requirements. The stock items required for the harvesting process is calculated by using the production report.

Cultivar	Area Planted	Number of Trees	Production		*Bins	**Trailers
			Tons / ha	Tons		
Star Ruby	15ha	7,500	40	600	1,765	252
Navels	20ha	10,000	35	700	2,059	294
Amber Sweet	15ha	7,500	40	600	1,765	252
Delta	30ha	15,000	45	1,350	3,971	568
Valencia	50ha	25,000	50	2,500	7,353	1,051
Total	130ha	65,000		5,750	16,913	2,417

* Each bin contains 340kg of fruit, meaning that that number of bins is calculated as follows:
Tons / 1,000 / 340

Either the number of bins or the number of trailers will be calculated, depending on the harvesting systems employed on the farm. These cultivars are naturally not all harvested at the same time, even though the harvesting periods of some cultivars may overlap. By adding the respective harvesting periods, the peak requirement for workers and equipment can be calculated. The equipment that will be required includes clippers, ladders, picking bags, bins and trailers.

3.3. Maintenance Item Requirements

Maintenance items include spare parts, lubricants, and other items that are required to repair and maintain vehicles, equipment, machinery and infrastructure. The maintenance items that will be required in a specific period can be calculated from the maintenance plans that are put in place. The number of spare parts that are required for the irrigation system, for instance, also depends on the age and general condition of the system.

Extraordinary requirements, such as when a decision has been taken to replace all the emitters in specific orchards, must be communicated in time to ensure that the items are ordered and available.

3.4. **Fuel Requirements**

The fuel that is required depends on the production practises, the size of the production unit and the number of vehicles in use on the farm. The consumption of fuel varies between different times of the year, depending on the activities on the farm, and this must be taken into account when the requirements are calculated.

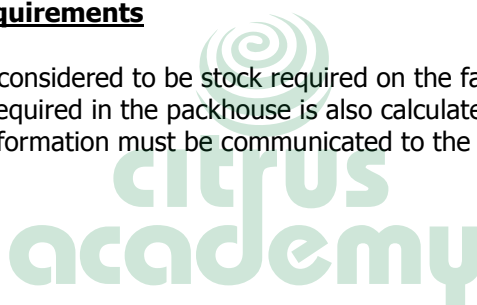
3.5. **Other Consumable Requirements**

The types and quantities of other consumables required depend mostly on the production practices and the number of employees on the farm.

Protective clothing, for instance, is ordered according to the number of workers on the farm, and must be sufficient to ensure that workers have the opportunity to wash and clean their clothing regularly. Special protective gear is also required for operations such as spraying and this must be taken into account.

3.6. **Packhouse Stock Requirements**

Packhouse stock is not considered to be stock required on the farm, except if the farm has its own packhouse. The stock required in the packhouse is also calculated with the help of the production information, and this information must be communicated to the packhouse as soon as possible.



Packhouse Stock Requirements

In the table below, information is added to the production information that was used in the previous example to calculate the harvesting requirements, to form the basis for calculating the packhouse stock requirement.

Cultivar	Production (Tons)	Packout %			Market		
		Export	Local	Juice	Export Cartons (15kg)	Local Units (7kg)	Juice Tons
Star Ruby	600	80%	5%	15%	32,000	4,286	90
Navels	700	55%	35%	10%	25,667	35,000	70
Amber Sweet	600	70%	20%	10%	28,000	17,143	60
Delta	1,350	65%	25%	10%	58,500	48,214	135
Valencia	2,500	60%	20%	20%	100,000	71,429	500

The packhouse team can now calculate the stock required to fit in with the harvesting plan drawn up by the production team. Stocks include postharvest chemicals, cartons, fruit labels, pallets, and identification stickers.

4. Maintaining Production Stock Levels

While certain items, such as fertiliser and most plant protection chemicals, are ordered only when they are required and in the quantities that are required, other items, such as maintenance items, fuel and consumables, are kept on hand at all times. The decision on how much of these items to keep on hand takes a lot of consideration. Deciding on stock levels is about balancing two equally important factors.

Firstly, **stock is money**. The stock that is held at any given point cost money to buy, and it is now money that could have been earning interest or put to other uses. Stock items that do not have a direct impact on production, meaning that will not affect production if not immediately available, should not be kept on hand.

Secondly, **production should never at any time be compromised or halted due to critical stock items not being available**. Compromising the quality or safety of fruit is never worth the money that could have been saved in not keeping stock items on hand.

Another factor that must be taken into account is the availability of the stock items. If the items are purchased from a local supplier who can be depended on to deliver the items in a short time, it is not necessary to keep it on hand. If however it is highly specialised items that can only be ordered from suppliers that are not local with a long delivery time, at least some of the items should be kept on hand.

The following steps are useful in maintaining stock levels:

- Determine minimum stock levels for all items, meaning the level below which the stock item should never fall. For example, one can decide that there should never be less than 200l of diesel available on the farm.
- Determine reorder levels for all stock items. The reorder level takes into account the delivery time for that specific item and the rate at which the item is used. For example, if you know that diesel is used on average at 100l per day, and that it will take three days for the supplier to deliver, the minimum reorder level should be set at 500l. Once it reaches that level, there is sufficient time to order the item and not fall below the minimum stock level.
- Identify suppliers for all stock items in good time, including alternative suppliers that can be used if the regular supplier is not able to deliver. When purchasing an item of the first time, it is good practice to contact a few suppliers to determine who are able to reliably deliver the best quality item at the best price. Suppliers who are well established is often more reliable, but if they have a secure market, they may not offer the best prices. Keep the contact details of suppliers at hand.
- Identify the persons who are authorised to order stock items and ensure that at least one of them is available at all times. Make sure that the suppliers are aware of who have been authorised, and that all authorised personnel have access to all the information required, including the contact details of preferred and alternative suppliers.

Management of stock is simplified if **standardisation** is applied wherever possible. If the same type of irrigation equipment is used in all orchards, stock control and supply is much easier. The same principle applies for instance to vehicles, tractors, trailer wheels and tyres.

5. Management of Production Stock

Systems for keeping track of stock requirements, ordering stock in time, controlling the issue of stock items, and monitoring current stock levels must be in place on all farms, and requires careful planning before the production unit is established.

While production stock items, such as agrochemicals, maintenance items, fuel and consumables are managed with the help of a stock control system, machinery and equipment are recorded in an asset ledger.

5.1. Stock Control System

Stock control systems assist in monitoring the levels of the stock items on hand. Stock control systems can be computerised or manual. Computerised systems are generally more accurate and easier to maintain. There are a variety of software packages available to assist with stock control.

Any stock control system must have the following components:

- **Purchasing** – Information of stock purchases must be entered on the stock control system, including the date, invoice number, supplier, and cost price.
- **Issuing** – The system must allow for the issuing of stock in a well-documented manner. Stock items must only be issued to authorised persons, and they must sign for the items when they are issued.
- **Current Stock Levels** – From the purchases and issues the system must be able to calculate the expected current stock level. An added benefit is if the system can calculate the value at cost price of the items currently on hand.

During a stock take, also referred to as an inventory count, all the stock items on hand are counted. The actual stock levels are then compared with the expected levels as calculated by the system. Variances that are found may be due to insufficient control, incorrect input of purchases or stock issues, theft, or incorrect counting during the stock take.

Another added bonus to some computerised stock control systems is that stock take data can be processed in the system, which then produces a report that compares actual and expected stock levels.

Keeping stock items well-organised and safely stored is essential for proper stock control. If items are not well-organised, it is very difficult to count the stock accurately, and it will take considerably longer.

Stock control, especially of agrochemicals, is very important in terms of GlobalGAP requirements. These requirements must be observed when deciding which system to use.

5.2. Asset Register

Assets are stock items that are kept for a long time, as opposed to other items that are used up in short periods. Machinery and equipment qualifies as assets, while fertiliser and spare parts are not assets. Fixed assets include equipment, machinery, vehicles, and office equipment and furniture.

Assets are generally expensive items, and there must be systems in place to keep track of these assets. An asset register, sometimes also referred to as an asset ledger, is a record of all the fixed assets on the farm, including its date of purchase, its cost price, its depreciation rate, and its date of sale when it is sold.

When the financial records of the farm are audited, the asset register is checked against the actual assets on the farm.

6. Management Reports and Financials

Management reports within any book year provide an overview of activities and results within that specific year and cover the progress in comparison to what was projected in the budget. Budgets usually cover the following:

- An overview of the previous years with regard to production, marketing, income and profit margins
- Projection of results foreseen in the new year
- Possible adjustments in approach to handle the foreseen circumstances
- Capital investment for longer or shorter term improvements or an increase in production

- Projected results in production, income and profits
- Projected cash flow

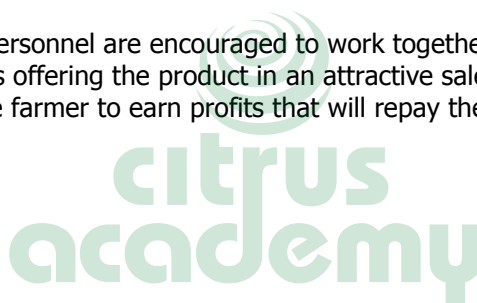
Depending on the time of the year, management reports include progress with regard to all the aspects covered in the budget. It also highlights possible changes in production or the market with recommendations to handle the situation, as well as the effect these will have on income, profits and cash flow.

7. **Breakeven Analysis**

Generally, breakeven analyses calculate on a year-to-year basis what the minimum on-farm income before tax should be to cover all the production costs incurred for the product or range of products. The direct production costs and income vary between cultivars and is recorded as such on a per hectare basis. Overhead costs, such as management and administration costs are difficult to allocate per cultivar and should be apportioned as a fixed cost on a per hectare basis.

In the case of a new planting, a breakeven analysis determines after what period the accumulative income will cover the investment and development costs of the planting. It is important that the breakeven point is reached as quickly as possible. The outcome of the process is therefore a product of the quality and cost of the inputs and provides an incentive to make the product development process as efficient as possible.

It stresses profitability. The personnel are encouraged to work together to produce a product that meets customer needs. This includes offering the product in an attractive sales channel at an attractive price and at a cost that enables the farmer to earn profits that will repay the development and investment cost.



Chapter 3

- Stock required for citrus production refers to two different types of stock, being the crop that is produced and the production stock items that are required to produce the crop.
- Selecting the correct cultivar is important and knowledge must be gathered on all available cultivar and suitability must be investigated.
- Determining the production stock required for a certain operation, such as establishing a new orchard, is quite easy.
- Determining the stock requirements for ongoing production is more difficult as more factors affects this projection.
- Stock requirements can be calculated with the help of the plant protection, fertilisation, and weed control programs, the maintenance plan and the production report.
- Agrochemicals include soil preparation chemicals, fertiliser, plant protection products, and herbicides.
- The type and quantity of machinery and equipment that is required depends on the size of the farm and the production practices that are employed, and is normally determined when the original planning for the farm is done.
- The maintenance items that will be required in a specific period can be calculated from the maintenance plans that are put in place.
- The fuel that is required depends on the production practises, the size of the production unit and the number of vehicles in use on the farm.
- The types and quantities of other consumables required depend mostly on the production practices and the number of employees on the farm.
- Packhouse stock is not considered to be stock required on the farm, except if the farm has its own packhouse.
- Deciding on stock levels is about balancing two equally important factors: the cost of keeping the stock on hand and the possible loss in production if the stock item is not readily available.

- Systems for keeping track of stock requirements, ordering stock in time, controlling the issue of stock items, and monitoring current stock levels must be in place on all farms, and requires careful planning before the production unit is established.
- Any stock control systems must have components for purchasing, issuing, and managing stock levels.
- An asset register, or asset ledger, is a record of all the fixed assets on the farm.
- Management reports within any book year provide an overview of activities and results within that specific year and cover the progress in comparison to what was projected in the budget.
- Breakeven analyses calculate on a year-to-year basis what the minimum on-farm income before tax should be to cover all the production costs incurred for the product or range of products.

A circular inset image showing a close-up of hands working with small, round objects, possibly seeds or small fruits, on a light-colored surface.

Practical

Complete activities 5 and 6 in the **Learner Workbook**.



Chapter 4

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

Define and interpret production procedures within the relevant enterprise

1. Introduction

The phenology, or growth cycle, of a citrus tree is closely related to the production actions that are taken at various times during the production season. Such production actions are aimed at supplying the tree with the nutrients and water at the stage in its growth when it requires it, and to assist it in protecting its crop through pest and disease control measures at the time when that is required.

Production actions are also influenced by the seasons. Irrigation is for instance increased during the hot summer months, and reduced during the winter months, adjustments which will depend on whether the production unit is located in a summer or winter rainfall area.

2. Monitoring and Maintaining the Production Cycle

Maintaining the production cycle in way that promotes the production of a high percentage of marketable fruit, is a complicated and exacting process and demands intensive and expert inputs. The elements involved in production of a crop of the required quality are the following:

- Healthy orchards
- Correct production inputs at the right time
- Trained personnel
- Appropriate and well-maintained equipment
- Well-designed information systems
- Sufficient funds to ensure necessary supplies

2.1. Healthy Orchards

Maintaining a healthy orchard for optimum production of quality fruit is based on the following:

- Good quality, well-drained soil
- Well prepared soil
- Good plant material
- A fertiliser programme based on soil and leaf analysis
- A well designed irrigation system and proper irrigation scheduling
- A balanced pest and disease control program
- Maintenance pruning to provide light penetration into the trees
- Proper orchard sanitation to remove fallen and infected fruit continuously

2.2. Production Inputs

The proper timing of all actions involved in the production process is essential.

In order to obtain sufficient flower initiation, blossom and fruit set, nutrient status of the trees and moisture supply must be optimal. Fertiliser applications must therefore be carefully executed, and irrigation scheduling done according to accepted methods to ensure sufficient available soil moisture.

Fruit set throughout the tree canopy, which will yield clean and large fruit, is dependent on light penetration, which depends on a proper pruning program.

The spray program for pest and disease control must also be well-planned, well-timed, and cost effective to result in a clean and profitable crop.

Ensuring the correct and timely production inputs depends on the following:

- Professional approach
- Well-trained management, supervisors and employees
- Planning and supervision
- Good recording and observation system
- Enough well-maintained and effective orchard equipment
- Stock availability when required
- Accessible technical knowledge and advice

2.3. Trained Personnel

Trained employees, with the level of training appropriate to the task which has to be performed, are essential for successful citrus production.

Training must be supported by ongoing mentoring, supervision and support to ensure that the tasks are well executed.

All training actions must be documented.

2.4. Equipment

Mechanised tasks can only be executed well with equipment which is designed for the task and in good working condition. Consider the following examples:

- Doing light work with a tractor designed for heavy work is not cost-effective and may cause damage to the equipment. The converse is true with heavy work with a tractor delivering insufficient power, which will also have a poor result with heavy wear and tear on the tractor.
- Spray machines must be calibrated to deliver the required amount of spray mixture onto the target area on or within the tree and be matched with a tractor that can deliver sufficient power for the task.
- At the packhouse, the in-feed rate of fruit must be matched to the capacity of the packing line to ensure efficient handling.

The same principles apply to all equipment utilised in the production, harvesting and packing process.

2.5. Information System

A well-designed information system which provides the required historical and current data on all aspects of the enterprise forms the basis of a well-managed farm. Always remember: if you cannot measure, you cannot manage.

This includes financial information on costs and income, production figures per orchard, fertiliser and spray programs, weather data, and personnel matters. All production inputs have to be recorded and records must be available for scrutiny at all times.

Current food safety legislation and compliance for registration for GlobalGAP requires a system which enables traceability back to the orchard of fruit delivered to the market.

2.6. Funds

Sufficient funds must be available to support the production activities at all times.

Being a seasonal enterprise, income is only generated from about two to four weeks after delivery of the first fruit which, depending on the cultivar mix and production area, could be anytime between mid-March to mid-June. Payments are normally finalised by the end of January of the following year. Cash flow must therefore be managed carefully to have the necessary funds available at all times.

3. Observation and Recordkeeping

Production cycles are influenced by a large number of factors. Observations and records of both historical and current season activities and crop response must be kept to enable the farmer to plan and react in order to produce a marketable crop.

A culture of recordkeeping must be developed and kept intact to achieve and maintain the standard which is required. It must be a part of everyday management and execution of all activities. The recordkeeping system should be as simple as possible to encourage the employees to use and maintain it – it should not be seen as a hassle. Regular feedback to employees indicating the results and use of the information gathered is a motivation and provoke interest.

3.1. The Purpose of Recordkeeping

Observation of a developing crop is aimed at monitoring the effect of orchard practices and weather conditions on the fruit, as well as the pest and disease status throughout the growing season.

It is important to know what the results were of similar practices during previous years as well as the effect of varying weather conditions on fruit development and quality. Recording rainfall, temperature, humidity, evaporation and wind velocity on a continuous basis is essential.

Crop volume and quality will, for instance, affect the nutritional status of a tree as reflected by leaf analysis. Adjustments to the fertilisation programme are made to accommodate the change in nutrient status, according to known parameters and according to the reaction of the orchard to previous adjustments. Historical and current records of crop volume, fertiliser applications and crop response are therefore necessary to develop an effective program.

Pest and disease status is monitored through a scouting system where trained employees go through the orchards regularly to inspect fruit and trees. The results are recorded to establish whether there is a build-up of specific diseases or whether the control measures are adequate.

Traceability is a major requirement of food safety legislation and is also required for GlobalGAP registration. Traceability means the ability to trace the origins of fruit, from where the consumer buys is in an overseas marketplace, right back to the orchard where it was grown.

3.2. Types of Records

The following records are normally kept:

- Records of pre-plant investigations, including the environmental impact study, soil surveys, water quality assessments, planning for handling of runoff water, the soil erosion impact assessment;
- Origin of plant material and nursery practices up to the point of delivery of plant material to the farm;
- The qualifications of all consultants or staff recommending actions for establishment and production processes;

- Proof of the training of workers that are required to perform tasks in the production process for each specific task;
- Instructions given to workers in writing with acknowledgement that they understand the instruction;
- Reports of execution of the instructions;
- The numbers or names of all orchards with indication of year of planting, cultivar, rootstock, number of trees, planting density and size, together with the historical yield information;
- Records of fertiliser and spray material applications;
- Test and calibration reports of all equipment utilised;
- Pre-harvest monitoring of external and internal quality, also called maturity indexing reports;
- Harvesting records and details of packhouse deliveries;
- Cull analyses per orchard from packhouse as well as records of internal quality;
- Records of all postharvest treatments and packhouse procedures with indication of dates of delivery together with packing records.

3.3. Interpretation of Records and Reports

Observation reports on citrus farms include reports on growth phenomena such as blossom dates and fruit drop, routine inspection of insect and fungal disease infestation, and surveys on the extent of hail or other physical damage to fruit. The reports are compiled from data received from the orchards that are collected by either well-trained scouts or other trained personnel. An efficient inspection and recording system is the cornerstone of successful citrus farming.

Inspections assist in the following three ways:

- Inter-seasonal decision making based on comparisons of results between seasons;
- Intra-seasonal decision making based on fruit set, growth, and pest and natural enemy trends; and
- Immediate decision making based on intervention thresholds.

The accuracy of orchard inspections depends on the scouts or other personnel used to inspect the orchards. They must be well-trained in basic identification of pests, damage symptoms, natural enemies and any other phenomena they are expected to observe and record. Monitoring of the work of the scouts is very important to ensure that the information supplied after inspections is correct.

Orchard maps facilitate the organisation of inspection systems, the interpretation of inspection data, and the subsequent execution of control operations. The maps can be used to record various aspects of orchard operations, the position of inspection sites or routes, and fluctuations in pest or disease presence. Copies of the maps can be utilised to show the development of a particular pest or growth phenomena in a specific area.

Placement of inspection sites should be as prescribed for each specific malady so that the results will represent the actual condition in the orchard.

The results of each inspection round should be recorded for permanent reference. Over time, regular inspection and the related written records will provide a good basis for fine tuning treatment thresholds for pests and other production, harvesting and crop projection requirements.

Below is an example of an orchard inspection used to record mealybug infestation in an orchard?



Orchard Inspection Form

The calyx and sides of ten fruit on each of ten reference trees are inspected and the occurrence of mealybug is recorded.

Sweet Street Farm													
Name:		Pete			Orchard:		Tophouse						
Pest:		Mealybug			Date:		7 November						
		Fruit											
		1	2	3	4	5	6	7	8	9	10	C	S
Tree	1			C	C			S		C		3	1
	2	C							C			2	
	3					C		S				2	1
	4									C		1	
	5				C						C	2	
	6		C									1	
	7			C								1	
	8												
	9					C			C	S		2	1
	10									C		1	
Total												15	3
C = calyx													

Weekly inspections provide a good picture of pressure of infestation and whether corrective measures are necessary. The same form can be used for recording most other orchard pests.

4. Market Information

The requirements of the market influence the decisions on what to produce and the production practices that are employed. Production practices are mostly impacted in terms of market requirements that relates to food safety and quality.

A prime example in this sense is maximum residue levels (MRL). MRLs are the residue of a given chemical that is allowed to be in the fruit when it is exported. MRLs are legislated by the Department of Agriculture, Forestry and Fisheries, who issues a list of MRLs for all plant protection products that are used in crop production. If it is found that a consignment of fruit exceeds the MRL for a Plant protection product, the consignment will be rejected for export and action can be taken against the grower.

Production practices, and in this case specifically the application of plant protection products, are influenced by this market requirement in that the spray program will be planned in such a manner that no plant protection product is applied too close to harvest time. The market information that is gathered in order to decide what to produce and to assist with production planning include the following:

- Market preferences
- Expected income per unit in the various markets
- The cost chain to various markets
- Price fluctuation over the production season
- Quality requirements of the various markets (food safety, fruit size, internal and external quality)
- Production trends in the local as well as overseas production areas

4.1. Market Preferences

The various export markets each have their own set of preferences for fruit type. The Japanese market has for instance a specific preference for grapefruit and soft citrus outside their own production season. The American market prefers navel oranges and soft citrus.

The European market will absorb a good quality fruit in more or less any fruit type except white grapefruit, which has a marketing niche in Italy. The Scandinavian markets prefer fruit of a larger size spectrum than the Russian market, whereas the complete size spectrum can be marketed in the rest of Europe.

Fruit marketed in the Middle, Far East and Japan must be relatively blemish-free and have good colour. Waste fruit is heavily discounted in these markets.

Growers can get access to this information by studying trade publications and historical market information. It is however most of the time easier to rely on market agents for this information. Knowledge of these preferences by the chosen market agent is imperative for success.

4.2. Expected Income per Unit

The income per unit is determined by placement of an accepted fruit kind of the right quality at the right time on the right target market.

The selection of an area to establish a new enterprise or replacement of an orchard will always be profit driven. The potential of the area or orchard to produce a highly marketable and profitable product will determine the final decision.

4.3. The Cost Chain

Income on the farm for any product is determined by market price and the cost chain to the market. Elements included in the cost chain are transport to port, handling, pre-cooling and loading at port, shipping, discharge, transport to the market, and market handling costs.

These elements differ for the various markets and play a large role in determining profitability of any farming enterprise.

Marketing in Japan and United States of America involves very strict and carefully monitored cold storage and in-transit sterilisation protocols, which adds substantially to the cost chain. The protocol was introduced to kill any fruit fly and false codling moth larvae that may be present in the packed fruit. A high market price is required to offset this cost to yield a profitable on-farm return.

4.4. Price Fluctuations

Prices on any market are determined by supply and demand. All markets are supplied by a number of countries, each with its own unique set of factors which determines the price it could accept to enable them to generate a profitable return.

The return is also heavily influenced by the quality of the product. The strong point of South African citrus is that it normally competes on most markets in the so called off-season of their local farmers or nearby countries.

It is important when projecting any price to consider the price chain involved in supplying fruit to the target market. The cost of transport to the various harbours in South Africa varies between production areas. In-harbour costs of cold-storage and loading differ depending on destination.

Only produce from the Western Cape is allowed into the United States as result of the phytosanitary exclusion of areas where bacterial blackspot occurs. In determining where to establish and what to plant in any of the established areas the above factors have to be weighed up carefully against to determine what the projected income and eventual profit margins could be.

4.5. Quality Requirements

The quality requirements of the various markets differ, but all markets require a sound, well-handled, and safe product.

Food safety is legislated through the Agricultural Products Standards Act. This act prescribes all requirements for ensuring that food is safe for human consumption. The most significant prescriptions of the Act are maximum residue levels (MRLs) for each plant protection product and traceability.

GlobalGAP registration is a must for most European countries and the United States. This requires traceability of all actions throughout the production and handling chain right back to the orchard in which the fruit was produced.

4.6. Production Trends

Volume of products on the markets is one of the determining factors of price. Planting any citrus orchard is a long-term commitment, making it very important to take notice of new plantings locally as well as in other citrus producing countries.

5. The Impact of Marketing Information on Production Planning

Production planning for citrus should at all times be based on the net on-farm returns from the markets for the types of citrus which can be produced successfully in the area which the farm is situated. Anticipated prices for the various products from the markets accessible to the produce from that specific area, are therefore important to start planning.

The next step is to determine what quality fruit need to be produced to provide entry into the various markets and to assess whether and how much of required quality can be produced. This information will only be available from medium- to long-term information on the production and quality trends in the area and on the farm.

It is for instance known that under normal circumstances high quality grapefruit can be produced in the Lowveld of Mpumalanga and Limpopo, but that navel oranges from that area seldom reach the required quality to provide entrance to high income markets. On the other hand, navels from the Citrusdal area are normally of high internal and external quality and can be marketed in the United States of America with high returns back on farm.

There are therefore a host of production and marketing factors which influences the ultimate decisions on what to produce and which markets to target to achieve a profitable result.



Chapter 4

- The growth cycle of a citrus tree is closely related to the production actions that are taken at various times during the production season.
- The elements involved in production of a crop of the required quality are the following healthy orchards, correct production inputs at the right time, trained personnel, appropriate and well-maintained equipment, well-designed information systems, and sufficient funds to ensure necessary supplies.
- Observations and records of both historical and current season activities and crop response must be kept to enable the farmer to plan and react in order to produce a marketable crop.
- Records must be kept to show the results of similar practices during previous seasons and to facilitate traceability.
- Records are normally kept of pre-plant investigations, origins of plant material, staff qualifications, staff training, staff instruction, orchard numbers, fertiliser and spray material applications, testing and calibration of all equipment, maturity indexing, harvesting, cull analyses, and postharvest treatments.
- Market requirements influence decisions on what to produce and the production practices that are employed.
- Market information that is gathered of different markets in order to decide what to produce and to assist with production planning, include market preferences, expected income per unit, cost chains, price fluctuations over the production season, quality requirements, and production trends for the specific cultivar in local and overseas production areas.
- Production planning for citrus should at all times be based on the net on-farm returns from the markets for the types of citrus which can be produced successfully in the area which the farm is situated.



Complete activities 7, 8 and 9 in the **Learner Workbook**.

Chapter 5

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

Determine and apply harvest procedures within the relevant enterprise

1. Introduction

At the previous level, we discussed the harvesting process for citrus in detail, together with the different methods that is used for harvesting. In short, harvesting is the process of gathering mature crops from the orchards and marks the end of the growth cycle.

Citrus is hand-picked from the trees, and mechanical harvesting is never used for fruit destined for export. The fruit is picked either by using clippers to cut the stem of the fruit, or by snap picking, which involves breaking or snapping off the stem without using a tool to cut it. Fruit is picked and placed into either bins or picking trailers in the orchard. The tools and equipment that are used include clippers, ladders, picking bags, and the bins or trailers.

2. Harvesting Principles

The principles of harvesting are:

- Budget, plan and forecast
- Do not harvest before the crop has reached the required minimum standards
- Adhere to specific instructions during harvest to maintain optimum food safety and crop quality and to withholding periods for agrochemical applications
- Maintain health and safety of workers during harvest
- Manage costs, equipment and staff to maximise profit

3. Harvest Planning and Preparation

Proper planning and preparation for the harvesting process is essential to ensure that the process is executed well and in good time. Once the fruit has matured, a limited time is available for picking after which the fruit will be over-ripe and will no longer comply with quality standards.

Planning and preparing for harvesting include the following:

- Deciding on the harvesting methods that will be used
- Crop estimates
- Maturity indexing and crop monitoring
- Personnel requirements and preparation
- Equipment requirements and preparation

3.1. Determining Harvesting Methods

Before the rest of the planning and preparation can be done, a number of decisions have to be taken with regard to how the harvest will be executed. These decisions are in many cases taken simply on the basis of how the fruit was harvested in the past. If it is however the first time that the fruit will be harvested, all the available options must be carefully considered.

The first decision that must be taken is whether to use bins or trailers to collect the fruit in the orchard. The following factors are taken into account:

- The volume of fruit that has to be harvested. An exact crop estimate is not required, but factors such as tree age and the expected average yield per hectare are taken into account.
- The availability of equipment. Bins can be rented from a number of suppliers or from the packhouse, while picking trailers require a capital investment. The availability of tractors must also be taken into account, as well as the need for flatbed trailers to transport bins.
- The distance to the packhouse and the state of the roads on the farm and to the packhouse.
- The ability of the packhouse to receive fruit in bins or trailers. Some packhouses have the facilities to receive fruit from picking trailers, while others have facilities to tip bins.

The second decision that must be taken is whether to use snap picking or clippers. Fruit is more likely to be injured when snap picking is used as the workers grip the fruit harder, but snap picking is considerably faster than clipping. It is also more difficult to keep stems short when snap picking. Fruit destined for export should be picked with clippers to limit injury while being picked and while being transported, while snap picking is acceptable for fruit that is destined for processing.

The third decision that must be taken is whether selective picking will be done. In some cases it makes sense to first selectively pick export fruit, using clippers and carefully handling the fruit. Workers that are well-trained select fruit in the orchard that comply with the external quality and size requirements for export fruit, leaving the fruit that obviously do not comply with these requirements on the trees. After the export fruit has been picked, a second team is sent in to strip the trees of the remaining fruit using snap picking, which is then sent straight to the processing plant. The advantage of this method is that the harvesting process is speeded up and receiving costs at the packhouse is reduced. It however complicates the management of the harvesting process and the danger exists that fruit that are of export quality can be sent directly for processing if the workers are not well-trained.

Methods of mechanical harvesting has been developed for citrus, but has met with limited success because of the damage that is caused to the fruit. Although not widely used in South Africa, it is however an option for fruit destined for processing.

3.2. Crop Estimates

An accurate crop estimate is the basis for calculating equipment and personnel needs to harvest the crop within the normal picking period of each cultivar. The estimate must, apart from crop volume, also indicate projected size spread per cultivar, external quality and estimated time of ripening.

There is no foolproof method for estimating the crop which takes into account seasonal variations due to climate and other factors. However, it is possible to achieve reasonable accuracy by basing estimates on the following information:

- Accurate tree and area census that indicate the number of trees and hectares, tree-age and tree-spacing per orchard.
- Historical export percentage, count distribution and total yield in carton equivalents per orchard.
- Seasonal variations, based on orchard observations and exchanges of information with other growers in the area.

The first estimate must be made available to management and submitted to the packhouse in January. It is used for both preparation of budgets, marketing planning, and the preliminary calculation of packing material requirements.

Fruit size predictions are based on measuring the diameters of 100 fruit per tree on 10 index trees per orchard at weekly intervals. A growth curve is then established and correlated with data from previous seasons and actual fruit size distribution at packing.

These calculations can be verified by conducting a strip estimate three to four weeks ahead of the estimated harvest date. All the fruit of at least one tree per orchard are picked and processed through the packhouse to determine yield, pack-out percentage, and fruit size distribution. This information is then interpreted and extrapolated to estimate the total export crop.

3.3. Maturity Indexing and Crop Preparation

Maturity indexing means the monitoring of internal and external development of the crop during the weeks before the harvest. This is done in conjunction with the actions described above for crop estimates. Fruit is picked and tested for internal quality from well before the harvest starts. The colour of the fruit is also judged and noted. The information is recorded and maturity curves are developed, which indicates the expected maturity time and therefore the expected harvest date.

Preparing the crop for harvest mostly involved ensuring that it remains protected from pests and diseases, especially fruit fly at this stage, and ensuring that pre-harvest intervals for plant protection products are adhered to.

Pre-harvest intervals are related to maximum residue levels, which we have discussed before. To ensure that maximum residue levels are not exceeded, the period for which each specific plant protection product should not be applied before the harvest is prescribed. This is referred to as the pre-harvest interval. Remember that maximum residue levels are legislated and must therefore be adhered to under all circumstances.

3.4. Personnel Requirements

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

Planning the picking process for soft citrus is more complex due to cultivar types, climate, optimum maturity periods and labour distribution. The following picking planning methodology has been developed for the Western Cape, but can be used as the basis for planning in other production areas.

In the table below, the picking hours per day for the Western Cape and the Lowveld area is shown to demonstrate the difference between areas. It is also shown for various times during the picking season, to show the seasonal variances.

<i>Month</i>	<i>Picking Time (Hours per Day)</i>	
	Western Cape	Lowveld
March	7	6
April	6	7
May to July	5	8
August and September	6	8

Table 5.1: Picking Hours per Day – Western Cape and Lowveld

The information in the table above is used to determine the estimated number of picking hours available to harvest the crop within the normal picking period for each cultivar, and for the entire production unit.

In the table below, the average expected yield (t/ha) and the average picking rate (kg/picker/hour) for the various cultivars are shown. The man-hours required per hectare are calculated by dividing the yield (kg/ha) by the average picking rate (kg/hour).

<i>Cultivar</i>	<i>Yield (t/ha)</i>	<i>Picking Rate (kg/hour)</i>	<i>Man Hours (per ha)</i>
Navels	40	170	235
Valencias	50	170	294
Lemons	55	85	647
Oroval / Marisol	45	80	563
Other Clementines	45	60	750
Satsumas	50	60-80	833

Table 5.2: Average Expected Yield (t/ha) and Picking Rate (kg/picker/hour)

The number of pickers per hectare is then determined by dividing the man hours needed for picking by the available picking hours, as in the table below.

<i>Cultivar</i>	<i>Picking Time</i>	<i>Effective Picking Days</i>	<i>Available Picking Hours</i>	<i>Man Hours per ha</i>	<i>Pickers Required per ha</i>
Miho Wase	Mar / April (3 weeks)	10	$7h \times 5d + 6h \times 5d = 65$	833	12.8
Marisol	April (2 weeks)	7	$6h \times 7d = 42$	563	13.4
Oroval	May (2 weeks)	7	$5h \times 7d = 35$	563	16.1
Other Clementines	May / June (5 weeks)	15	$5h \times 15d = 75$	750	10
Navels	May / June (6 weeks)	20	$5h \times 20d = 100$	235	7.4
Valencias	Aug / Sept (7 weeks)	25	$6h \times 25d = 150$	294	2
Lemons	April / June (8 weeks)	30	$5h \times 30d = 150$	647	2.6

Table 5.3: Required Number of Pickers per Hectare

The number of supervisors and quality monitors depends on the number of pickers required. The ideal number of pickers per picking team varies between 18 and 25. The ratio of pickers to supervisors will decrease with an increase of susceptibility of the fruit to injury.

Additional temporary workers are taken on for the harvest period. Permanent workers usually act as supervisors during the picking process. Temporary workers are sourced from the surrounding community. Workers must be trained in the harvesting process well in advance of the harvesting process. Training of supervisors should start at least three weeks, and pickers two weeks before harvest.

As part of the training process, all temporary and permanent workers must be made aware of the need for maintaining the quality and safety of the crop throughout the harvesting process, and of the regulations with regard to worker health and safety.

It is also useful to allow temporary workers, especially those that will be involved in the picking process for the first time, to familiarise themselves with the layout of the farm before the harvest starts. It is essential that all workers must be aware of the location of ablution facilities, and that enough facilities must be available to accommodate the additional workers.

Protective clothing must be issued to all workers. As a rule, workers are issued with overalls and gumboots and with gloves where necessary. The clothing should at all times be clean, neat and in good condition.

3.5. Equipment Requirements

The equipment that is required for the harvest is determined as follows:

<i>Item</i>	<i>Method</i>
Clippers	One each per picker
Picking bags	One each per picker
Ladders	Depending on the tree size between 2 and 6 per picking team
Trailers or bins	Based on the volume in weight of fruit that has to be transported per day and the number of picking teams that will be taking part in the harvest.
Tractors	At least one per picking team

Table 5.4: Harvest Equipment Requirements

The tools and equipment must be checked, cleaned and, where necessary, serviced before the harvest starts. Picking bags must be clean and whole and, where picking is monitored per bag, of the same internal size. Ladders must be well maintained and strong enough to withstand daily handling and the weight of individual pickers. Clippers must be in a condition to enable the picker to clip the fruit without injury to the fruit and without leaving a long stem on the fruit, which will cause injuries to adjacent fruit during handling and transport.

Picking trailers and bins must be checked carefully to ensure that the fruit will not be injured when placed inside. They must also be checked for loose parts and trailers must preferably be serviced beforehand.

4. Maintaining Food Safety and Crop Quality

During the harvesting process the quality and safety of the fruit must be maintained at all times. The most important principles in this regard are:

- Pickers must be aware of the hygiene requirements for the safe handling of fruit.
- Pickers must keep their nails short at all times to prevent injury to fruit.
- Pickers must wash their hands regularly, especially after using the toilet.
- The stems of fruit must be short so as not to cause injury to other fruit during transport.
- Pickers must not run with filled bags, as this can cause bruising to the fruit.
- Fruit must not be picked if they are wet or if the humidity is high.
- Fruit must not be left for too long before taken to the packhouse.

5. Health and Safety

Worker health and safety is prescribed and regulated by the Occupational Health and Safety Act. The Act prescribes what employers should do to create a safe working environment for workers and how

workers should adhere to the health and safety policies and procedures in the workplace. The requirements of the Act were described in detail at a previous level.

Workers must be made aware of the possible dangers to their health and safety during the harvesting process, and specifically:

- Ladders must be placed securely against the tree canopy to prevent injury.
- Ladders must be checked regularly to ensure that they are in a good condition.
- Clippers have sharp blades and can cause injury if handled carelessly.
- Trailers and tractors pose a specific risk because they have moving parts.
- Pickers must be aware of other production activities, especially activities such as spraying.

The employer must ensure that the workers have all the tools and equipment that they require to perform their tasks, and that the tools and equipment is in a good working condition. The employer must furthermore ensure that workers are well-trained for the tasks that they have been given, and that they are given clear instructions on what is expected from them. Developing and enforcing health and safety policies and procedures are also the responsibility of the employer.

6. **Harvest Management**

Harvesting is a labour intensive process that also has to be completed under considerable time pressure. It is also extremely important that it is done correctly and with as little damage to the fruit as possible. A whole year of effort and all the production inputs can go to waste if the fruit is not harvested correctly.

During the harvesting process, continuous attention to detail is required from management to ensure that the process goes according to plan. If a problem occurs it must be addressed immediately and contingency plans must be in place to react to emergency situations.

In the orchard, supervisors must pay attention to the following:

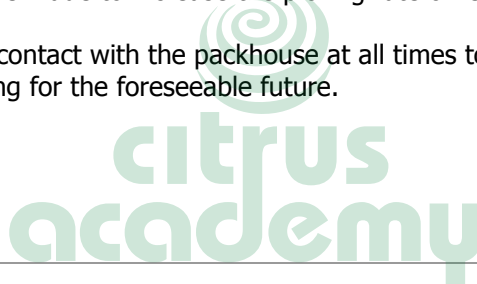
- Inspect the cleanliness and condition of ladders, clippers and picking bags daily. The picking process is intensive and demanding on employees as well as equipment. It is therefore important to establish on a continuous basis whether the equipment used is in good order and would not cause a drop in productivity or injury to workers.
- Inspect the fingernails of pickers, which must be short to prevent injuries to fruit.
- Ensure that enough drinking water is available.
- Monitor hygiene standards, including hand-washing after using the toilet. Ensure that there is a sufficient supply of soap, clean water, and single use towels, and encourage their use.
- Ensure that fruit are not picked when wet or when conditions are very humid to prevent pressure bruising (oleocellosis).
- Supervise general picking and handling of fruit from tree to bin. The picking quality must be monitored continuously in the bins or trailers and recorded, with immediate feedback to the pickers of both good and poor results.
- Inspect fruit as picking bags are emptied when picking on colour. The fruit colour in the bins must be compared to the required standard during picking to ensure that picking is done to the required standard.
- Ensure that the pickers do not run to empty the picking bags and that the 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 overfull before transport to the packhouse.

- Inspect all fallen or decayed fruit to establish the reasons why it is sub-standard. Intact fallen fruit may be a result of careless picking and should be managed to a minimum as it is a direct loss of income. The reason for decay must also be established to determine the cause and whether it can be avoided.
- Workers must never pick up fallen fruit from the orchard floor, even if the fruit is intact and was dropped by accident. Pathogens and other contaminants are found on the orchard floor, and if a fruit has been in contact with the floor, it is no longer safe.
- Sanitising all fallen and decayed fruit is an important factor to reduce the possibility of pathogens being carried by fresh produce. Decay can also be caused by insects such as fruit fly and false codling moth which can re-infest fruit in unpicked orchards. Such fruit should be either mulched at the side of the orchard or buried under at least a metre of soil.

Harvesting records are kept as part of the harvesting process. Records of the daily picking are kept that include details of the orchard and the volumes picked. Management is able to monitor the harvesting process by using the information on the harvest records, and must ensure that progress is according to plan. If there is a marked drop in productivity, the reasons for this must be determined without delay.

If time is lost during harvesting due to the weather – remember that citrus fruit cannot be picked while the fruit is wet – plans must be made to increase the picking rate or lengthen the picking period.

Management must remain in contact with the packhouse at all times to inform them of the progress that is being made and the planning for the foreseeable future.



Chapter 5

- The principles of harvesting are to budget, plan and forecast, not to harvest before the crop has reached required minimum standards, to adhere to instructions during harvest to maintain food safety and quality and to withholding periods for agrochemical applications, to maintain health and safety of workers during harvest, and to manage costs, equipment and staff to maximise profit.
- Harvest planning and preparation include deciding on the harvesting methods that will be used, crop estimates, maturity indexing and crop monitoring, personnel requirements and preparation, and equipment requirements and preparation.
- During the harvesting process, continuous attention to detail is required from management to ensure that the process goes according to plan.
- Harvesting records, including daily picking records are kept as part of the harvesting process.



Complete activity 10 in the **Learner Workbook**.

Chapter 6

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

Compare and interpret postharvest procedures within relevant enterprise

1. Introduction

Postharvest handling is the stage of crop production immediately following harvest and includes cooling, cleaning, sorting and packing. The moment that a crop is removed from the tree, it begins to deteriorate. Postharvest handling largely determines final quality of the product in the market. Initial postharvest storage conditions are critical to maintaining quality. Each crop has an optimum range of storage temperature and humidity.

In the level 2 material the postharvest procedures were discussed in depth. For the sake of revision, we will look at the main procedures and requirement shortly.

The main postharvest procedure for citrus is packing, which applies to export fruit and to fruit sold on local fresh fruit markets. There are a number of processes that the fruit undergo in the packhouse, and that are therefore considered to be part of the packing process. The fruit undergo the following processes in the packhouse:

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

The main requirements for postharvest processes are:

- Postharvest treatment chemicals
- Packing material
- Employees

2. Postharvest Practices

Before addressing postharvest measures, it is important to stress that numerous postharvest diseases and disorders, such as split and creased peel, result from pre-harvest practices and infections and have to be adequately dealt with to assist with successful postharvest handling and control measures.

The postharvest procedures which are considered are divided into the following focus areas:

- Transport and handling from orchard to packing line
- The packing line
- Chemical treatments and waxing

2.1. Transport and Handling

Fruit should be delivered to the packhouse with minimal delay after picking. Trailers and bins must be clean and in good condition so that the fruit will not be injured during transport. Fruit should be covered if transported over dirt roads.

The fruit that are taken for processing directly from the orchard are unwaxed and untreated, while the fruit from the second point has normally been dumped in or treated with chlorinated water after arrival at the packhouse. Fruit graded out in the packhouse are waxed and have been treated with postharvest chemicals.

Local market fruit can be marketed untreated directly from the orchard or taken along the same process as export fruit through the packhouse with all the relevant postharvest treatments. Untreated fruit are only sold loose or in 7kg pockets on the informal market and does not have a long shelf-life as it is more prone to decay.

Export fruit and the local market fruit packed in packhouses generally receive the following postharvest treatments:

- Drenching with chlorinated water on arrival from the orchard before storage or processing;
- Dumping in chlorinated water at the beginning of the pack line;
- Washing and de-scaling with jets of chlorinated water;
- Removal of excess water with hot air jets in drying tunnel;
- Fungicide application in either hot water baths or brushed on to prevent decay;
- Drying in tunnel;
- Waxing applied through spray or brushing technique to prevent moisture loss during transport to markets and to create a more attractive presentation at the point of sale;
- Final drying before entering the grading area.

The concentrations of chlorine and fungicides are carefully monitored to ensure that exactly the correct concentrations are used throughout the process.

4. Monitoring Postharvest Procedures

The only way to ensure that correct practices are being followed is a recordkeeping system which is enforced and monitored on an ongoing basis.

Tyre pressures must for instance be tested and recorded at least at the beginning of every day. The condition and cleanliness of trailers and bins must also be monitored throughout at both the packhouse and arrival at the orchard.

Recording all actions and procedures in the packhouse is imperative with regular inspection, observation and feedback to all concerned by supervisors and management.

5. Health and Hygiene Principles, Regulations and Legislation

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

The Occupational Health and Safety Act of 1993 regulates 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. The basic duties and responsibilities of the employer towards the employee and those of the employee in the work place are also applicable to all postharvest procedure.

Apart from the legal requirements, registration for GlobalGAP also requires a number of specific actions with regard to postharvest handling of produce:

- Although only categorised at a minor level for compliance, a hygiene risk analysis should be performed for the produce handling process. It should be well-documented and cover the complete process up to the point of despatch to the market.
- Training and instruction of workers with regard to the relevant aspects of produce handling hygiene must be recorded with signed acknowledgement by the workers of receiving the training and instructions.
- The implementation of the actions identified in the risk analysis should be visible, documented and monitored on a regular basis.
- Water used for washing the final product should be potable and declared safe for use by the competent authorities.
- Re-circulated water should be filtered and pH, concentration and exposure levels to disinfectants regularly monitored.
- Water analysis should be carried out by an accredited laboratory.
- All postharvest treatments must be applied as prescribed by trained employees and be thoroughly documented.
- All products used to treat the fruit must be officially registered, permitted by the appropriate governmental organisation, and allowed under the regulations of the country of destination.

Audits of all the processes identified under the quality management system should be carried out on a regular basis and preferably by staff who are independent of the operation or process being audited, or an external agency. The results of the audits and corrective actions taken should be recorded and subject to ongoing management assessment or review of the effectiveness of the system.

The legislation on health and hygiene, as well as requirements for registration for GlobalGAP and other systems, clearly states the conditions for employees and non-employees in a working environment. A well-documented risk analysis covering the complete process from production to despatch should form the basis of determining actions and facilities to ensure a healthy work environment.

All actions and activities emanating from that should become part of a permanent management culture of training, monitoring and assessing in the organisation. If that is not the case and a lot of actions were for instance identified for GlobalGAP registration, but not followed up thereafter, old habits and practices will quickly again become the norm.

Examples of good practices and the effects of non-compliance are:

- Training and instruction must be documented. If this is not documented nobody will know who has received training or what instructions have been given.
- Employees must acknowledge training and their understanding of their instructions in writing. It is important to be sure that they comprehend the detail of the job they are required to do.
- Work stations and the environment must be assessed to determine their effect on sight, hearing and fatigue. The quality of work and employee's health can suffer if these aspects are not addressed.
- Regular audits must be conducted by independent staff or an external body of all processes. Regular staff members sometimes do not see mistakes or deviations from procedures.
- Audit results and corrective measures must be recorded. It is important in the process of ensuring that actions were actually taken and determining recurring problems.



Chapter 6

- The postharvest procedures which are considered are divided into transport and handling from orchard to packing line, the packing line, and chemical treatments and waxing.
- The main markets for citrus fruit are export markets, local fresh fruit markets and processing.
- The only way to ensure that correct practices are being followed is a recordkeeping system which is enforced and monitored on an ongoing basis.
- Apart from the legal requirements, registration for GlobalGAP also requires a number of specific actions with regard to postharvest handling of produce, being a hygiene risk analysis, staff training, documentation of implementing actions, water quality monitoring, filtering and monitoring of re-circulated water, water analysis, monitoring of all postharvest treatments, verification of all products used to treat the fruit.



Complete activity 11 in the **Learner Workbook**.


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the environment must be constructed in such a way to ensure that they are effective and don't cause more damage to the environment.

3.1. **Bunds**

Bunds are constructed to regulate and direct the flow of water. Smaller bunds are constructed across farm roads to direct the flow of runoff water and lessen erosion. For the purpose of this instruction we will look at how smaller bunds across roads are built.

Firstly the area must be selected where a road with a slight gradient shows marks of where erosion has damaged the road. A bund is constructed diagonally across the road with the angle of the bund not being more than 15 degrees. The angle of the bund must follow the natural slope of the road, so that it will channel the water off the road. The bund must be at least 150mm high at its highest point, but make sure that the bund is shaped in such a way and is of such a height that it will not cause damage to vehicles passing over it at normal speeds.

After the positioning, size and shape of the bund have been determined it can be constructed. The bund can be formed by either bringing soil from another site or by digging a shallow trench along the line of the bund. The trench should be made on the side of the bund where the water will flow down.

Normally a bund will be about 400mm wide and 200mm high. Mark the lines along on the road along which the bund will be built and shape the bund using the soil, starting from the middle and working towards the outer edges, and compacting the soil regularly. When the desired height has been achieved, shape the bund in a half moon shape and again compact the soil. Bunds can also be constructed using concrete or tar, which will make them stronger and less likely to be damaged. After the first rain, all newly constructed bunds must be checked and repaired where necessary.

3.2. **Gabions**

To construct a gabion, decide first on where and for what purpose the gabion will be used. Smaller, lighter gabions can be handled and transported more easily. Bigger gabions are more effective at controlling water flow, but more difficult to handle and move. Also remember that the bigger the gabion, the thicker the wire mesh must be to handle the extra weight of the stones.

To construct a gabion: form a cube using the wire mesh and the pliers. Leave the top of the wire mesh cage open and fill it with stones big enough not to fall through the holes in the wire mesh. Close the top section, making sure that the wire is secured.

3.3. **Wetland Contours**

Wetland contours should be constructed by professional earth moving companies after an official survey has been performed by environmental agencies.



Chapter 7

- The equipment and tools used for the construction of basic infrastructure are governed by the design and purpose of the structures.
- Bunds are constructed to regulate and direct the flow of water, such as across roads.
- Gabions are cages, normally constructed using wire mesh, filled with stone.
- Wetland contours are used to protect wetland and are constructed by professional companies.



Complete activity 12 in the **Learner Workbook**.



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