LEARNER GUIDE

Food Safety

Level 5

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Title:		**Develop and Implement a Food Safety and Quality Management System in an Agricultural Supply Chain**					
Applied Title:		**Develop and Implement a Food Safety and Quality Management System in the Citrus Supply Chain**					
Field:		Agriculture and Nature Conservation					
Sub-Field:		Primary Agriculture					
SETA (SGB):		AgriSETA					
Skills Area:		Food Safety					
Context:		Citrus Production					
US No:	116419	**Level:**	5	**Credits:**	7	**Notional Hours:**	70
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Based on the Production Guidelines of:

Supported by:

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Directions

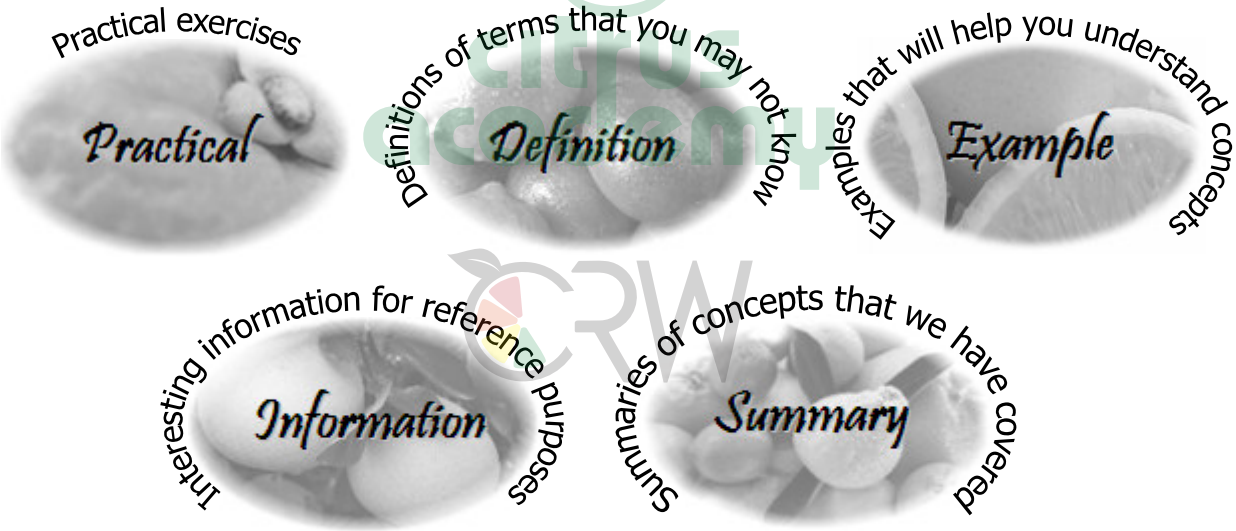
This learning material has been developed to assist the learner wishing to complete this unit standard. The guide contains all necessary learning to ensure that the learner will attain the competencies required by the unit standard.

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

A learner achieving this unit standard will be able to develop, implement and optimise a management system for food safety and quality practices in an agricultural supply chain in a context of the citrus industry. Successful learners will be fully competent in food safety practices thereby providing the environment for the application of quality practices and thus strengthening agricultural practices in general.

Learners will gain an understanding of sustainable agricultural practices as applied in the plant production sub-field. This unit standard focuses on the application of food safety principles in primary agriculture. Learners will be able to participate in, undertake and plan farming practices with knowledge of their environment. This unit standard will instil 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:

NQF Level	***Unit Standard Number***	***Unit Standard Description***
NQF4	Literacy and Numeracy	
2	116125	Apply crop protection effectively and responsibly.
4	116278	Implement a food safety and quality management system in the agricultural supply chain.
4	116288	Execute sustainable resource use and quality control.

Revision of Level 4

1. Traceability and Recordkeeping

- Traceability allows the grower to provide proof of the origin of all their fresh produce.
- The citrus supply chain is a series of distinct activities that take place in order to move the product from orchard to market.
- Tracking is the ability to follow a product forward as it moves through the supply chain towards its final destination, while traceability is the ability to trace the product backward to its origins.
- The six elements of traceability are product traceability, process traceability, genetic traceability, inputs traceability, disease and pest traceability, and measurement traceability.
- Recordkeeping is central to traceability and the availability of records is as important as the records themselves.
- Checklists and compliance criteria have been developed to be used as an aid and self-assessment tool, and are also used during internal and external food safety audits.
- Records can be kept manually or electronically with information accessibility, internal capacity, and prevailing resources forming the basis for deciding on the type of system.
- All workers must be trained in recordkeeping, including how documents must be completed, how and for how long records must be stored, and the recordkeeping requirements of traceability.
- HACCP principles can be used for the implementation of a traceability and recordkeeping system.

2. Good Agricultural Practices (GAP)

- Good Practice guidelines aim to improve the manner in which a variety of businesses conduct themselves.
- In agriculture, Good Practice guidelines have been developed for the entire supply chain, and they include Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP), Good Distribution Practices (GDP), Good Health Practices (GHP), Good Social Practices (GSP), and Good Environmental Practices (GEP).
- Good Practices that are implemented in crop production are collectively referred to as GAP, even though some of these practices actually may be GHP, GSP or GEP.
- More specifically, GAP is a collection of principles and basic environmental and operational conditions that are necessary for the sustainable production of safe, wholesome fruit and vegetables.
- GMP are guidelines for manufacturers to ensure the quality, consistency and safety of products and processes.
- GDP applies to the handling, transport and distribution of fresh produce.
- GHP focuses on personnel health and hygiene.
- GSP addresses issues such as economically disadvantaged producers, transparency and accountability, capacity building, payment of a fair price, gender equality, and working conditions.

- GEP promotes the management of farming operations to promote minimum impact on the natural environment and sustainable land use.

- GAP principles have been developed for the following areas:

  - **Land Use and Soil**
    - Cultivated land information
    - Current or prior use of adjacent land

  - **Water Sources and Irrigation Practices**
    - Potential contamination associated with water sources
    - Hazards introduced by irrigation practices
    - Chemigation
    - Agricultural water microbiological testing procedures

  - **Implementation of Soil and Water Conservation Principles – Organic Fertilisers**
    - Management of organic fertilisers
    - Hazards associated with animal manure and treatments to reduce the risks
    - Hazards associated with manure treatment and storage location
    - Precautions for the application of organic fertilisers
    - Keeping complete records of organic fertiliser preparation and use

  - **Implementation of Soil and Water Conservation Principles – Inorganic Fertilisers**
    - Keeping complete records of inorganic fertilisation programs
    - Appropriate storage of inorganic fertilisers

  - **Animal Exclusion from Production Areas**
    - Methods for keeping animals out of production areas
    - Cleaning surrounding areas
    - Preventing cross-contamination between animals and water

  - **Pest Control**
    - Pest Control in fresh produce operations
    - Common pest control procedures
    - Pesticides
    - Pesticide handling
    - Pesticide application
    - Pesticide storage
    - Pesticide residues
    - Pesticide disposal
    - Training and documentation

  - **Worker Health and Safety**
    - Relationship between worker health and hygiene
    - Health programs
    - Worker hygiene training program
    - Drinking water
    - Worker hygiene practices and sanitation facilities
    - Hand washing and hand-washing facilities
    - Basic requirements for and placement of sanitary field stations

  - **Safety Hazards Associated with Harvesting**
    - Physical damage caused by mechanical and / or manual harvesting methods
    - In-field packing operations

  - **Safety Hazards Associated with Postharvest Treatments and Handling**
    - Postharvest water quality
    - Cooling considerations

3. Non-Conformance and Corrective Actions

- "Non-conformance" describes, firstly, the identified product that is potentially unsafe because it deviates from set standards and, secondly, the deviation from the prescribed processes and procedures that were the cause of the deviation in the identified product.
- Deviations from food safety procedures may render the product unsafe for human consumption or unsuitable for meeting specifications of export markets.
- Data and records associated with traceability are analysed and interpreted to identify instances of non-conformance, and to determine the point at which the deviation occurred.
- Validation is a process that is used to ensure that food safety control measures are capable of being effective: "Is the control measure adequate and appropriate to control the particular food safety hazard?"
- Verification is a process that uses objective evidence to confirm that specified requirements have been met: "How well is the control measure managing the risk?"
- Corrective actions are steps that are taken to eliminate the causes of an existing non-conformance and are designed to prevent recurrence.
- Planned corrective actions are described in the Quality Management Standard Operations Procedure Manual or in the Standard Operating Procedures manual for the food safety management system.

4. Internal Audits

- Internal audits are used to monitor and probe the integrity of the food safety management system continuously and to thereby ensure that it is implemented as prescribed.
- The common elements to all internal audit systems are an audit charter, risk assessment process, an audit plan, an audit cycle, audit work programs, audit reports, requirements for audit documentation, follow-up procedures, and professional development programs.
- A pre-harvest internal audit on a citrus farm is normally conducted as a single audit, usually in the sequence of chemical storage, fertilisers, water and irrigation, waste disposal and pollution, transport from orchard, machinery and equipment maintenance, personal hygiene, and lastly training.

5. Standard Operational Procedures

- Standard operating procedures (SOPs) are written documents that describe step-by-step and in detail how a procedure should be done.
- Food safety SOPs are the documentation for the food safety management system.
- SOPs are used during audits and for personnel training.
- Standard operating procedures are often compiled into a SOP manual.
- SOP manuals should be catalogued and detailed, and should be written by persons that have a good knowledge of food safety and a sound understanding of the organisation.
- SOPs should be reviewed and validated by one or more individuals with appropriate training and experience with the process.
- SOPs should be systematically reviewed on a periodic basis to ensure that the policies and procedures remain current and appropriate.

- Checklists or forms included as part of an activity should be referenced at the points in the SOP where they are to be used and attached to the SOP manual.

- Each organisation should develop a numbering system to systematically identify and label their SOPs, and the document control should be described in its quality management plan.

Tracking
Tracking is the ability to follow a path of a specified unit and / or batch of product through the supply chain as it moves between organisations towards the final point-of-process, point-of-sale or point-of-service. Tracking is also referred to as **forward traceability**.
Tracing
Tracing is the ability to identify the origin, movements and relevant associated information of a particular unit and / or batch of product located within the supply chain by reference to records held upstream. Tracking is also referred to as **backward traceability**.

Chapter 1

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

Correctly interpret current market requirements in the agricultural supply chain.

1. Introduction

The South African citrus industry is export oriented with about 60% of commercially grown citrus exported as fresh fruit. Of the balance, about 25% is sold on the local market and 15% is sent for processing at fruit juice factories. Yet over 90% of total revenue is generated from export sales.

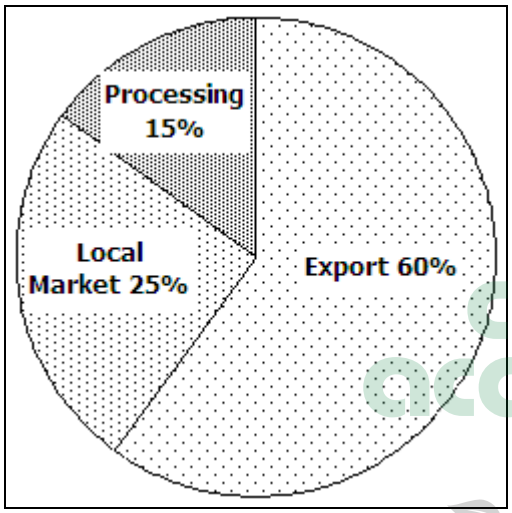


Figure 1.1: Citrus Sold per Market Segment

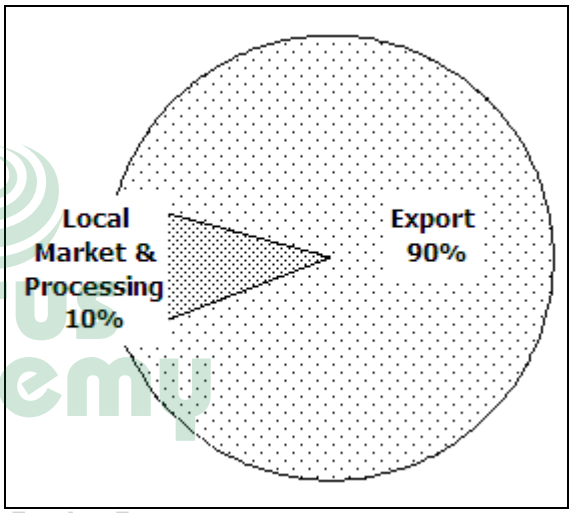


Figure 1.2: Income per Market Segment

For this reason, production practices are geared toward maximising the export crop by ensuring that the requirements of foreign consumers are met. While there is currently a movement towards exploring alternative markets and producing for alternative local markets, it remains important to manage production so that optimum quality and food safety is maintained.

In this chapter, we examine examples and methodologies related to higher level market requirements.

Citrus Marketing Learning Material

The learning material that has been produced by the Citrus Academy about the marketing of citrus is a useful additional resource. Please visit our website at www.citrusacademy.co.za to download the material.

2. Market Requirements

Various factors determine which market is targeted by a grower, of which the most important are:

- Price (returns from sending to that market)
- Citrus types and cultivars

- Production volumes
- Commercial certification
- External and internal fruit quality
- Local pest and disease pressure and phytosanitary requirements

External and internal quality is determined by factors such as the location of the farm, climatic conditions, and pest and disease pressure. Pest and disease pressure also plays a very important role in terms of the phytosanitary requirements for certain markets. As an example, in 2007 only farmers in the Citrusdal area in the Western Cape and a few producers in the Northern Cape were allowed to export oranges to the USA, because only these two regions in South Africa were categorised as being free of citrus blackspot.

In terms of food safety, there are both legal and commercial minimum requirements. For example, exporting to the European Union requires growers to adhere to the food safety laws governing fruit imported into the European Union, and selling to the TESCO supermarket chain in the United Kingdom (part of the European Union) requires Nature's Choice certification.

Commercial certification schemes, such as GlobalGAP (previously known as GlobalGAP) and Nature's Choice, prescribe a list of requirements that the grower must meet in order to become a supplier to that business. These requirements are not only concerned with the production practices on the farm that may impact on food safety and quality, but also with social and environmental issues. They often prescribe a full range of Good Agricultural Practices (GAP) to be implemented.

In level 3 and 4 guides we discussed in detail where information on current agricultural trade legislation can be found and how food safety and quality management systems can be developed and implemented based on this information. Information about the regulatory requirements of specific markets can be accessed on the links below.

Regulatory Requirements

Information and checklists can be obtained from the PPECB or on the PPECB website at www.ppecb.com.

Citrus minimum export standards can be accessed on website of the Department of Agriculture, Forestry and Fisheries at: www.daff.gov.za. Minimum export standards are available per type and per cultivar for various export markets.

3. Implementation Strategy for Market Requirements

Once a market has been initially identified as a potential target market, it is essential that the grower researches all the requirements of that market. Detailed management plans must be developed and implemented to meet these requirements, including:

- Production management plans
- Human resource management plans
- Food safety and quality management plans, and
- Environmental management plans

Bear in mind that some markets restrict the use of plant protection products to 50 percent petal fall (before the fruit has been formed on the tree) which means plans must have a lead time of up to 11 and a half months before harvest.

The impact of market requirements on the day-to-day activities on a citrus farm is best explained using the example below.

Market Requirements and Production Practices

Bright Orange Citrus Farm in the Citrusdal area has decided to export their lemons to the USA, TESCO in the UK and to mainland Europe. The requirements for these markets were researched and the following documentation and checklists were obtained:

- Standards and Requirements checklist for lemons
- Special markets information for lemons to USA market for all cultivars in class 1
- TESCO Nature's Choice checklist

In addition, the **Recommended Usage Restrictions for Plant Protection Products on Southern African Export Citrus** document was obtained from the Citrus Growers' Association.

Below is an example of one of these checklists, in this case the special markets information for lemons to the USA.

Citrus type: Lemons

Cultivar: All Lemons | **Market:** United States of America

No.	Quality Factor	Class 1 (Permitted Deviations)
1	Decay	1.5%
2	Endoxerosis	
2(a)	Minor Endoxerosis	5%
2(b)	Major Endoxerosis	1.5%
3	Deviations specified in items 1 and 2 collectively	1.5%
4	Factors that may cause decay:	
4(a)	Major injuries	1.5%
4(b)	Minor injuries	4%
4(c)	Skin weakness	2%
4(d)	4(a) and 1 collectively	3%
4(e)	4(a, b, c) and 1	5%
5	Greening disease	2.5%
6	Superficial black fungus growth	2.5%
7	Granulation	
7(a)	Major granulation	2%
7(b)	Minor granulation	Permissible
8	Scale	4%
9	Blemishes, wilt, shrivelling, skin defects, malformation, bruises, underdeveloped or out of season, over ripeness, hail marks, oleocellosis and foreign matter	4%#
10	Long stems	4%
11	Insufficient external colour development	10%
12	Absence of buttons	20%
13	Packing requirements	10%

14	Incorrectly sealed flaps (excluding loose flaps)	5%
15	Loose flaps	Not allowed
16	Minimum diameter (too small)	10%
17	Lack of uniformity in size in the same container	10%
18	Deviations from prescribed marking requirements, excl. date codes	2 containers per consignment
19	Unpunched out ventilation holes	4%
20	Absence of date codes	50%
21(a)	Deviations not specified in items 1 to 7 of this table collectively, that affect the exterior appearance of the fruit	10%
21(b)	21(a), 1 – 6 Collectively, excluding 7(b)	10%
22	Dirty fruit	10%
23	**Internal quality**	
23.1	Minimum juice content	40%
24	**Minimum colour$**	
24.1	Set no. 37	print no. 4 with a 10% tolerance to print no. 5 only

$ Colour must be uniform in the same container
# A maximum average tolerance of 4% is allowed for blemishes. The total deviations of all external factors may not exceed 6%, excluding colour and the absence of buttons.

The production manager must now integrate these requirements to ensure that the standards for all markets are adhered to. Production planning is done in line with the requirements that have been identified, and the necessary quality management system, such as for instance HACCP, is put in place to ensure that standards are achieved.

The production manager must remember that, due to the multiple fruit set pattern of lemons, plant protection products would only be used as specified during the first spring blossoming and fruit set period. Special caution has to be exercised to ensure that pesticides applied to protect later sets do not result in unacceptable residues in fruit remaining on the trees from earlier sets.

In addition social and environmental requirements are assessed and integrated. Systems and programs to ensure adherence to these requirements are designed, planned and implemented.

Lastly, a recordkeeping system that enables full traceability must be designed and implemented in accordance with the integrated requirements. Records are also used for internal as well as external audits that are implemented to ensure that the standards and requirements are met.

Because varieties are generally suitable to specific regions with particular climatic and soil conditions, farms in an area tend to produce the same varieties and target the same export markets. For example, valencias produced in Letsitele region will typically be exported mostly to the UK, Europe, and the Middle East, while clementines produced in the Citrusdal area would be exported mostly to the USA.

It can be beneficial for growers in an area to share their knowledge of export markets and cooperate in the implementation of production practices that meet the requirements of those markets. For example, growers in the Citrusdal area must work together to ensure that they retain their blackspot-free status, which is a requirement for exporting to the USA. If one grower in the area does not implement proper production practices, the status of the entire area may be in jeopardy.

Another very good example of grower cooperation on a much wider scale was the formation of the organisation Citrus Research International (CRI). The CRI is entirely grower owned and supported, and is responsible for coordinating and conducting all research required by citrus growers in Southern Africa.

The majority of this research is oriented towards maintaining and improving market access, but also includes improving production practices to suit the needs of export markets.

4. Managing the Implementation of Market Requirements

Once all the necessary plans and strategies have been designed and implemented, ongoing management is vital to ensure that standards are maintained. The best system in the world, implemented perfectly at first, may not accomplish its goals and ensure food safety if it is not constantly monitored and managed.

Every person that comes into contact with export citrus in the production cycle, from the person responsible for irrigation to the pickers and packers, must be aware of food safety and quality standards, with a very clear idea of the manner in which they need to perform their specific tasks to ensure that standards are maintained.

Workers must also be familiar with the requirements and procedures of the food safety and quality systems that are implemented on the farm. While recordkeeping and traceability are the responsibility of the grower and management, these systems are implemented to a large extent by the workers. If every person is not aware of its importance and requirements, it will not be implemented on an ongoing basis in the required manner.

Hazard Analysis and Critical Control Point (HACCP) systems are used on many farms to ensure that quality standards are maintained in all areas. The procedures that are developed as part of this system are documented in the form of Standard Operating Procedures (SOPs), with which all workers must also be familiar.

Chapter 1

- The South African citrus industry is export oriented with about 60% of commercially grown citrus exported as fresh fruit.
- Production practices are geared toward maximising the export crop by ensuring that the requirements of foreign consumers are met.
- The most important factors that determine which market is targeted by a grower are citrus types and cultivars, production volumes, commercial certification, external and internal fruit quality, and local pest and disease pressure and phytosanitary market requirements.
- For food safety there are both legal and commercial minimum requirements. Examples of commercial requirements are GlobalGAP and Nature's Choice.
- Once a market has been identified as a possible target market, it is essential that the grower researches all the requirements of the market and adjust production and handling practices accordingly.
- It can be beneficial for growers in an area to share their knowledge of export markets and cooperate in the implementation of production practices that meet the requirements of those markets.
- Once all the necessary plans and strategies have been designed and implemented, ongoing management is vital to ensure that standards are maintained.
- Every person that comes into contact with export citrus in the production cycle must be aware of food safety and quality standards.

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

Chapter 2

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

Develop a food safety and quality management system to meet market requirements within the agricultural supply chain.
Implement and manage a food safety and quality management system in the agricultural supply chain.
Analyse existing food safety and quality management systems in the agricultural environment.
Evaluate, take corrective action and make improvements to ensure the effectiveness / efficiency of the food safety and quality management system.

1. Quality Management and Food Safety Systems

The implementation of food safety management systems (FSMS) and quality management systems (QMS) were discussed in detail in the learning material for previous levels. In the table below is a brief summary of the steps for the implementation of a formal quality control system.

Step Number	***Step***	***Description***
1	Obtain the Standard	A Standard prescribes the requirements of a type of QMS or FSMS. Before preparing for application, obtain a copy of the standard and familiarise yourself with it. The standard may have to be purchased.
2	Review implementation support systems such as literature and software	There is a wide range of quality publications and software tools designed to help one to understand, implement and become registered with a QMS.
3	Assemble a team and agree on a strategy	The implementation process begins with the preparation of an organisational strategy with top management. The QMS is the responsibility of senior management, and it is vital that they are involved in the process from the beginning.
4	Consider the training needs at all levels of the organisation	Assess the skills development needs of all employees that will be involved with the implementation of the QMS. Find out about workshops, seminars and training courses that may be available.
5	Review consultancy options	Seek advice from independent consultants on how best to implement the quality management system. Ensure that the consultants have the necessary experience and track record.
6	Choose an certification body and auditors	A certification body assesses the effectiveness of the QMS and issue a certificate if it meets the requirements of the standard. Identify the certification body at this point, although the first audit will occur after the QMS is implemented. Factors to consider when choosing a certification body include industry experience, geographic coverage, cost and service levels.
7	Develop a Quality Manual	A Quality Manual is a high level document that outlines the intent of achieving a quality standard. It outlines the manner in which the business operates, what the intentions are, and how the standard is to be applied.

Step Number	***Step***	***Description***
8	Develop support documentation	Support documentation is typically a Procedure Manual that supports the Quality Manual. It details what it to be done to complete a task. It describes who does what, in what order and to what standard.
9	Implement the Quality Management System	The key to implementation is communication and training. During the implementation phase everyone operates in line with the standard procedures and generates records and proof that demonstrate that the procedures are being adhered to.
10	Consider a pre-assessment	A pre-assessment by the certification body normally takes place about six weeks into the implementation phase. The purpose of the pre-assessment is to identify areas where operations may not be compliant to the standard. This allows one to address areas of concern before the audit.
11	Gain certification	The initial audit is arranged with the certification body. The appointed auditor reviews the QMS and determines whether a recommendation for certification should be made.
12	Continual assessment	To maintain certification the QMS is checked periodically by the standard owner to ensure that it continues to meet the requirements of the standard.

Table 2.1: Steps for Implementation of Quality Management System

The most well-known quality management systems are ISO22000 and HACCP. Many citrus growers hold additional certification for voluntary systems such as GlobalGAP, BRC, Natures Choice, Fair Trade and others, to ensure that they remain a first choice supplier and conform to the requirements of specific buyers. It would be futile for an organisation to spend a lot of money implementing a voluntary and very demanding quality assurance system if the benefits from improved market access cannot justify its implementation.

All these systems are excellent tools to ensure that quality standards are maintained and will provide food safety guarantees if they are implemented, managed and maintained correctly.

There are many reasons why quality management systems (QMS) and food safety management systems (FSMS) fail, or fail to produce the desired outcome. This does not necessarily mean that the design of the system is not appropriate – it may be that implementation of the systems fails. Failures might be due to the original implementation and design of the systems, or it might be due to a lack of resources, infrastructure or capacity in the organisation. Some systems may be inherently effective, but may not meet the requirements of a specific market or customer. It may be that small modifications at strategic points in the system are necessary for organisations to meet the requirements in terms of produce quality and food safety assurance.

The key is to remember that all systems have to be maintained, evaluated, adapted and improved continuously. It is also important to remember that these systems are not rigid, and should be adapted to the organisation, and its workforce, resources and capacity.

The most important considerations when analysing an existing food safety management system are:

- **Process**, including procedures and mechanisms
- **Infrastructure** such as facilities, tools, and equipment
- Physical, chemical and microbiological **hazards**

The elements of an effective FSMS and QMS are as follows:

- Traceability
- Recordkeeping

- Variety and cultivar selection (including genetically modified organisms and seed quality)
- Site management
- Assessment of soil history
- Soil quality management
- Agrochemical application (taking into account maximum residue levels)
- Product handling
- Waste and pollution management
- Focus on social welfare
- Environmental management
- Internal auditing
- Measurement, evaluation and improvement

2. The Role of Measurement, Evaluation and Improvement

By now you should have a thorough understanding of all the elements of a QMS, with the exception of measurement, evaluation and improvement. Figure 2.1 is a schematic representation of the decision-making process for the ISO22000 model that indicates the importance of this element.

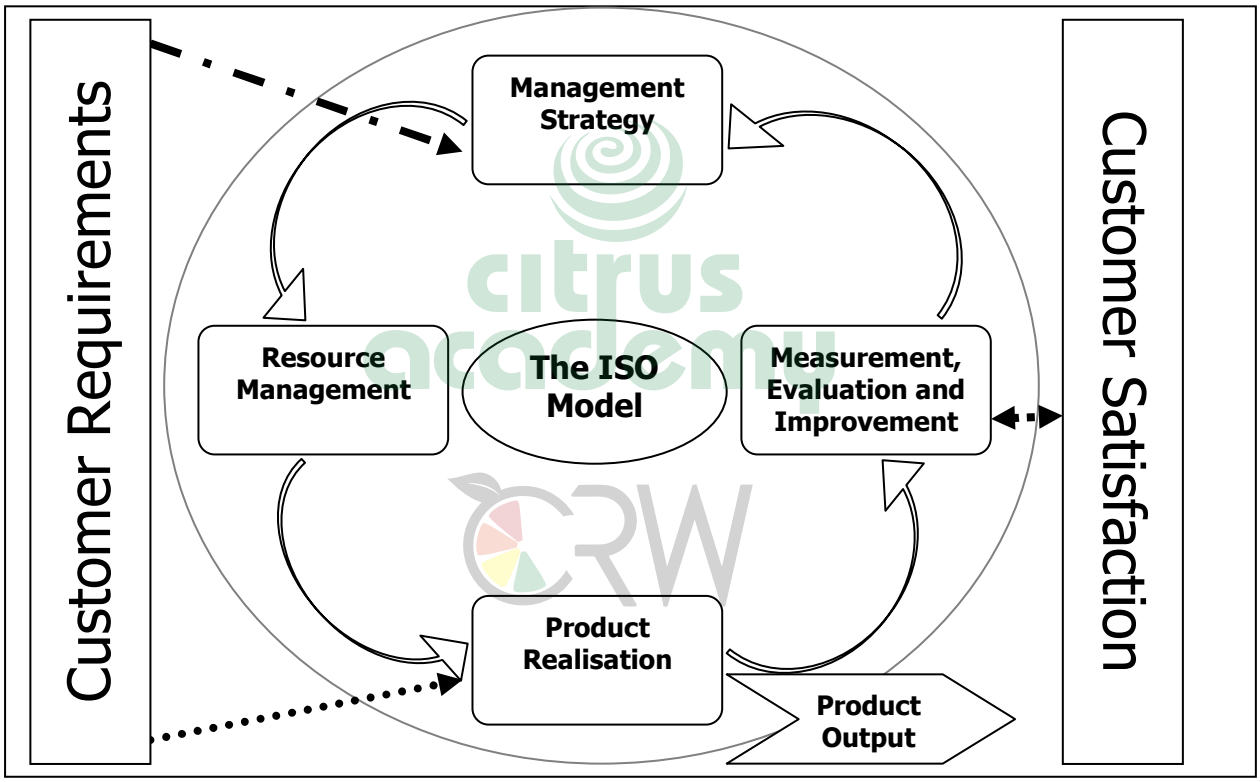


Figure 2.1: ISO Model of Continual Improvement

The main areas for measurement, evaluation and improvements in the citrus production are:

- Application of crop protection products
- Control of phytosanitary pests
- Orchard sanitation
- Crop estimation and maturity indexing
- Harvest procedures and transportation

3. Measurement and Assessment

It has been said that "you can't manage what you don't measure". The ability to accurately measure and assess data related to FSMS and QMS depends on the quality of the recordkeeping system. In level 3 and 4 learner guides effective recordkeeping and traceability systems are discussed in detail.

It is important to remember that the overall objective of a food safety management system and an integrated quality management system is to produce the best quality produce that meets food safety standards and market requirements and expectations. Keep this overall objective in mind when collecting data and measuring performance. Do not fall into the trap of analysing all the data for all strategic objectives – focus on those pertaining to FSMS and QMS, and only analyse additional data related to problem areas.

The data that is collected from the recordkeeping system must be assessed for its relevance to assessing the effectiveness of the FSMS and QMS.

Data collation is a systematic and objective process. There are many analytical systems and software available to assist in the process. One example of a model for use is the "Sydney Model" developed by ISO, for aligning the QMS with the achievement of organisational and business success.

A simple representation of this data analysis principle is demonstrated in figure 2.2, with the gap or shortfall identified by the large white arrow.

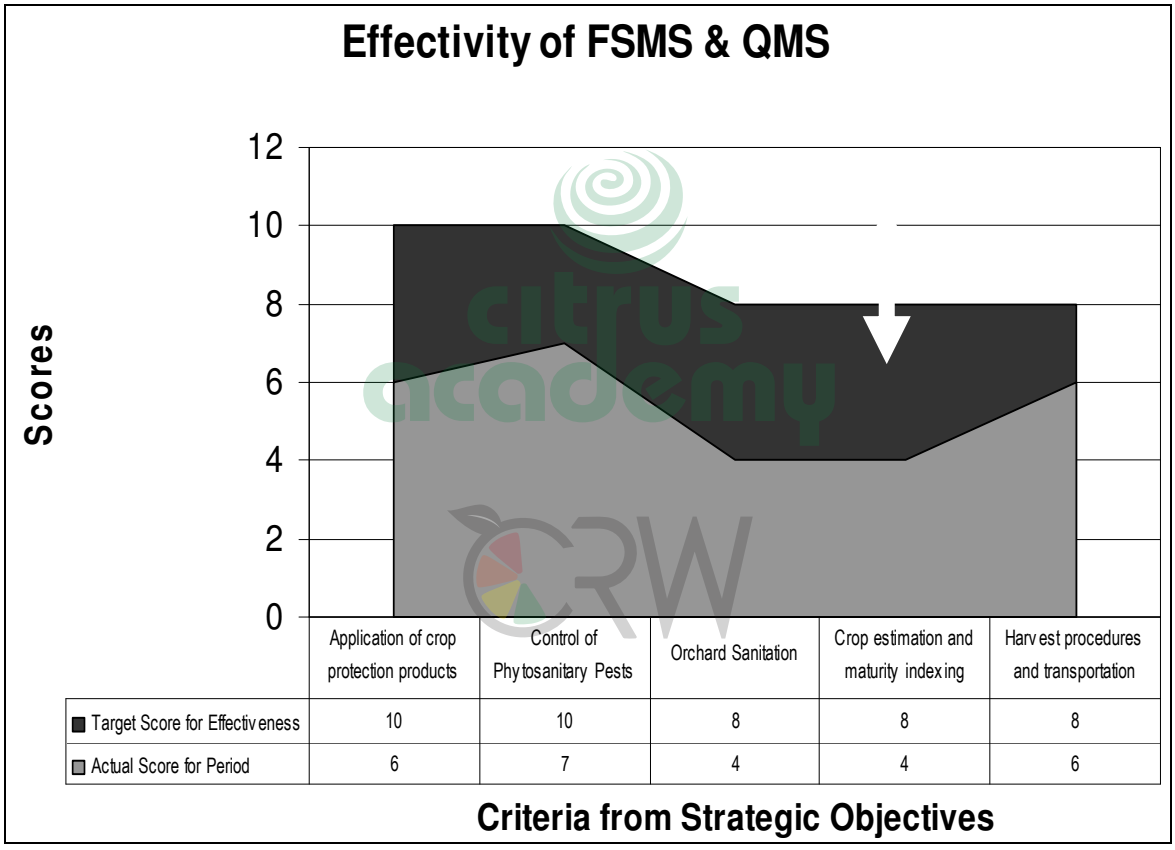


Figure 2.2: Data Analysis

4. Evaluation

Once all the relevant data has been collected, collated and analysed, an evaluation of the system can be done.

The flow diagram in figure 2.3 demonstrates the process of evaluation. Note that the evaluation process always ends in recommendations for action that must be taken. The objective of this process must be to improve the system.

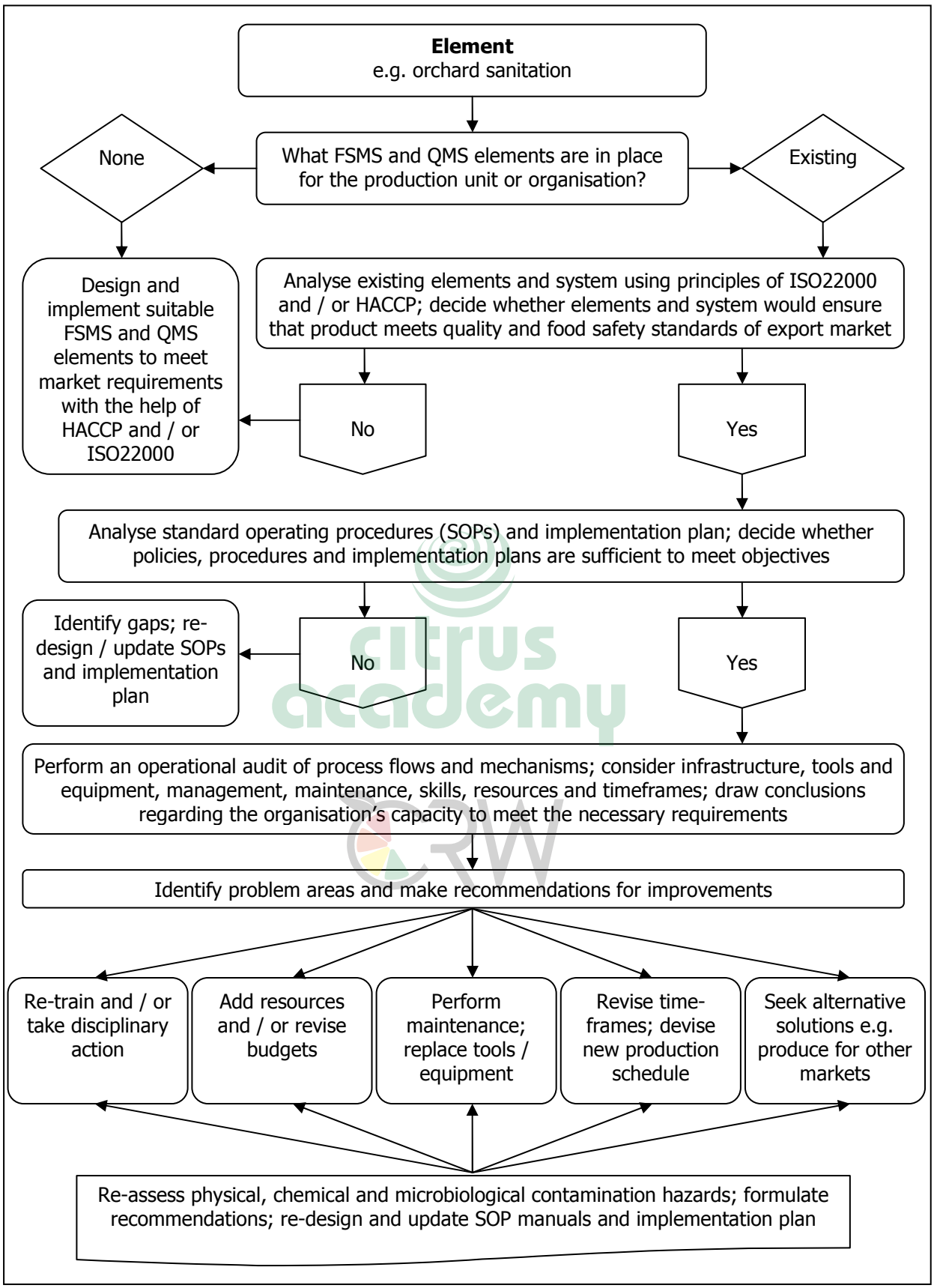


Figure 2.3: Process Evaluation Flow Diagram

5. Recommendations for Improvements

Recommendations and conclusions drawn from analysis and evaluation should bear the following principles in mind:

- ***Long-Term Sustainability***– Quality and food safety is dependent on balancing and satisfying the needs of all relevant stakeholders, including shareholders, employees, customers, suppliers and society in general.

- ***Customer Focus*** – The customer is the final arbiter of product and service quality. Customer loyalty, market retention and gain in market share are best optimised through a clear focus on the needs of current and potential customers.

- ***Leadership and Constancy of Purpose*** – The behaviour of on organisation's leaders determines the clarity and unity of purpose within the organisation and whether it is an environment in which the organisation and its people can excel.

- ***Management by Processes and Facts*** – Organisations perform more effectively when all interrelated activities are understood and systematically managed, and when decisions concerning current operations are planned. Improvements can only be made using reliable information that includes stakeholder feedback.

- ***People Development and Involvement*** – The full potential of an organisation's people is best released through shared values and a culture of trust and empowerment, which encourages the involvement of everyone.

- ***Continuous Learning, Innovation and Improvement*** – Organisational performance is maximised when it is based on the management and sharing of knowledge within a culture of continuous learning, innovation and improvement.

- ***Partnership Development*** – An organisation works more effectively when it has mutually beneficial relationships with its partners, built on trust, sharing of knowledge and integration.

- ***Public Responsibility*** – The long-term interests of the organisation and its people are best served by adopting an ethical approach and exceeding the expectations and regulations of the community at large.

Chapter 2

- The steps for the implementation of a formal quality control system are as follows:
  - 1 – Obtain the Standard
  - 2 – Review implementation support systems such as literature and software
  - 3 – Assemble a team and agree on a strategy
  - 4 – Consider the training needs at all levels of the organisation
  - 5 – Review consultancy options
  - 6 – Choose an certification body and auditors
  - 6 – Choose an accreditation body and auditors
  - 7 – Develop a Quality Manual
  - 8 – Develop support documentation
  - 9 – Implement the Quality Management System
  - 10 – Consider a pre-assessment
  - 11 – Gain certification
  - 12 – Continual assessment
- The most well-known quality management systems are ISO22000 and HACCP, and many citrus growers hold additional certification for voluntary systems such as GlobalGAP, BRC, Natures Choice, Fair Trade and others.
- The most important considerations when analysing an existing food safety management system are process, including procedures and mechanisms; infrastructure such as facilities,

tools, and equipment; and physical, chemical and microbiological hazards.

- The main areas for measurement, evaluation and improvements in the citrus production environment to ensure quality and food safety are application of crop protection products, control of phytosanitary pests, orchard sanitation, crop estimation and maturity indexing, and harvest procedures and transportation.
- The ability to accurately measure and assess data related to FSMS and QMS depends on the quality of the recordkeeping system.
- Once all the relevant data has been collected, collated and analysed, an evaluation of the system can be done.
- Recommendations and conclusions drawn from analysis and evaluation should be results oriented, focused on the customer, show leadership and constancy of purpose, display management by processes and facts, and encourage people development and involvement, continuous learning, innovation and improvement, partnership development, and publich responsibility.

Complete activities 2, 3 and 4 in the **Learner Workbook**.

Chapter 3

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

Design a traceability system for operational efficiency in the agricultural supply chain.

1. Introduction

Traceability systems help growers and production managers to isolate the source and extent of safety or quality control problems. This helps to reduce the production and distribution of unsafe or poor-quality products, which in turn reduces the potential for bad publicity, liability and recalls. The better and more precise the tracing system, the faster a grower can identify and resolve food safety or quality problems.

The principles of traceability and traceability systems have been discussed in detail in the learning material on levels 2, 3 and 4. By now you should have a thorough understanding of the requirements for and objectives of traceability.

In the first two chapters we examined the elements of an integrated FSMS and QMS and its implementation, management and evaluation. A good FSMS and QMS might still have shortcomings in tracking and tracing the correct information that would be required by an effective traceability management system. In this chapter we will consider how traceability aspects are tied into each element of an integrated FSMS and QMS.

2. The Scope of a Traceability System

ISO (International Organisation for Standardization), who develop voluntary international standards for products and services, defines traceability as *"the ability to trace the history, application, or location of that which is under consideration"*.

This is a broad definition that does not specify a standard measurement for "that which is under consideration" (one valencia orange or a truckload), a standard location size (field, farm or country), a list of processes that must be identified (pesticide applications or social welfare), or a standard identification technology (pen and paper or computer). For example, it does not specify that a hamburger should be traceable to the cow or that a loaf of bread should be traceable to the field where the wheat was grown.

The definition of traceability is necessarily broad because food is a complex product and traceability is a tool for achieving a number of different objectives. No traceability system is likely to cover all potential functions. Even a hypothetical system for tracking citrus in which consumers scan their pocket of oranges at the checkout counter and access the harvest date, orchard location, cultivar, producer history, plant protection product application records, fertiliser application records, and use of genetically modified organisms and rootstocks, might not provide information about the shipping of the fruit, the bacterial control in the orchard, the bacterial control around the packhouse, or provide accurate data on worker health or groundwater bacterial counts.

A system for tracking every input and process to satisfy every objective would be enormous and very costly. Consequently, growers have developed appropriately detailed systems for specific purposes, having determined the necessary **breadth**, **depth**, and **precision** of their traceability systems depending on characteristics of their production process and their traceability requirements.

2.1. The Breadth of a Traceability System

The **breadth** of a traceability system relates to the **amount of information** collected by the system related to a specific product. A recordkeeping system cataloguing all the attributes of a product would be overwhelming, unnecessary and expensive. The information that is collected is determined by the type of product and requirements of the market that the fruit is destined for.

Consider as an example a glass of orange juice. The oranges could come from any number of growers from different areas. The oranges could have been sprayed with numerous plant protection products or just a few, grown on huge corporate farms or on small family-run conventional farms. They could have been harvested by hand or by machines, and pressed using either manual or mechanical lines with exposure to solvents or hot water. Few, if any, consumers would be interested in all this detail provided the juice was safe for consumption. The breadth of most traceability systems would therefore exclude some of these attributes and make sure the critical information is available to demonstrate the juice is suitable for consumption.

2.2. The Depth of a Traceability System

The **depth** of a traceability system relates to **how far back or forward the system tracks** the relevant information. A traceability system for decaffeinated coffee would extend back only to the processing stage. A traceability system for Fair Trade coffee might extend to information on price and terms of trade between coffee growers and processors. A traceability system for fair wages would extend to harvest and cultivation. A system for non-genetically engineered products must extend to how the propagation material (bean or seed) was handled.

For food safety the depth of the traceability system depends on where hazards could enter the food production chain. For some health hazards, such as Bovine Spongiform Encephalopathy (BSE or Mad Cow Disease), ensuring food safety requires establishing safety measures at the farm. For other health hazards such as food-borne pathogens, organisations may need to establish a number of critical control points along the entire production and distribution chain.

2.3. The Precision of a Traceability System

The **precision** of a traceability system reflects the **degree of assurance** with which the tracing system can pinpoint a particular product's movement or characteristics. More precise traceability systems may be able to identify a particular carton on a particular pallet, as part of a consignment, in a particular warehouse. Less precise traceability systems may only be able to identify the location of a consignment and have no information about the cartons and pallets making up that consignment. Again, the precision of a system must be aligned to the overall objectives for implementing that traceability system.

3. Designing and Implementing An Internal Traceability System

Conceptually, it is possible to have a separate internal and external traceability system. Consider a plant that mixes fruit juices and receives raw materials from different suppliers. The raw materials are mixed to create a final product. For effective **internal** traceability the raw materials must be linked to batches of final product. An **external** traceability system would be used to trace the batches of final product only, because not all the detail about what occurred within the facility would be of interest to the next receiver of the goods.

This section deals with internal traceability systems, but in practice both the internal and external traceability systems work very closely and it may not be easy to separate the two. In fact, the principles for designing and implementing an internal system apply equally to an external system.

Traceability is multi-disciplinary because many departments (sections) of an organisation are involved in its development and implementation. Besides the food quality and safety managers, it is likely the logistics and IT managers would also need to be involved. The marketing and financial departments will also benefit from a traceability system. A fundamental decision to take at the beginning of this process is to define who has internal responsibility and who would benefit from traceability system.

Once the right team has been assembled, it is necessary to determine the scope of the traceability system to meet the specific purpose of your organisation. In other words, the breadth, depth and precision must be discussed and agreed upon. Once these parameters are known one can begin either creating a home-grown system or start looking for systems that can be purchased and that can deliver on the required specifications.

Home-grown systems are not discussed in much detail here given the potentially wide range of needs and circumstances that these systems would be implemented in. Therefore the next section considers the types of commercial traceability systems currently available in South Africa. The purpose here is not to focus on the company providing the traceability system, but rather to learn what each type of system offers.

3.1. Types of Traceability Systems

Most traceability systems that are commercially available in South Africa are based on internationally accepted methods of identifying products, consignments, containers and locations. The benefit of aligning with these internationally accepted coding standards means trade units need not be re-labelled along the supply chain, and both growers and retailers can "see" up and down the supply chain to establish where the fruit is because the information systems "talk" the same language.

The GS1 standard, which evolved from the EAN.UCC standard, is the most commonly used standard globally. GS1 is a global organisation dedicated to the design and implementation of global standards and solutions to improve the efficiency and visibility of supply and demand chains across sectors. Consumers will be familiar with the GS1 system of standards as most products purchased at retailer stores have their bar codes printed on the item. The Consumer Good Council of South Africa ensures that companies that adopt the GS1 systems of standards use these GS1 standards correctly.

Paltrack is the most widely used fruit management and traceability system in the South African fruit industry. Paltrack conforms to the GS1 standards. Like most traceability systems, Paltrack prints labels that are stuck onto each pallet. These labels have bar coding which allows for machine reading (scanning) of the pallet and also shows human-readable information. See the resource references below for a list of other service providers.

Radio frequency identification (RFID) is a growing technology that utilises radio frequencies to identify products, pallets, consignments etc., throughout the supply chain. Recent EAN.UCC standardisation developments in the field of RFID are internationally known as the Electronic Product Code (EPC) Network. RFID technology is more expensive but as the costs of producing the tags decreases, the benefits may begin to outweigh the costs and more companies will adopt the tags.

Resource References

For more information look at the following resources:

Efficient Consumer Response	www.ecrnet.org
GS1 Global	www.gs1.org
GS1 South Africa	www.cgcsa.co.za
Paltrack	www.paltrack.co.za
DiPAR	www.dipar.co.za
Farsoft Information Technology	www.farsoft.co.za

3.2. Selecting a Traceability System

When selecting a traceability system, the value of such a system needs to be considered against the cost. Because the implementation of a traceability system requires upfront investments, organisations are advised to take all costs (risks) and benefits into consideration. This process will therefore include a cost / benefit analysis.

The expenditure involved should be considered as a long-term strategic investment given the role it will play in maintaining positive consumer perception of the company, and the trust that consumers will continue to display when buying a product.

It is of great importance to define the exact specifications for the products to be traded (**breadth**) and on batch sizes (**precision**). Batch sizes can be based on production or run time, on volume, or on expiry date. To successfully trace to ever greater detail, i.e. to product or small batch level, increases the costs of the traceability system. Deciding to use big batches as the traceability unit will probably make the system less costly, but will increase the risks (if a problem arises more products will be involved).

For export fruit the product must be traceable at least to a pallet level. In other words, the **precision** of the traceability system must be at least at pallet level. Based on the cost / benefit analysis, the ideal balance should be sought between present, investment and future costs.

3.3. Implementing an Internal Traceability System

Once the team has been assembled, the scope of the system has been defined and the cost / benefits exercise has been completed, two further considerations must be given attention before implementing the internal traceability system, namely planning and identifying a driver for the process.

3.3.1. Planning

To reduce the impact of the implementation process on the day-to-day activities of the operation, a clear step-by-step plan should be developed well in advance. Guidelines for drafting such a plan include:

- Have all the technical requirements for implementing the system been considered, for example are there enough electricity points, is it necessary to change the path that fruit flows through the packhouse, etc.?
- When should the traceability system be implemented, for example in the off season or during the season, or perhaps at the end of the season in preparation for next year?
- How long will it take to implement?
- Who will be required during the implementation process, and how much of their time will it take?
- Will those involved in capturing data and managing the system require training? Does this involve on-the-job training or can it be done off-site? Who can conduct this training? How much will it cost?
- Can milestones or target dates for phases of implementation be set? What if the process is heavily delayed?

Once the implementation plan has been drafted, all the people that will be involved in the process must be briefed about their roles to ensure that they have a clear idea on what will be required from them.

3.3.2. Selecting a Driver

Since an internal traceability system affects many sections of a business, as discussed above, it is important to identify a single person that will take responsibility for the implementation process. This person's job will be to engage with each of the sections, keeping them updated on progress, and helping to address teething problems as they arise.

3.4. Monitoring Traceability Systems

Many buyers, including restaurants and some supermarket chains, now require their suppliers to verify, often through third-party certification, that their internal traceability systems work effectively. The growth of third-party standards and certifying bodies is helping to push the entire food industry toward documented, verifiable traceability systems.

Traceability is also a legal requirement in terms of South Africa's food safety laws and it is therefore incorporated into the various checklists used by the officially assigned body to conduct audits. Capacity has been created at the Perishable Products Export Control Board (PPECB) to help with all aspects of traceability management, from design, through implementation to on-going monitoring and verification. Additionally, there are various recognised specialists who operate independently from the system providers and can be consulted to assist with all aspects of traceability management systems.

4. External Traceability

With effective internal traceability systems in place, the next step is to achieve external traceability. The main requirements for handling withdrawals and recalls across the supply chain is having reliable data, data exchange capability, and properly mapped business processes.

A good internal traceability system is a prerequisite to an external traceability system. The investments in an internal traceability system will not be wasted in moving towards external traceability. All good external traceability software should be able to integrate seamlessly to any internal system.

From an information management point of view, implementing a traceability system within a supply chain requires all parties involved to systematically associate the relevant data with the physical flow of raw materials, and intermediate and finished products.

This is best attained by deploying a common business language, such as GS1 discussed above.

Because of GS1's ability to provide globally unique identification of trade items, logistic units, parties and locations, standards such as the GS1 system are particularly well suited to be used for traceability purposes. The GS1 standards provide a global business language that is used to enable accurate and fast communication between different internal traceability systems used by suppliers, manufacturers and retailers around the world. Again it is critical to determine what your main clients require in terms of a business language they can interpret.

As an example, the elements of GS1 Standard are considered here in more detail:

- ***Identification of Locations*** – Unique identification of locations is ensured through the allocation of a GS1 Global Location Number (GLN) to each location and functional entity (i.e. packhouses, farms, cold stores).

- ***Identification of Lots / Batches*** – Traceability of lots and batches (consignments) is ensured through the allocation of an GS1 Global Trade Item Number (GTIN).

- ***Identification of Trade Items*** – Unique product identification is therefore ensured through the allocation of the GS1 Global Trade Item Number (GTIN) to each and every product (consumer unit) within that consignment.

- ***Identification across Product Hierarchies*** - A GTIN needs to be allocated to each of the three levels of the product hierarchy, namely consumer unit, traded unit and pallet.

- ***Identification of Logistic Units (Pallets)*** – For logistics purposes, identification and traceability of pallets are ensured through the allocation of a GS1 Serial Shipping Container Code (SSCC), which is a combination of the GTIN and GLN. Every pallet, independently of its type must carry an SSCC allocated at source. A new SSCC must be allocated to every new pallet, especially if it is reconstituted at a location down the supply chain.

- ***Data Capture and Recording*** – Products, standard trade items, and pallets identified with applicable GS1 standards (GTIN, SSCC, Application Identifier (AI)) must be bar coded in relevant GS1 bar code symbols.

Figure 3.1: Example of EAN/UPC Barcode

Figure 3.2: Example of UCC/EAN-128 Barcode

EAN International has defined key traceability principles and produced an implementation grid, which links them to enabling technologies and relevant GS1 system tools.

Traceability Principles	***Enabling Technologies***	***GS1 System Tools***
Unique Identification	Automated Identification	GTIN, SSCC, GLN, Application Identifiers
Data Capture and Recording	Automated Data Capture	EAN/UPC, UCC/EAN-128
Links Management	Electronic Data Processing	Software Applications
Data Communication	Electronic Data Interchange (EDI)	Eancom®/XML

Table 3.1: EAN International Implementation Grid

The example below demonstrates the external traceability with the GS1 system.

GS1 System Application

1. Consumer	The consumer signals an anomaly in the sales transaction, and reports this to the retailer, who contacts the distributor.
2. Distributor	The distributor relays the complaint to the supplier and the product manufacturer, specifying the item reference (Global Trade Item Number - GTIN).
3. Manufacturing Plant	The manufacturer identifies the raw material associated with the anomaly and identifies the corresponding upstream supplier (Global Location Number – GLN).

4. Upstream Supplier	The upstream supplier analyses the cause of the anomaly, identifies the production batches associated with all units shipped from these production batches (Serial Shipping Container Code - SSCC), and informs receiving customers about the nature of the problem and the batch number of the raw material in question.
5. Manufacturing Plant	The manufacturer decides to withdraw the finished products related to the problem. Through its traceability system, the manufacturer searches its records for batches of finished products for which the raw material in question has been used, identifies the SSCC of cartons and pallets containing batches of finished products to be withdrawn (which may be in the process of being delivered, in external storage and / or already delivered to customers), quarantines the cartons and pallets still present in its stocks, identifies customers (GLN), and provides them with information related to products to be quarantined and returned (SSCC, GTIN, batch numbers).
6. Retail Distribution Centre	The retail distribution centre identifies the cartons and pallets (SSCC) to be quarantined and returned from the stock picking and shipment areas, and those already delivered at the retail points of sale, removes and returns affected products still within its premises (SSCC), and provides retail stores with the SSCC, GTIN and batch number of the items to be removed.
7. Point of Sale	Retail store quarantines suspect products (GTIN and batch number).

The ability to retrieve traceability data in a fast and accurate manner along a supply chain is critical. This requires the management of successive links between what is received, produced, packed, stored, and shipped across the entire supply chain.

If one of the partners in the supply chain fails to manage these links, this will result in a break in the information chain and in the subsequent loss of traceability. It is impossible to attain full product traceability without correctly identifying products in all their configurations at each different point in the supply chain.

For data exchange (how information is passed from one IT system to the next), the applicable GS1 standards are EANCOM® and GS1 XML messages. In a majority of supply chains, products are tracked and traced by their production batch, which has undergone the same production process, and by their transport and storage path (distribution process).

GS1 standards for links management and traceability in a production environment are applied as follows:

- ***Reception*** – The SSCC of an incoming pallet is recorded and linked to the GLN of the supplier. Each time the pallet is moved its SSCC is recorded and linked to the GLN of its new location.

- ***Production*** – Under ideal conditions the SSCC of the pallet and/or GTIN and batch number of materials used in the production process are recorded and linked to the GTIN of the product made and its production batch. At the end of the production process, standard trade item groupings are made from individual products. A new GTIN is assigned and linked to the production batch number.

- ***Packaging, Storage and Expedition*** – The GTIN of a standard trade item grouping is linked to the SSCC of the pallet onto which it is packed. The SSCC of an outbound pallet is linked via scanning to the GLN of its destination. The GLN of its destination must not necessarily be displayed on the label.

Chapter 3

- Traceability systems help growers and production managers to isolate the source and extent of safety or quality control problems.
- The definition of traceability is necessarily broad because food is a complex product and traceability is a tool for achieving a number of different objectives.
- It is necessary to determine the breadth, depth, and precision of a traceability system, depending on the characteristics of the production process and the traceability requirements.
- The breadth of a traceability system relates to the amount of information collected by the system related to a specific product.
- The depth of a traceability system relates to how far back or forward the system tracks the relevant information.
- The precision of a traceability system reflects the degree of assurance with which the tracing system can pinpoint a particular product's movement or characteristics.
- Traceability is multi-disciplinary because many departments (sections) of an organisation are involved in its development and implementation.
- Once the right team has been assembled, it is necessary to determine the scope of the traceability system to meet the specific purpose of your organisation.
- Most traceability systems that are commercially available in South Africa are based on internationally accepted methods of identifying products, consignments, containers and locations.
- The GS1 standard, which evolved from the EAN.UCC standard, is the most commonly used standard globally.
- Radio frequency identification (RFID) is a growing technology that utilises radio frequencies to identify products, pallets, consignments etc., throughout the supply chain.
- The implementation of a traceability system requires upfront investments, therefore organisations are advised to take all costs (risks) and benefits into consideration, which requires a cost / benefit analysis.
- Two further considerations that must be given attention before implementing the internal traceability system are planning and identifying a driver for the process.
- To reduce the impact of the implementation process on the day-to-day activities of the operation, a clear step-by-step plan should be developed well in advance.
- Since an internal traceability system affects many sections of a business, as discussed above, it is important to identify a single person that will take responsibility for the implementation process.
- Many buyers now require their suppliers to verify, often through third-party certification, that their internal traceability systems work effectively.
- Traceability is also a legal requirement in terms of South Africa's food safety laws and it is therefore incorporated into the various checklists used by the officially assigned body to conduct audits.
- For external traceability, the main requirements for handling withdrawals and recalls across the supply chain is having reliable data, data exchange capability, and properly mapped business processes.
- GS1 standards for links management and traceability in a production environment are applied through reception, production, and packaging, storage and expedition.

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

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