FACILITATOR GUIDE

Production Management

Level 4

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Title:		**Execute Sustainable Resource Use and Quality Control**					
Applied Title:		**Execute Sustainable Resource Use and Quality Control**					
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Sub-Field:		Primary Agriculture					
SETA (SGB):		AgriSETA					
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Table of Contents

Directions **5**
1. Learning Material 5
2. Learning Program Timeframe 5
3. Technical Program Specifications 6
4. Facilitator's Checklist 7
5. Proposed Floor Plan 8

Introduction **9**
1. Purpose 9
2. Learning Assumed to Be in Place 9

Revision of Level 3 ..... **10**
1. Different Levels of Planning 10
2. Scheduling 10
3. Production Optimisation Techniques 11
4. Assessing Planning and Scheduling 11

Chapter 1 ..... **13**
1. Introduction 13
2. Resource Planning 13
   - 2.1. Climatic Features 14
   - 2.2. Land 15
   - 2.3. Soil 15
   - 2.4. Water 15
   - 2.5. Nursery Trees 15
   - 2.6. Capital 16
   - 2.7. Labour 16
   - 2.8. Agrochemicals 16
   - 2.9. Machinery and Equipment 16
3. Sustainable Resources Use 17
4. The Production Plan 18
5. Legal Requirements 20

Chapter 2 ..... **23**
1. Economies of Scale 23
2. Factors Determining the Size of the Enterprise 24
3. Evaluation of Factors Determining Enterprise Size 24
   - 3.1. The Trade Off between Production Efficiency and Market Demand 25
   - 3.2. The Trade Off between Cultivar Suitability and Costs 25

Chapter 3 ..... **27**
1. The Meaning of Quality 27
2. Quality Standards 28
3. Quality Management 29
   - 3.1. Quality Assurance 29
   - 3.2. Quality Control 29
4. Quality Management Systems 30

Chapter 4 ..... **32**
1. Introduction 32
2. The Citrus Production Process 32
3. Integrating Production Processes and Quality Assurance 35
   - 3.1. Hazard Analysis 36

3.2. Identification of Critical Control Points 36
3.3. Establishing Critical Limits 36
3.4. Monitoring Critical Control Points 37
3.5. Establishment of Procedures for Corrective Action 37
3.6. Recordkeeping 37
3.7. Verification 37
4. Integrating Production Processes and Quality Control 37
5. Cost-Benefit Analysis for Quality Improvement Processes 40

Bibliography 42

Directions

1. Learning Material

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

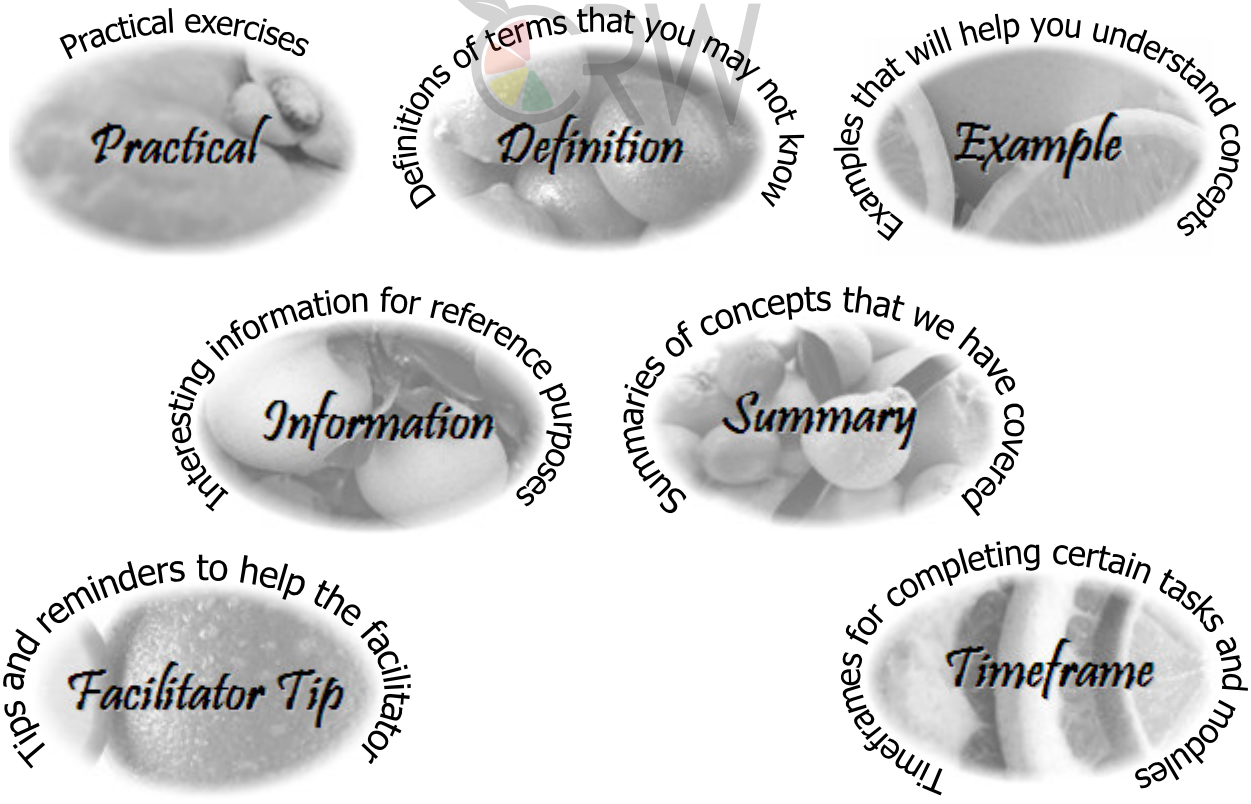
This set of learning material consists of the following guides:

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

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

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

Information in boxes is indicated by tags that show:



2. Learning Program Timeframe

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

Process	*Total Allocated Time*	*Theoretical Learning*	*Practical Learning*	*Activities*
Complete Program (Including summative assessment)	**30h**	**14h**	**16h**	**8**
Learner Orientation and Ice Breaker	30min	15min	15min	n/a
Purpose, Introduction and Learner Directions	30min	15min	15min	n/a
Revision of Level 3	45min	30min	15min	n/a
Session 1 (Chapter 1)	5h 45min	3h	2h 45min activities	1-3
Session 2 (Chapter 2)	5h	3h	2h activities	4
Session 3 (Chapter 3)	6h	3h	3h activities	5
Session 4 (Chapter 4)	6h 30min	3h	3h 30min activities 4h work in production management	6-8
Experiential Learning and Research towards Completion of Summative Assessment	4h		4h	n/a
Preparation for Assessment and Revision	1h	1h		n/a

3. Technical Program Specifications

Format	Programmed instruction workshop, combined with structured internship format as prescribed for learnership, skills program or short course.
Target Learner Description	A typical level 4 learner should have been exposed to the working world for a reasonable period and should have a reasonable level of experience in the subject matter. **EE Ratios:** 1 Male:1 Female 8 PDI:2 W 1 Employed:1 Unemployed
Articulation Options	Nil formal in place

Delivery Mode	A combination of small group mode and individual mode
Training Method and Activities	**Program Instruction:** This program forms part of an apprenticeship where coaches provide practical training in the fields requiring functional competency. The theoretical study section of the training is conducted as a 4-day workshop in the Cohort group format. Additional training activities include buzz groups, rotating role plays, simulations, games and brainstorming sessions, and group discussions.
Learner Support Strategies	Learners are inducted by "explore strategies to learn program". Learners are supplied with all resources and aids as required by the program, including: • Objects and devices such as equipment • Manuals and guides • Visual aids

This unit standard is aimed at level 4 learners.

Typical level 4 learners:

- Have a broad knowledge base of the theoretical concepts related to the skills area.
- Have wide ranging scholastic and technical skills related to the industry and skills area targeted in this learning program.
- Are able to access, analyse, and evaluate information independently.
- Are able to operate in a range of contexts under broad guidance and evaluation.
- Are able to select from a considerable range of procedures in order to give quantity and quality output in terms of evidence required.
- Are able to give presentations to others.
- Take complete responsibility for the quality and quantity of their outputs and may possibly also be responsible for the output of others, meaning they are in a supervisory position, a member of junior management, or technical experts in their field.

The examples given in this resource guide might be for a different geographical area or commodity to what the learner is exposed to. Please adapt your examples according to the learning context.

4. Facilitator's Checklist

This checklist has been designed to assist you in delivering the best possible facilitation to the learners.

Please use it and supply whatever resources you might have in short supply at your venue of learning.

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

5. Proposed Floor Plan

No floor plan is prescribed for this training module.

Introduction

1. Purpose

The learner achieving this unit standard will be able to understand efficient resource allocation, determining the size of the business and carry out efficient quality control methods. In addition they will be well positioned to extend their learning and practice into other areas of agriculture and business management, benefiting the agricultural industry in the provision of competent trained management.

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

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.

2. Learning Assumed to Be in Place

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

NQF Level	*Unit Standard Number*	*Unit Standard Description*
NQF3	Literacy and Numeracy	
3	116218	Explain the planning and scheduling of tasks in a production environment
3	116240	Explain store inputs categories, labelling and storage methods
3	116237	Explain costing and the viability of an agri-business

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

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

Revision of Level 3

You have to complete this section as follows:

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

Use this opportunity to revise concepts that were covered at level 3 and on which this module builds. This is the ideal opportunity to determine learners' level of knowledge and experience, to identify learners who do not have the required background knowledge, and to determine where you will have to spend additional facilitation time.

1. Different Levels of Planning

- The level of planning is determined by the level of goal-setting.
- Reaching strategic goals requires strategic planning, reaching production goals requires a production plan, and reaching pest and disease control goals requires a pest and disease control plan.
- Product selection depends mostly on environmental factors (climate, soil, water availability, etc.) and on market opportunities.
- Planning has to be flexible, allowing changing circumstances to guide their relevance and validity.
- A budget is a financial expression of a plan.
- Income is money generated from the sale of a product.
- Expenditure is the cost associated with generating income.
- Costing means determining the actual cost of producing a specific product or delivering a specific service.

2. Scheduling

- Scheduling is about putting plans to a timeframe.
- Scheduling indicates who will perform the work, where will the work be performed, what resources are required, how progress will be measured against the scheduled work, and how progress will be reported on.
- Scheduling techniques are tools used to facilitate the scheduling process.

- The most commonly used scheduling techniques are flow, milestone, CPM, PERT and Gantt charts.
- Schedules can be created forwards, meaning from a certain date onwards with an estimated completion date, or backwards, meaning from a predetermined completion date back to the date on which the task will begin.
- Schedules must be displayed prominently and communicated well.

3. Production Optimisation Techniques

- Production optimisation techniques are about making accurate, early predictions relating to the crop, and manipulating the tree and its environment to produce the best possible quality and quantity crop.
- Decisions on production interventions are made on the basis of accurate information, which is obtained from records.
- Records must be kept of inputs made and their costs.
- Output records that must be kept include yield and fruit size distribution, percentage to each market segment, cull factor analysis, maturity indexing data, and actual versus budgeted income.
- Statistical analysis is used to evaluate the validity or significance of the results from data collected, and to determine the extent to which two variables are proportional or linearly related to each other.
- The steps required to manage a citrus production unit are:
  1. Decide the objective or goal
  2. Set the required standards
  3. Decide on the implementation plan
  4. Schedule the activities
  5. Allocate responsibilities and resources, or inputs
  6. Measure progress and results
  7. Evaluate by comparing the results with the goals and targets set
  8. Adapt the goals and/or targets
  9. Adapt the inputs, and go back to step 5

4. Assessing Planning and Scheduling

- Production activities are varied, often overlap, and should follow a logical sequence.
- Goal-setting is followed by planning, which is followed by scheduling, which is followed by implementation, of which records are kept, which are used to evaluate the implementation of the plan and the achievement of the goals, which allows for optimisation.

Production Practices

Production practices are the actions and processes carried out to achieve production objectives, such as fertilisation, irrigation, pest and disease control, pruning, harvesting, etc.

Production Systems

Production systems are concerned with the production practices required to **convert resources** into a desired **product**, which in this case is a marketable citrus crop.

Production Management Production management is the management of production systems and production practices.
Production Objectives Production objectives are measured in terms of yield (quantity), export percentage, fruit size, and external and internal quality.
Export Pack-out Percentage Export pack-out percentage means the percentage of total fruit produced that can be exported. If a total of 1,000 tons are produced and 600 tons (40,000 15kg cartons) are exported, then a 60% export pack-out percentage is achieved.
Planning Planning means to formulate a scheme, program or method to accomplish a specific goal, within a specific timeframe, and with a specific purpose in mind.
Scheduling Scheduling is a management term that involves entering or drawing up a timetable for the completion of various stages of a complex project, or the co-ordination of multiple related actions or tasks into a single time sequence. Scheduling is most commonly used with regard to repetitive tasks, such as the application or irrigation water.
Organising Organising means to arrange tasks into an orderly functional, structured, coherent and systematic manner to bring about harmonious or united action.
Implementation Implementation is the act of carrying out the agreed plan according to an agreed schedule to achieve been agreed should be done.
Budgeting Budgeting is the process that provides a detailed breakdown of what is planned to be spent and earned for each item of income and expenditure by month for the financial year.
Income Income is money generated from the sale of the product and may include other minor sources, such as interest received.
Expenditure Expenditure is the cost associated with generating the income and supporting the business over the longer term.
Costing Costing is a process for determining the actual cost of producing a particular product or providing a particular service.

Chapter 1

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

Determine availability of resources and maintain sustainable resource use

You have to complete this section as follows:

Total time	*Theory*	*Practical*
5h 45min	3h	2h 45min activities

1. Introduction

In previous unit standards, we defined **planning**, identified some of the different levels of planning, and considered the factors influencing planning. We also defined **resources** and made the distinction between fixed, or natural, resources and mobile resources.

We have also seen that resources and inputs are similar, though resources are generally viewed as start-up requirements, while inputs usually refer to ongoing operational requirements.

In this section we bring together these concepts to assess the status and availability of resources for a citrus production operation as the first step towards using resources in a responsible and sustainable manner.

2. Resource Planning

Lead a class discussion around the following questions:

- What market opportunities exist for citrus?
- How will market opportunities affect citrus production?
- What are all the resources that a citrus producer requires?
- Which of the resources can be manipulated to grow citrus suited to market requirements?

It is recommended that a bill of quantities is drawn up to hypothesise how much of what a citrus grower will need. This will make the idea of resource planning more interactive and allow learners to think through the viability of a citrus enterprise.

Assume that the decision has been made to produce citrus for the first time, or to expand existing plantings or production. The first question should be: **Is there a market opportunity for the range**

of citrus cultivars that I can produce here? Let us assume that the results of the market study are positive.

The second question is: **Do I have the necessary resources to produce what the market wants?** Finding the answer to this question is the essence of resource planning, along with determining how the available resources can be used to ensure that quality production is sustained for as long as possible without depleting resources.

To determine whether the required resources are available, an inventory needs to be made of the quantity and quality of the resources and inputs that are available, compared to what is required for the production of specific cultivars. One can then determine whether it makes financial and practical sense to undertake the enterprise.

An inventory of this kind would include the following:

- Climatic Features
- Land
- Soil
- Water
- Plant material
- Capital
- Labour
- Agrochemicals
- Machinery and equipment

2.1. Climatic Features

Climate is viewed as a resource in the sense that temperature, humidity and sunshine are vital contributors to the productivity of the trees and the marketability of the product. They are factors characteristic of a region or area that determine the suitability of that location for the purpose of high quality citrus production.

If grown in an unsuitable or marginal climate, citrus trees require more manipulation to deliver a desirable yield and fruit quality. The greater the need to manipulate or intervene, the more the long-term sustainability of production in that location is threatened, the greater the impact on the environment, and the higher the production costs.

The questions that need to be answered are the following:

- What are the long-term average monthly maximum and minimum temperatures of the area?
- When converted into heat units, how do these compare with other areas known to be suitable for the selected range of cultivars?
- What are the dominant prevailing wind directions and strengths? Are windbreaks necessary and, if so, can they be accommodated?
- Will the climatic conditions, such as high temperatures and humidity, increase pest and disease pressure?
- Or conversely, what is the range of cultivars that could be produced given the climatic profile of the area?

In South Africa, commercial citrus production is confined to areas with mild and almost frost-free winters and where temperatures seldom drop below -2°C.

Factors limiting citrus production in some areas are:

- High spring and summer temperatures

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

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

2.2. Land

Apart from the availability and cost of land, the following questions need to be answered regarding the qualities of the land:

- Is it sufficient in size and topography to support the required planting?
- Can the majority of tree rows be planted in the ideal north-south orientation?
- Does the orientation of the land create microclimates to favour the production of certain cultivars or cultivar selections?
- Is the land located near to suitable infrastructure, especially transport?

2.3. Soil

Generally speaking, citrus requires well-drained, deep, sandy loam soils with clay content of below 30% and a neutral pH. The chemical and physical properties of the soil should be analysed before a decision is taken to establish citrus.

By deep ripping and ridging, some marginal soils can be made more suitable. Although these actions will increase costs, they can also be of use in crop manipulation, such as for heating soil in cold climates.

2.4. Water

The peak water requirement of the envisaged planting must be calculated and compared with the available water resource. As a rule of thumb, provision should be made for between 50 litres per adult tree per day for high density plantings (>1000 trees / hectare) and 100 litres per adult tree per day for widely spaced trees (<600 trees / hectare). Allowances should be made for evaporation if holding dams are to be used.

The water source should also be analysed to determine its chemical quality and the presence of any harmful fungal diseases.

2.5. Nursery Trees

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

The physical requirements for certified citrus nursery trees are as follows:

- All trees must be healthy in all respects and must not have any serious damage.
- The trees must be free of pests.
- The stems of all trees must be straight.
- The bud union must be at least 200 mm above soil level.

- The trees must have a healthy, well-developed root system that is free of harmful pathogens and nematodes.

- Trees must comply with the basic tree size standards as specified in the CIP Scheme.

2.6. Capital

The cost of capital can be viewed as the annual interest payment on the sum required. A business plan is required, which sets out the marketing plan, the production objectives and the capital required to fund the establishment and operation of the farming unit. Here, the cash flow projection is critical and should be based on conservative prices and constantly rising costs.

Capital can be borrowed from a number of financial institutions. The interest rates and repayment terms that are negotiated with the financial institution have a great impact of the viability and sustainability of the farming enterprise.

2.7. Labour

There must be a source of permanent and temporary labour available in the area. Experienced and skilled permanent workers bring a competitive advantage to a farming enterprise. Many farmers also continue to develop the skills of their permanent workforce through ongoing capacity building programs.

The industry average for fieldworkers is said to be one worker for every five hectares. In addition, lower, middle and upper management personnel are also employed, with the management structure and number of positions depending on the size of the farming enterprise, and the farming practices.

Harvesting and packing are highly labour intensive activities, during which temporary workers are employed. The number of temporary workers required depends on the total crop yield and the time available for picking and packing.

2.8. Agrochemicals

Agrochemicals includes ameliorates for soil preparation, fertilisers and crop protection chemicals, herbicides, and postharvest chemicals. The types and quantities of agrochemicals that are required depend on the size of the production operation and the farming practices that are employed.

Agrochemicals are purchased from reputable firms or from farmer cooperatives. Thought must be given to the availability of agrochemical sources in the area where the farm is to be established. If the farm is not in or close to an established farming community, the cost of transporting inputs may increase production costs considerably. The farm may also need to keep considerable stock on the farm because of inaccessibility, resulting in higher capital requirements.

2.9. Machinery and Equipment

Machinery and equipment that are used on citrus farms include:

- Tractors
- Spray machines, also referred to as mist-blowers
- Herbicide carts
- Flatbed and picking trailers
- Grass slashers
- Water carts
- Harvesting equipment, including ladders, clippers and picking bags
- Planting equipment, including measuring equipment and spades
- Soil preparation equipment, including rippers

- Maintenance tools and equipment

The types and quantities of equipment that are required depend on the size of the farming operation and the farming practices that are employed.

Machinery, equipment and tools are purchased from reputable suppliers or from a farmer cooperative. It is important to purchase machinery and equipment, especially large and expensive machinery such as tractors and spray machines, from dependable dealers in the area where the farm is located, because after-sale service plays an important role in how effectively the machinery can be used.

3. Sustainable Resources Use

It is a good idea to revise the concept of sustainability and to refer to land-use sustainability and sustainable production management practices. Work through the examples of suboptimal resource use in this section and allow learners to come up with more examples of their own.

The sustainable use of resources means the use of the resources in such a way as not to damage, harm or deplete them, while using them to maintain production of the required yield and quality. The important principle underpinning this is minimum intervention.

If citrus is established in an unsuitable environment or with soils, water or nursery trees of inferior quality, there will be an ongoing need for interventions of various kinds. Such interventions are not only costly, and therefore threatening to the profitability of the enterprise, but may require the repeated use of chemical treatments that can start a spiralling cycle of damage to the environment.

Suboptimal Resources

- If the climatic conditions in the area do not favour the production of good yields of high quality fruit of the chosen cultivars, the production manager will face an ongoing battle to attain the required standards by crop manipulation. Such manipulation may take the form of physical treatments such as trunk girdling or pruning, or chemical treatments such as hormone or supplementary nutritional sprays.
- If the pH of the soil is too high or too low, corrective action, in the form of applications of certain chemical formulations, has to be taken on a regular basis.
- If the nursery trees are of inferior horticultural quality, the production of high yields may require ongoing physical and chemical manipulation, or may not even be achievable whatever interventions are made.
- If the trees become infected with fungal, bacterial or viral diseases, there may be a requirement for regular chemical or physical disease control actions. Such diseases may have their origin in the nursery trees, be endemic to the production area, or be induced by poor management practices.

Water is one of the scarcest resources and the use of water must be managed and controlled very carefully to ensure its sustainability. In order to preserve the supply of water the irrigation system

should be effective and efficient. In water scarce countries, such as Israel, important pioneering work was done in the design of micro-sprinkler and drip irrigation systems to optimise water use efficiency. Such systems form the basis of sustainable water usage in citrus.

Water quality must also be maintained to ensure that the available water remains useful. Every farmer has the responsibility to ensure that the water that leaves the farm is of the same quality as the water that is received on the farm. Regular sampling and analysis is required to ensure that the water quality remains acceptable.

Agrochemicals pose a direct threat to the environment. If certain broad-spectrum pest control treatments are used, they may damage the populations of beneficial insects. Pesticides must be chosen carefully on the basis of their specific impact on the targeted pest and their minimal disruption to beneficial insect populations.

4. The Production Plan

Where possible, discuss the concept of production planning around actual production plans. Work through the example below in as much detail as possible and constantly refer to its place in production planning.

The production plan ranks alongside the marketing plan and financial plan as major contributors to the overall strategic plan of the enterprise. These plans form the basis of the business plan that demonstrates how the different facets of the enterprise are linked in achieving targeted revenue and profits, and sustainable cash flow.

The production plan comprises a number of component sub-plans, each with their own objectives and timeframes. These include, for example, individual orchard yield plans or projections, pest and disease control plans, the fertiliser and irrigation application plan and so on. In this section we focus on the production plan itself, which represents the combined outcome of all the sub-plans.

At the heart of the production plan for citrus is the production or yield model. This takes into account cultivar, rootstock, tree spacing, climate, soils, irrigation, and pest and disease factors. The yield model in fact takes into account the role of all resources and inputs, together with observations that are made in the orchard, to project the year-on-year yield for the lifespan of the specific planting. The sum of the yield models for each cultivar gives the production model for the entire farm or enterprise.

Yield Model

An entrepreneur decides to establish citrus for fresh fruit export on a 100ha farm located in the Mpumalanga Lowveld. Having conducted an evaluation of the market potential for cultivars known to be suited to the region, he takes stock of his resources. He evaluates the location of the farm and its topography in terms of its suitability for citrus. He conducts a soil survey and determines the availability of water. He investigates the availability of labour and identifies a source of certified nursery trees. He conducts a risk analysis of the pests and diseases in the region. He determines his labour requirements and ensures that there is enough skilled labour available in the area. He determines his agrochemical and machinery and equipment requirements and identifies reputable suppliers in the area.

He then uses all this information, add factors such as rootstock, planting distances, etc., and determines a production or yield model for each citrus variety he intends planting. For the sake of simplicity, let us say he decided to plant only two varieties, grapefruit and valencia oranges, of which he intends planting 50ha each. The production or yield model for these inputs could look something like the table below for the first sixteen years of the respective plantings' life spans, with the total yield calculated by multiplying the yield per hectare with the number of hectares.

Years After Planting	***Yield / Hectare*** (Metric Tonnes)		***Total Yield*** (Metric Tonnes)		
	Grapefruit	**Oranges**	**Grapefruit** (50ha)	**Oranges** (50ha)	**Total**
1	0	0	0	0	**0**
2	12	0	600	0	**600**
3	29	5	1,450	250	**1,700**
4	45	17	2,250	850	**3,100**
5	52	24	2,600	1,200	**3,800**
6	57	33	2,850	1,650	**4,500**
7	63	40	3,150	2,000	**5,150**
8	67	46	3,350	2,300	**5,650**
9	67	51	3,350	2,550	**5,900**
10	67	54	3,350	2,700	**6,050**
11	67	58	3,350	2,900	**6,250**
12	67	59	3,350	2,950	**6,300**
13	60	60	3,000	3,000	**6,000**
14	55	60	2,750	3,000	**5,750**
15	53	60	2,650	3,000	**5,650**
16	47	60	2,350	3,000	**5,350**

A figure for the estimated percentage of exportable fruit can be factored into the yield model to calculate the amount of fruit available for export each year. Fruit size ranges could similarly be introduced into the model. A price projection can now be done based on historical data. With projected export percentages for class 1 and class 2 fruit, and projected size ranges, prices per size range and per class can be projected and the total projected income can be calculated.

This information would then be used as the basis for determining the extent to which estimated production will meet projected demand. This could in turn be used for planning packhouse capacity and as the basis for compiling financial and business plans for the enterprise.

The production practices that are required to achieve the projected production can now be formulated. It may for instance be found that in order to produce fruit in the size range that is most profitable in the market that is targeted by the producer, specific irrigation and fertilisation practices are required. Once the production practices have been determined, the labour requirements to implement the planned practices can be calculated.

The production plan for the enterprise is now in place and can be implemented, managed and monitored.

The production plan can now also be used as a basis for developing a business plan for the enterprise. The cost of the planned production practices and projected labour requirements can be calculated and the capital requirements, profitability and cash flow of the enterprise can be calculated.

5. Legal Requirements

It is recommended that the learners pre-read this section and that different groups prepare a short presentation each on a different Act and its purpose in citrus production. Ensure that learners have access to the Acts to study them in detail.

The employment of resources to support the production plan has to be compliant with legislative requirements. These legal requirements that are promulgated as acts of parliament effectively place boundaries on the various production and marketing activities and how they are conducted.

The citrus production manager should be aware of the key requirements of these and other relevant pieces of legislation when planning his citrus production enterprise. Compliance with the requirements may involve costs that have to be factored into the plan.

The following are examples of some of the activities and the related Acts:

- **Conservation of the environment** – *Conservation of Agricultural Resources Act of 1983 and National Environmental Management Act of 1998, Plant Improvement Act.*
- **The minimum citrus fruit quality standards for local and export products** – *Agricultural Products Standards Act of 1990*
- **Health and safety and good agricultural practices** – *Health Act of 1977, Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act of 1947, Agricultural Pests Act 1983, Occupational Health and Safety Act*
- **Marketing of citrus** – *Marketing of Agricultural Products Act (Amended) of 2001, Agricultural Produce Agents Act*
- **Citrus research** – *Agricultural Research Amendment Act of 2001, National Advisory Council on Innovation Act of 1997*
- **Citrus technical advisory activities** – *Natural Scientific Professions Act 0f 1993*
- **Equity and fair labour practices** – *Employment Equity Act of 1998, Basic Conditions of Employment Act, The Land Reform Act (Labour Tenants) of 1996*

Summary

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

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

Chapter 1

- Resources and inputs are similar, but resources are generally perceived as being start-up requirements, while inputs refer to ongoing production requirements.
- Resource planning is about determining whether the resources to produce what the market wants are available, and how these resources can be used to sustain quality production.
- An inventory of the available resources includes assessments of climatic features, land, soil, water, plant material, capital, labour, agrochemicals, and machinery and equipment.
- Climate is viewed as a resource because temperature, humidity and sunshine play an important role in the productivity of the trees and the marketability of the product.
- Apart from land cost and availability, its topography, size, orientation and location are important.
- Generally speaking, citrus requires well-drained, deep, sandy loam soils with a clay content of below 30% and a neutral pH.
- The peak water requirement must be calculated to assess the availability of water, and the water should be analysed to determine the quality of the available water.
- Nursery trees must be purchased from a reputable nursery and be certifiable in terms of the requirements of the Citrus Improvement Programme.
- The availability of capital and the cost of capital must be assessed and incorporated into a business plan and cash flow projection.
- A source of skilled and experienced permanent and temporary workers in the area where the farm is located is essential.
- Agrochemicals include fertilisers, crop protection chemicals, herbicides and postharvest chemicals. Their availability must be assessed in terms of the location of the farm.
- The type and quantities of equipment required depend on the size of the farming operation and the farming practices that are employed.
- Sustainable resource use means the use of the resources in such a way as not to damage, harm or deplete them, while using them to maintain production of the required yield and quality.
- The production plan ranks alongside the marketing plan and financial plan as major contributors to the overall strategic plan of the enterprise.
- A yield model forms the basis for the production plan.
- The employment of resources to support the production plan has to be compliant with legislative requirements.

Complete activities 1, 2 and 3 in the **Learner Workbook**.

Activity 1 – Worksheet

Remind learners to complete this worksheet individually and with reference to the farm on which they work. Remind learners to utilise subject matter Experts on the farms to determine the approach and quantities.

Timeframe: 1h

Activity 2 – Report Writing

Remind learners to complete this report in their own words and according to their own understanding, to pay special attention to inclusion of breakeven input quantities compared to actual input quantities per hectare for citrus production for the farm where they are performing their practical duties. Encourage learners to subject matter experts on the farms to assist them in this report.

Timeframe: 1h

Activity 3 – Research

Much of the research for this activity will have been done through the group presentations in the previous section and learners can summarise their conclusions to complete this activity.

Timeframe: 45min

Chapter 2

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

Determine the scope of the enterprise / production unit

You have to complete this section as follows:

Total time	*Theory*	*Practical*
5h	3h	2h activities

1. Economies of Scale

Economy of Scale

Economy of Scale simply means that, theoretically, as one produces more, the cost per unit produced decreases.

In citrus production, economies of scale means that as a citrus enterprise grows and the number of tons of fruit produced increases, the cost of producing each successive ton of fruit should decrease. The same would apply to a packhouse operation or any activity involving inputs and outputs.

Economies of scale are achieved through:

- Buying inputs, such as fertiliser, pesticides or nursery trees, in bulk and therefore at a lower per unit price
- Spreading the cost of expensive inputs, such as specialised staff and technical specialists, over a larger number of tons produced
- The application of better and more efficient organisational skills and structures

Just like there are economies of scale (ES), there are also diseconomies of scale (DS) (*Investopedia*). This occurs when management inefficiencies result in rising average costs and production is not able to keep pace with the proportional increase in inputs. Inefficient management of labour can, for example, lead to the employment of additional staff whose output is not necessarily higher than it was with a smaller staff number.

There are also external economies of scale. These occur outside of the enterprise itself within the industry, for example using collective bargaining for lower freight costs of fruit out of a region or country. There is a strong case for growers to work together in making more efficient use of packing, transport, and other logistical services. This principle is the basis of citrus cooperatives or companies

comprising a number of growers producing citrus in close proximity to one another, and sharing infrastructure and facilities.

2. Factors Determining the Size of the Enterprise

Where possible, assign actual examples of different citrus enterprises to different groups to analyse in terms of the size of the enterprise, why the enterprise is the size it is and what would happen if the enterprise changed in size. Allow each group to present their findings and learners can comment on the conclusions of each group.

The size of a citrus production enterprise depends on:

- The availability of fixed and mobile resources, including suitable land in the right climatic area, sufficient good quality soil and water, capital, and skilled and unskilled labour.
- The targeted return on capital, and therefore the possibilities for optimising return on investment through economies of scale.
- The availability and condition of existing facilities, equipment, machinery and infrastructure, such as pump-houses, suitable roads, dams, offices, packhouses, spray machinery, tractors, trailers, and vehicle maintenance units.
- The market demand for the range of cultivars that can be produced on the available land. If there is, for example, high demand for a cultivar which is suited to the area, but the market window is very short, care will have to be taken to ensure that the cultivar is not over-produced, thus stretching the capacity of the resources over a short period of time.

3. Evaluation of Factors Determining Enterprise Size

Divide the class into four groups to prepare for a debate.

- Group 1: For Production Efficiency
  versus
- Group 2: For Market Demand

- Group 3: For Cultivar Suitability
  versus
- Group 4: For Costs

Remind learners of the format of a debate and point them toward information sources to assist them in preparing for the debate. At the end of the two debates, draw conclusions and remind learners to make notes.

Of the factors listed above, a few taken in combination are critical in determining the size of a citrus production enterprise.

3.1. The Trade Off between Production Efficiency and Market Demand

The ideal situation is to be able to produce large volumes of all the cultivars the market most wants. This is however seldom possible, because at a single locality the climatic conditions suited to one favoured cultivar may be unsuited to others.

For example, it may be possible to produce high quality, early-maturing Star Ruby grapefruit in an area with a hot climate, which may be a winner on the market. It is however not possible under these same climatic conditions to produce one of the other market favourites, such as high-quality late-maturing seedless mandarins.

The grower in the hot area should therefore focus on producing grapefruit. He can do this effectively and efficiently, getting high yields of excellent quality fruit. The grapefruit harvest season however only lasts eight weeks. The principle of economies of scale says that he should plant other later maturing cultivars to spread his risk and his costs. But these cultivars may not be ideally suited to the region and so his overall or average production efficiency will not be optimal.

Sometimes growers are faced with the paradox of being in a region where they are able to successfully produce those cultivars that only have a fair market demand, while struggling to produce those cultivars that are in high demand on the market.

Clearly a balance has to be struck and very careful planning has to be put into deciding on the ratio and overall quantity of the different cultivars to produce, given the market opportunities and the characteristics of the area.

It is this that plays an important role in determining the overall size of the enterprise: **The greater the opportunity to produce a range of market-desired cultivars well, the lower the chances of outright failure in a particular season (risk), the larger the likely return on investment, and thus the larger the enterprise can afford to be.**

3.2. The Trade Off between Cultivar Suitability and Costs

Market forces will normally dictate that the more suitable a region is for the production of the greatest diversity of market-desired cultivars, the more expensive the land and other resources will be. For example, the Western Cape is a region that has access to the full range of available citrus export markets. Climatically it is also a region that can support the production of high quality fruit of the most desired cultivars. However land for citrus planting is scarce and expensive.

Here too, careful analysis is required to decide on the final size of the enterprise, taking all of these factors into account.

There will be circumstances where it will make sense for a grower to invest in two or even three production units located in different regions so that the full range of cultivars can be produced and packed under one fruit label or brand name.

There are also instances where, for technical reasons, it may pay to focus all attention on just two cultivars, such a grapefruit and valencias, so as to exploit the inherently high yield and quality factors related to the climatic conditions that best favour both of them.

It should be clear from the information given above that deciding on the size of a citrus enterprise is a complex issue that is dependent on the interaction of various factors. The ability to produce high yields of a spread of market-desired cultivars coupled with the availability of key resources, of which capital is critical, are the defining factors. The financial or business plan that is able to interactively compare the merits of various options is a vital planning tool in this regard.

Summary

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

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

Chapter 2

- In citrus production, economies of scale means that as a citrus enterprise grows and the number of tons of fruit produced increases, the cost of each additional ton produced decreases.
- The size of the enterprise depends on the availability of fixed and mobile resources, the potential return on capital, the availability and condition of existing facilities, and the market demand for the cultivars that can be produced on that land.
- Deciding on the size of a citrus enterprise is a complex issue that is dependent on the interaction of various factors, but a few taken in combination are critical, such as the trade off between production efficiency and market demand and the trade off between cultivar suitability and cost.

Complete activity 4 in the **Learner Workbook**.

Activity 4 – Report Writing

Remind learners to complete the report individually and to include as much detail as possible and to reference their sources of information.

Timeframe: 2h

Chapter 3

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

Apply the principles of quality management systems

You have to complete this section as follows:

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

1. The Meaning of Quality

Lead a class discussion in which you pose the following questions:

- What does quality mean to the consumer of citrus?
- What does quality mean to the citrus producer?
- Why is quality important in citrus production?
- Who determines the quality of citrus?
- How can quality be assured?
- How can quality be controlled?
- How can quality be managed?

The term **quality** has been defined in many different ways, from simply '**a measure of excellence**' to the more analytical definition of '**a reduction of variation around the mean**' (www.qualitydigest.com/html/qualitydef.html).

The definition could also be expanded to the following: *'Quality is the outcome of the sum of all of the features and characteristics of a program, process, or service that impact their ability to meet or surpass the needs and requirements of a customer*'. Quality defines desirable characteristics of a product, a process, or a service. For the purposes of this learner guide, the term quality applies to that of the product, or fruit.

In the case of fresh citrus, quality, whether it is good or bad, is evident in the appearance and / or taste of the fruit, and by its apparent storability, freshness or condition. It therefore has to do with the perception and expectation of the customer, and like beauty, is something that is in the eye of the beholder.

Quality is therefore a relative concept, and a moving target, depending on various factors that may happen to influence customers' expectations at any particular time. Issues such as the quality of

competitors' products, price, and the demand-supply balance all influence the customers' perception of the quality of specific fruit at any given time.

Over a longer period, a particular source of fruit may develop a good quality reputation because it consistently meets or exceeds customer expectations. Consumers may come to associate this with a particular brand name and seek this in their purchases. This aspect is discussed further in the ***Marketing*** learning material.

In the fresh fruit business, the term quality also has a wider meaning. It also refers to the extent to which the product is safe to eat. Factors related to food safety are not usually apparent to the eye. A situation can therefore exist where a product looks attractive, tastes good but is unsafe to eat because of high levels of chemical residues. Such a product could hardly be considered to be of high quality. Any reference to fruit quality in the citrus industry therefore should also incorporate the concept of food safety.

In the past, retailers used the quality of their fresh produce to differentiate themselves from their competition. Today, with the strong purchasing power of the supermarket chains, it is said that fruit quality is a given. This simply means that in order to participate in this market at all, the supplier, or producer, must be able to virtually guarantee a certain minimum quality standard regardless of whatever problems or costs he may encounter in achieving this.

2. Quality Standards

Because quality is relative and subjective, standards have to be set that are accepted and applied throughout the industry. Standards protect the grower, the industry and the consumer.

Food safety standards in South Africa are prescribed by the Department of Agriculture, Forestry and Fisheries through the Agricultural Product Standards Act (APS), which in turn underpins a number of Regulations, and ultimately Standards and Requirements applicable to all stages of the supply chain.

These standards comprise a detailed list of more than thirty different minimum requirements applicable to the external appearance of the fruit and an equally detailed set of standards applicable to internal quality factors. Included here are phytosanitary standards that apply to certain pests and diseases whose symptoms indicate their presence in the orchard and which importing countries have banned or placed certain restrictions on.

The standards also include maximum residue levels for every plant protection product that is used in South Africa. Maximum residue levels, MRLs, prescribe the amount of every product that is still allowed to be on the fruit when it is exported.

In addition to the general standards prescribed by the APS, there are also commercial standards organisations to which farmers can subscribe on a voluntary basis. The most well-known of these is GlobalGAP.

In the mid 1990s, the Euro Retailer Group (EUREP), representing the leading European food retailers, agreed to accept and promote a set of good agricultural practices (GAP). This was in response to increasing consumer interest in the impact of agriculture on food safety and the environment. GlobalGAP was consequently established as a private non-profit organisation with its headquarters in Germany. In terms of GlobalGAP requirements, suppliers, or producers, are required to demonstrate their commitment to:

- Maintaining confidence in food quality and safety
- Minimising detrimental impact on the environment, whilst conserving nature and wildlife
- Reducing the use of agrochemicals through adoption of Integrated Production Systems
- Improving efficiency of use of natural resources such as soil, water air and energy
- Ensuring a responsible attitude to worker health and safety, welfare and training

The GlobalGAP standard comprises three categories of control points that require different levels of compliance. These are the major musts, (100% compliance required), minor musts (95% compliance)

and shoulds (recommendation level). The major and minor musts constitute most of the food safety related aspects at the production sites with strong emphasis on the regulation of GAP in the application of agricultural chemicals.

The higher paying markets are usually those requiring proof of compliance to their specific quality standards. The producer must analyse the costs involved in meeting the quality standards of the different market segments available to him. Such cost-benefit analyses will assist the producer to decide on the overall strategy of his enterprise.

3. Quality Management

To ensure the quality of a product, and to ensure compliance to general and specific standards, quality management must be exercised on every farm. Quality management does not stand apart from other production processes and is not a reactive process, but should rather forms an integral part of every production process.

Quality management is about two key aspects, being quality assurance and quality control. These are discussed further below.

3.1. Quality Assurance

Quality assurance is concerned with the practices, processes and procedures used to assure the final quality of the product. The quality assurance procedures and practices that are followed for example while the fruit is developing on the tree are critical in determining the final quality of the product. This is because the internal quality of the fruit is fixed by the time the fruit is ready for harvest. There will be no perceptible change in the sugar or acid content of the fruit after harvest. The rind of the fruit will also by then have developed certain characteristics that will make it either more or less prone to physiological disorders or waste.

Climate, irrigation, and nutrition are the overriding factors determining internal quality and in predisposing fruit to postharvest quality and condition problems. Since little can be done to modify the climate, orchard practices should be directed at reducing the possible negative effects of unfavourable climatic conditions in a sustainable manner.

The implementation of good agricultural practices (GAP) in the pre-harvest environment and good manufacturing practices (GMP) in the packhouse or processing facility are an integral part of quality assurance.

It is also important to have systems in place for tracking the quality of the fruit as it develops on the tree. In the case of quality defects to the rind caused by insect or disease damage, this can be achieved by adherence to pest and disease control programs based on the monitoring of pest and disease levels in the orchard. In the case of internal fruit quality characteristics, it can be achieved by monitoring the timing and evenness of flowering, measuring fruit size increases at regular intervals, monitoring irrigation and the moisture status of the soil, and implementing fruit maturity indexing procedures.

3.2. Quality Control

Once fruit has been harvested and packed it has to be inspected, or subjected to quality control, to determine its compliance to pre-determined minimum standards. Since quality cannot be 'inspected into a product,' it must be remembered that the process of quality inspection cannot improve a product, nor guarantee that, in the case of a perishable product such as citrus, it will not deteriorate subsequent to the inspection.

On a national basis, The Perishable Products Export Control Board (PPECB) is an assignee of the Department of Agriculture, Forestry and Fisheries and is mainly responsible to ensure that perishable products meet the minimum standards laid down by local authorities or those of importing countries. PPECB are therefore an agency responsible for Quality Control.

Quality control is however not only concerned with 'end point' inspection. Quality can also be inspected at various other points in the production and trade chain. For example, maturity indexing is a case of on-farm quality control, which is aimed at measuring the response of trees and / or fruit to the various inputs made.

In Chapter 4, the integration of quality control in the production process is discussed and demonstrated by using Maturity Indexing as an example.

4. Quality Management Systems

It is clear from the above that formal quality assurance and control systems and procedures are required for the successful production and packing of citrus. The more specialised the market requirements are, the more effective the quality assurance and control procedures need to be. The Hazard Analysis Critical Control Point (HACCP) system is a good example of a formalised quality assurance system.

HACCP is a systematic approach to the identification, evaluation and control of food quality hazards in the process-flow of a product. The HACCP system is designed for the packhouse environment, but can be applied to any other segment of the trade chain, such as production, harvesting, and distribution to assist with quality control. The seven principles of HACCP are the following:

- Hazard analysis
- Identification of critical control points
- Establishing critical limits
- Monitoring critical control points
- Establishing procedures for corrective action
- Recordkeeping
- Verification

Summary

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

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

Chapter 3

- Quality defines desirable characteristics of a product, a process, or a service.
- Quality refers to the how the fruit looks and tastes, and also to the safety of the fruit for human consumption.
- Minimum standards for fresh fruit are prescribed by the Agricultural Products Act (APS), which relates to internal and external quality, and food safety and phytosanitary issues.
- There are also commercial standards organisations, such as GlobalGAP, whose standards growers are obliged to comply with in order to gain access to particular markets
- Quality management should form an integral part of every production process.
- Quality management is concerned with quality assurance throughout the production and packing process and quality control, which refers to inspections.
- A formalised quality management system must be in place that provides for quality assurance and quality control.
- HACCP is an example of a quality assurance system.

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

Activity 5 – Research and Discover

Remind learners to draft their own Quality Management plan based on their practical experience or a fictitious citrus enterprise. Remind learners to answer all sections of the activity and to reference their sources of information.

Timeframe: 3h

Chapter 4

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

Integrate the concept of quality management into the production process

You have to complete this section as follows:

Total time	*Theory*	*Practical*
6h 30min	3h	3h 30min activities 4h work in production management

Please remind learners to refer to their workbooks for guidance regarding the experiential learning and research required to complete their summative assessment task.

1. Introduction

In the previous chapter, we said that quality management is concerned with quality assurance throughout the production process and quality control, which is aimed at ensuring that the product meets certain standards.

The Hazard Analysis Critical Control Point (HACCP) system was also mentioned as a good example of an effective quality assurance system. In this chapter, the integration of quality assurance in the production process will be discussed by using the HACCP system as a tool. The process of maturity indexing will be used as an example of quality control.

2. The Citrus Production Process

Most learners will be familiar with the citrus production process. Prepare a flow chart to use during facilitation. Group assignments can be given to make production decisions for fictitious citrus farms producing different citrus crops along the guidelines of the tables in this section. The decisions should be motivated and the expected result of the decisions given.

Before a quality management system can be implemented, the stages of the production process must be identified so that the points at which quality can be adversely affected can be identified.

Each stage in fruit development is influenced by the preceding stage and influences in turn the following stage. The stages are:

- Flower induction and initiation
- Flowering
- Fruit set
- Fruit growth
- Harvest
- Flower induction and initiation for the following years' crop.

A broad distinction can be made between factors affecting internal and external fruit quality caused by pests and diseases on the one hand, and physiological problems on the other. Physiological problems are those brought about by the effects of climate, nutrition and irrigation. In this section, the focus is on these physiological factors, although similar principles are applicable to pest and disease factors.

Crop can be manipulated in various ways including fertilisation and irrigation, pruning, thinning (by hand and chemically), girdling, hormone application (to reduce flowering, increase fruit set, extend the harvest season, and extend the shelf-life of the fruit), fruit acid reduction and fruit colour improvement.

The table on the next page is a typical management schedule, in this case for easy-peeler production in the northern areas of the country. The table indicates the timing of various treatments to achieve desired fruit set, fruit size and quality.

The citrus production manager should create such a management schedule for each of the citrus cultivars he produces. Over time, a database of the specific treatments and treatment timings applied annually to achieve a premium quality product should be developed. In this way the risks attached to the production of high quality fruit will be systematically reduced.

Guide to Annual Soft Crop Management Program – Northern Areas												
	Jan	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***
A. Fruit Set and Size												
Urea Sprays KNO_3 Sprays					X (1%) X (4%)	X (1%) X (4%)					X (4%) for Size	
Pruning and Blossom Thinning						XXXX		X	XX (Blossom Thinning)			
Girdling for Set					`				XX 2 Weeks			
N Applications (Soil)			Leaf Samples		¼ N – Soil (After colour break)				XX ½ N Soil	XX ¼ N Soil		
Fruit Thinning (by hand)	XXXX		XXXX (Sunburn)									XXXX
Corasil Y Sprays / XGR Thinning / Sizing											XXX	
Irrigation (for fruit set and growth)	"Quality Stress" (see below)			-50kPa					-30 to -50 kPa			-50kPa
B. Fruit Quality				**Harvest**								
Reduced Irrigation (Increased Sugars)	Stress -60kPa XXXX XXXX XXXX			Irrigate before harvest								
Calcium Arsenate – Reduced Acid											XX	
Maturity Indexing		XX	XXXX	XX	(6-8 weeks before harvest)							
Ethrel Sprays (Colour) + Ca Acetate for sensitive cultivars				XXXXXXXX (Colour break) Acetate one day before ethrel								
Degreening (Packhouse)				XXXXXXXX (from colour break)								
Summer Girdling (Higher sugars)												XXXX
C. Harvest Timing Extension				XXXX	XXXX	GA_3 at colour break or December						XXXX
Early Harvest			See ethrel / ethylene / calcium arsenate / summer girdling methods above									

X = Week of month during which activity is carried out.

For the purpose of explaining some of the practices which impact on fruit quality, it is necessary to understand the fundamental interactions between the environment, tree growth and fruiting.

Certain factors or conditions, either alone or in combination, give rise to strong and vigorous vegetative growth in the tree. Such factors include warm day and night temperatures, sufficient water, young tree age, high levels of nitrogen, no nutrient deficiencies, and the absence of root or leaf diseases. When trees grow vigorously the quality of the fruit is usually poor. Fruit colour is slow to develop, the sugar content is low, and the fruit has an insipid taste due to low acid levels. Fruit is usually too large, have coarse rinds, and tree yields are only fair.

Conversely, when trees are less vegetatively vigorous due to light water stress, low night temperatures and a properly balanced nutritional status, better fruit colour and a higher internal fruit quality will result. Fruit will have smooth rinds, be well-coloured, and in a more acceptable fruit size range.

The challenge of the production manager is to understand the influence of inherent factors, being tree age, rootstock, cultivar selection, climate, soil type, on fruit quality for the specific cultivar concerned, and to be able to use appropriate production practices to influence or mitigate any possible negative effects of these inherent factors.

In the case of quality defects caused by the effects of pests and diseases, the monitoring of the levels of the specific pest and disease agents and the their natural enemy populations is a vital aspect of being able to provide cost effective and ecologically sustainable control options.

The citrus production manager therefore needs to be familiar with the pros and cons of the various procedures and practices to improve fruit quality, both in respect of those required to address the harmful effects of pests and diseases, and those aimed at counteracting the detrimental effects of adverse climate and nutritional imbalances.

3. Integrating Production Processes and Quality Assurance

Remember that all learners are not exposed to the same quality assurance processes in their workplaces. Expose learners to as many examples as possible, even if the examples are not necessarily applicable to the group of learners. Explain to learners that this will assist them in understanding and judging other quality management systems.

Work through the example in the section in detail and allow learners to come up with similar examples related to their own experience.

As mentioned in chapter 3, quality assurance aims to assure that the quality of the product is protected and maintained throughout the production process and must therefore be integrated with each process involved in citrus production. Using the HACCP system as an example, this means that the seven principles of HACCP must be applied to each process.

The HACCP system is aimed primarily at maintaining the integrity of the process, meaning it aims to ensure that the process is conducted and completed as it should be and within certain limits.

Quality Assurance

Refer to the irrigation process in the table above under section A (Irrigation for fruit set and growth) for September to November. HACCP principles for the process can be applied as follows:

HACCP Principle	***Application in Irrigation***
Hazard analysis	• Water supply to plants can fall below critical levels, causing damage to plant and leading to lower fruit set and smaller fruit. • Plants can be saturated with water, causing anaerobic conditions in root-zone and adversely affecting plant health.
Identification of critical control points	• Water delivery at tree (soil-water balance)
Establishing critical limits	• Tensiometer readings in root-zone: -30 to -50kPa
Monitoring critical control points	• Regular tensiometer readings recorded on a datasheet
Establishing procedures for corrective action	• Report to management • Investigate pump system, water availability, emitter delivery, damage to irrigation system
Recordkeeping	• Tensiometer readings, other irrigation monitoring equipment readings • Incident reports to management
Verification	• Verify that corrective action has resulted in tensiometer readings within the critical limits

Please note that this is a simplified example for the purpose of illustrating a point. Many other critical control points can be identified and controlled in this process, such as pump delivery, emitter delivery, valves, and so on.

3.1. Hazard Analysis

What can go wrong in this process?

Hazard analysis is about identifying the possible quality hazards that can occur in the process.

3.2. Identification of Critical Control Points

Where in the process can quality be compromised?

Identifying the critical control points is about finding the points in the process that must be controlled to ensure that the quality hazards that were identified in the hazard analysis are prevented, eliminated or reduced to acceptable levels.

3.3. Establishing Critical Limits

What are the limits for the measurable values at each critical control point?

Establishing critical limits is about determining how critical control points can be monitored and about setting the critical limits for each control point. Critical limits mean limits beyond which fruit quality will be compromised.

3.4. Monitoring Critical Control Points

How are the critical levels at each critical control point monitored?

Monitoring is about developing a system that will record the values for which critical limits have been established at each critical control point. The system should be able to record the relevant data, convert it into useful information where necessary, and flag values that are approaching critical limits and that are posing a quality risk. The information generated by this system forms an important part of the recordkeeping system.

3.5. Establishment of Procedures for Corrective Action

What must be done if the critical limits at a control point are exceeded?

An action plan must be in place that can be implemented immediately if a critical limit is exceeded to ensure that damage to the quality of the fruit is prevented or at least limited.

3.6. Recordkeeping

What must be documented about the system and what records must be kept?

Records will firstly include the written HACCP plan which sets out all the critical control points, their critical limits, monitoring procedures and corrective actions. Every person that is involved in a process must be well versed in the HACCP plan and must be aware of what his role is in implementing the plan.

Further records includes those generated at each critical control point and reports on corrective actions that were taken.

3.7. Verification

How do I make sure that the quality management system is effective and remains relevant?

Verification means the documenting of the validity and effectiveness of the HACCP plan. If it is forever found that fruit quality was compromised in spite of the implementation of the quality control system, the reasons for this must be established and adjustments to the HACCP plan must be made.

4. Integrating Production Processes and Quality Control

As mentioned in Chapter 3, quality control is concerned with inspecting or monitoring fruit quality at various points in the trade chain. This includes formal inspections by agencies such as the PPECB against the standards that are prescribed by the relevant legislation, but also on-farm quality control, which is aimed at measuring the response of trees and / or fruit to the various inputs made, for example maturity indexing.

Maturity indexing is a technique used to provide information on the rate of change of fruit maturity prior to harvest. Maturity may differ by as much as three weeks from season to season, primarily due to the time of flowering and the weather conditions subsequent to it. This can have a major impact on management decisions relating to such issues as the contracting of labour for harvesting, the preparation of the packhouse, and logistical arrangements for transporting the packed fruit from packhouse to market.

Fruit sampling commences four to six weeks before the expected harvest date. Fruit samples are tested for acid and sugars and the ratio is calculated, and fruit colour is rated. The results of these quality factors are plotted on a graph. By so doing the test data is converted into information which will begin to show clear maturity trends after a few weeks. This enables appropriate management decisions to be taken in good time.

It is important to work through the example below in detail and to emphasise the role of maturity indexing in quality control. Make specific reference to minimum standards and where minimum standards documents can be obtained.

Clementine Maturity Indexing

In the table below is the typical average weekly fruit size, colour, sugar, acid and ratio values for clementines as a reference for maturity indexing purposes.

Long-term reference framework for picking maturity and combined weekly average maturity progress (Industry) **Clementine**							
Week	***Date***	***Size (mm)***	***Colour***	***Hydro TSS (%)***	***REFRAC TSS(%)***	***Acid (%)***	***Ratio***
10	8 Mar	43.6	8.0	10.5	9.8	2.35	4.47
11	15 Mar	43.4	7.8	10.1	9.3	2.13	4.75
12	22 Mar	42.3	7.9	10.3	9.6	2.04	5.03
13	28 Mar	45.2	7.9	10.0	9.2	1.73	5.76
14	4 Apr	45.9	7.5	10.4	9.5	1.52	6.85
15	13 Apr	50.4	7.5	10.3	9.5	1.40	7.38
16	19 Apr	49.2	7.2	10.4	9.6	1.24	8.37
17	25 Apr	53.0	6.2	10.6	9.8	1.21	8.75
18	3 May	52.1	5.2	10.9	9.9	1.11	9.78
19	10 May	52.3	4.6	10.4	9.8	1.00	10.39
20	17 May	53.1	4.2	11.0	9.9	0.98	11.21
21	23 May	56.5	3.3	11.2	10.4	0.98	11.36
22	31 May	52.5	2.9	10.6	9.9	0.92	11.52
23	7 Jun	53.1	2.6	11.1	10.4	0.85	13.14
24	14 Jun	52.6	2.5	11.5	10.8	0.87	13.31
25	21 Jun	50.6	1.1	13.5	12.2	0.90	15.08

The minimum national standards are given in the table below as a control.

Internal Quality Standards					
	Juice	***TSS***	***Acid (Min)***	***Acid (Max)***	***Ratio***
Clementine	48	9.5	0.70	1.50	8.0:1

Below is a typical Maturity Indexing information sheet template. The internal quality test data from each sampling is entered onto the sheet and the relevant points connected once sufficient samples have been taken to show trends.

Similar graphs can be developed for colour development and other maturity information. The graphs give an indication of the expected maturity date and of the expected internal quality of the fruit. By adding information such as notations on external blemishes, one can also get an indication of external quality.

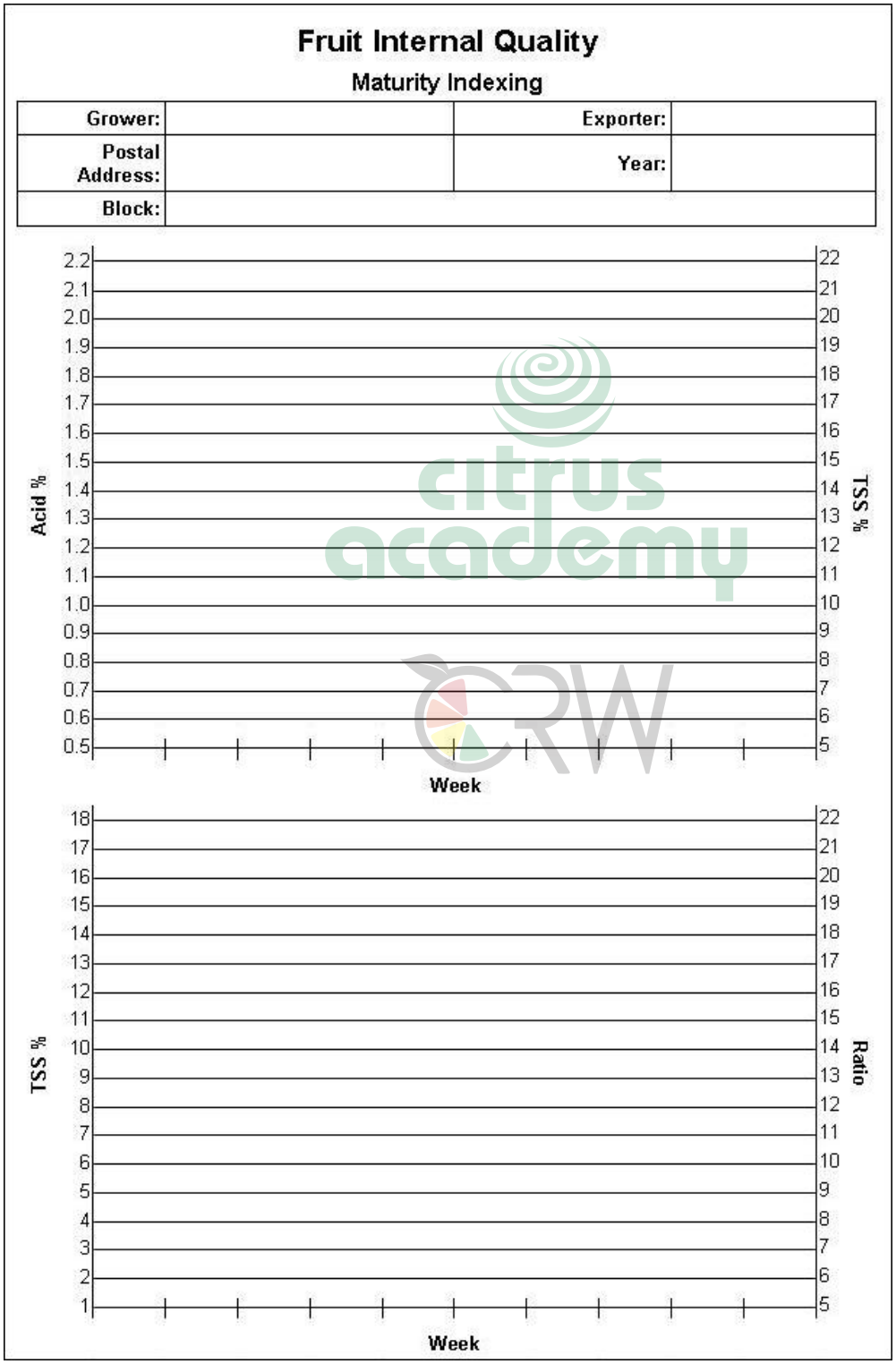


Figure 4.1: Maturity Indexing Information Sheet Template

5. Cost-Benefit Analysis for Quality Improvement Processes

It is recommended that a variety cost-benefit analyses are conducted in class, both as a group and in smaller work groups. Obtain as many examples as possible to work through and emphasise the thought processes of each analysis.

The term cost-benefit analysis is used frequently in business planning and decision support activities (www.solutionmatrix.com). The term does not refer to any specific approach or methodology, but usually implies a study to provide some form of financial justification for an action. Financial justification is a business-case analysis that helps the production manager to decide whether or not to proceed with a proposed action.

In deciding which quality improvement processes to employ, the citrus production manager should conduct some form of cost-benefit analysis to determine whether the cost of implementing a specific action is financially justifiable.

The nature of the analysis would depend on the manager's ability to quantify the cost of the planned treatment against the financial benefit accruing from the action.

It is relatively easy to accurately estimate the cost of a prospective treatment, whether this is a chemical spray, pruning or the implementation of an amended fertilisation or irrigation schedule.

Estimating the financial benefit that could arise from the chosen treatment or treatment combination is usually less precise. This is because the quality of the final product is the result of a number of interacting factors, some of which are out of the control of the manager, such as climatic conditions.

The recommended approach is to use past records as an indication of the potential financial losses that could be incurred from quality defects or to estimate the cost of non-compliance to the relevant market standards.

Summary

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

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

Chapter 4

- The stages of the production process and the points at which quality can be adversely affected must be identified before a quality management system can be implemented.
- A management schedule indicating the various production processes at specific times during the season must be developed for each cultivar on the farm.

- The production manager must understand the affect of various factors on the tree and the fruit quality.
- Quality assurance must be integrated with each process involved in citrus production.
- HACCP involves hazard analysis, identification of critical control points, establishing critical limits, monitoring critical control points, establishing procedures for corrective actions, recordkeeping and verification.
- Quality control is concerned with inspecting or monitoring fruit quality at various points in the trade chain.
- Maturity indexing is a technique used to provide information on the rate of change of fruit maturity prior to harvest.
- A cost-benefit analysis is about determining the financial justification for taking an action.
- The cost of implementing and maintaining a quality management system must be compared with the possible financial advantages of achieving better quality.

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

Activity 6 – Report Writing

Remind learners to use this activity to test the knowledge and skills that they have gained and to attempt the activity with as little external input as possible.

Timeframe: 1h 30min

Activity 7 – Worksheet

Before allowing learners time to complete the activity, hold a visualisation exercise in which the learner the learner has to think like a production manager.

Timeframe: 1h

Activity 8 – Worksheet

Remind learners to revise quality control systems and complete the activity along with contingency plans. Where possible, an actual quality control system should be used as reference.

Timeframe: 1h

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