

LEARNER GUIDE

Harvesting

Level 3



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Title:		Monitor and Coordinate the Harvesting of Agricultural Crops					
Applied Title:		Monitor and Coordinate the Harvesting of Citrus					
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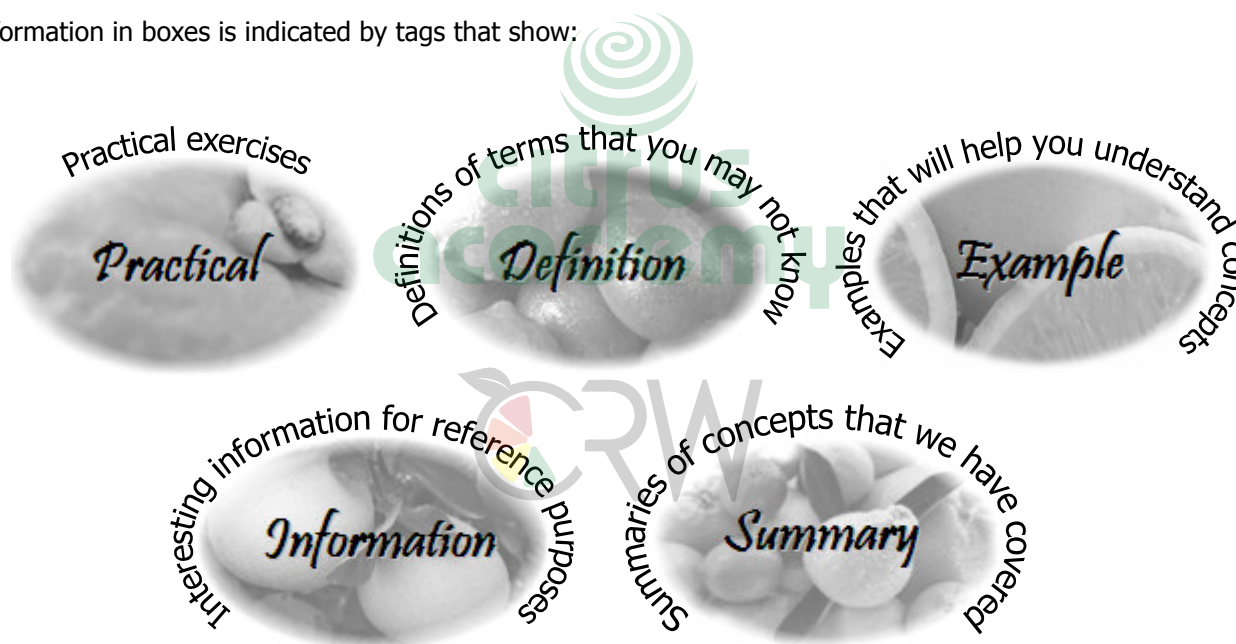
This learning material has been developed to assist the learner wishing to complete this unit standard. The guide contains all necessary learning to ensure that the learner will attain the competencies required by the unit standard.

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

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

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

Information in boxes is indicated by tags that show:



Introduction

1. Purpose

A learner achieving this unit standard will be able to supervise the harvesting of crops according to the necessary procedures making use of harvesting tools as described in the harvest plan.

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

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

2. Learning Assumed to Be in Place

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

<i>NQF Level</i>	<i>Unit Standard Number</i>	<i>Unit Standard Description</i>
NQF2	Literacy and numeracy	
2	116111	Harvest agricultural crops: Procedures
2	116060	Utilise and perform minor repair and maintenance tasks on implements, equipment and infrastructure.
3	116218	Explain the planning and scheduling of tasks in the production environment.
3	116272	Demonstrate a basic understanding of the physiological functioning of the anatomical structures of a plant.

Revision of Level 2

1. Harvesting Equipment and Tools

- The tools and equipment requirement for harvesting is determined by the number of picking teams and pickers that is required for the picking operation.
- The number of picking teams and pickers that is required is determined by the size of the farm, the cultivar spread, the picking period and the capacity of the packhouse.
- Tools and equipment used commonly during citrus harvesting are clippers, picking bags, ladders, bulk bins or picking trailers, and tractors.
- Clippers are used to cut the stem of the fruit to remove it from the tree.
- Fruit is placed into picking bags, which are emptied into bulk bins or picking trailers.
- Tractors are used to transport the picking trailers, or bulk bins on trailers to the packhouse.
- Tools and equipment must be maintained to limit downtime during the harvesting operation, to prevent injury to fruit, and to minimised risks to worker health and safety.
- Every worker is responsible for maintaining and cleaning the tools and equipment he or she is using.
- The blade alignment and spring action of clippers must be checked before harvesting and regularly during picking.
- Clippers must be sterilised before and during picking.
- Picking bags must be checked before and during harvesting for holes and tears.
- Ladders must be checked for sharp edges, splinters and loose components.
- Bulk bins are cleaned and maintained by the supplier from which the bins are rented.
- Picking trailers and tractors must be serviced before harvesting.
- Tools and equipment must be stored in a secure, clean and dry room.
- Faulty tools and equipment must be reported to the supervisor or manager immediately and repaired or replaced.

2. Sampling for Maturity Indexing

- Fruit maturity can be defined as the point at which the fruit needs to be harvested from the tree.
- Monitoring fruit maturity assists in guiding orchard practices, indicating expected harvesting dates, indicating the picking window, and predicting postharvest fruit behaviour and susceptibility to decay.
- Maturity indexing is the process of monitoring the physiological development of fruit as it ripens.
- External factors that are monitored during maturity indexing are colour, size and firmness.
- Internal factors that are monitored include juice percentage, Brix, acidity, and the Brix to acid ratio.

- Internal factors are measured through sampling and testing.
- Sampling starts two months before the expected start of picking, and is generally done on a weekly basis.
- Juice is extracted from the sample fruit in the laboratory and the juice percentage, Brix and acidity is determined, from which the Brix to acid ratio is calculated.
- The results are plotted on a graph over time, and the trends that become apparent is used to predict future maturation and the expected picking date.

3. Harvesting Crops

- Citrus is generally picked by hand, either by snap picking or clipping.
- Snap picking is faster, but there is a greater danger of injury and damage to the fruit.
- Clipping is slower, but safer, and are used most often.
- To limit damage and injury to the fruit, picking bags must be suspended from the side of pickers, and placed against fruit that is already in the bin or trailer before being emptied, after which all loose twigs and leaves must be shaken from the bag.
- Pickers must walk and not run while carrying picking bags.
- Fruit that are lying on the ground must never be picked up and mixed with export fruit.
- For varieties that are susceptible to oleocellosis, bins and trailers must not be over-filled.
- Fruit must be taken to the packhouse within 24 hours after being picked.

4. Health, Hygiene and Safety during Harvesting

- Every worker involved in the harvesting process must be aware of the health and safety procedures.
- In terms of safety, the actual picking of the fruit, especially where ladders are used, and the transport to the packhouse are the most critical points.
- Workers must wear the prescribed protective clothing at all times.
- Workers must be aware of personal hygiene requirements, including hand-washing and general cleanliness.
- Workers that are suffering from contagious diseases must report this to the supervisor or manager.
- All injuries and other unusual occurrences must be reported to the supervisor or manager immediately.

5. Waste Disposal Requirements

- Orchard hygiene and proper waste disposal is critical in ensuring that the spore load in orchards are minimised and in the control diseases and pests that are hosted in fallen.
- Fallen fruit must be collected and disposed of from before picking starts until all the fruit has been harvested.
- Waste fruit are disposed off in dryer climates by chopping it up and leaving it on the orchard floor to dry out.

- In more humid climates, the fruit must be buried away from the orchard at least 30cm under the soil.
- Waste fruit can also be used to make compost.



Maturity Indexing

Maturity indexing is, simply put, the process of monitoring the **physiological development** of fruit as it ripens. A number of parameters can be used to measure maturity and changes in maturity, such as colour, firmness, juice content, and levels of sugar, acid, and carbohydrate.

Sampling

Sampling means taking a representative portion of a whole for analysis. Always remember the first principle of any sampling, which is that a sample must be **representative** of the bulk of the medium that is being sampled. A sample is not a piece or a section of a whole, but rather a whole reduced to a manageable volume.



Chapter 1

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

Select harvesting equipment and tools for specific agricultural enterprise
Manage the care and maintenance of harvesting equipment

1. Introduction

The equipment used for harvesting citrus ranges from tools such as clippers that are used to cut the fruit off the trees, to tractors that are used to transport the harvested crop from the orchard.

Harvesting must take place as quickly as possible, within the planned timeframe, while care must be taken to make sure that fruit is not damaged in the process. As the harvesting supervisor, you must ensure that enough equipment is available for use. Extra equipment must also be on hand to replace any equipment that gets damaged during harvesting.

Harvesting must be structured and planned in such a way that if any problems arise during harvesting it can be solved and harvesting can continue with the minimum of interruption.

2. Harvesting Tools and Equipment

The tools and equipment that are used most often while harvesting citrus are:

- Clippers
- Gloves
- Picking bags
- Ladders
- Bulk bins and picking trailers
- Tractors

2.1. Clippers

The most common tool used for removing fruit from trees is steel clippers. They are used to cut the stem of the fruit as close to the button, or calyx, as possible without injuring the shoulder of the fruit. Clippers are made from a steel alloy. It has a spring that keeps the clipper in an open position and a finger loop made of leather to help control the clipper during picking.

Clipper blades must always be sharp and must not overlap. If the blades are not sharp or if they overlap, the fruit stem could be torn or cut unevenly, leaving a sharp stem that could damage other fruit. Every person in the picking team must be issued with clippers before the start of the day's harvesting. At least two pairs of extra clippers should be kept on hand by the supervisor to replace clippers that might be damaged during the day.

Clippers should be handed in at the end of the day and must be sterilised, oiled, and inspected to ensure that the blades are sharp and do not overlap, before they are used the next day.

2.2. Gloves

For some types of citrus, a glove is also used while harvesting. The glove must always be on the hand that touches the fruit, i.e. if the picker is right-handed, the glove will be on the left hand with the right hand holding the clippers.

Gloves are made of strong material that won't catch easily on twigs and thorns. Before they are given to the pickers, the supervisor must make sure that there are no tears or holes in the gloves.

At least five extra gloves should be available to a team during picking, to replace gloves that become damaged or soiled during picking. A glove that is wet or soiled must be replaced immediately – remember that soil-borne pathogens can be spread to healthy fruit by soiled gloves.

At the end of the day, each picker must hand in his / her gloves, along with the clippers and picking bag. Check that gloves are still in a good condition and clean, before they are used the next day.

2.3. Picking Bags

Picking bags have a single strap and are slung over the shoulder of the picker. As the picker picks the fruit, it is placed inside the bag until it is full. It is then taken to a general collection point in the orchard where the bags are emptied into bulk bins or picking trailers.

Two types of picking bags are commonly used when harvesting citrus. The one type only has an opening at the top, while the other has a flap at the bottom that can be opened as well.

The type of bag that is only open at the top is emptied into the picking trailer by laying the bag down on the fruit in the trailer and lifting it from the bottom allowing the fruit to roll out. The bag with an opening and flap at the bottom has quick release straps that keep the flap at the bottom closed. The bag is emptied into the picking trailer or bin by releasing the quick release clips and lifting the bag.

Picking bags are made from a heavy canvas material or polyvinyl, with a canvas strap. Always ensure that picking bags are clean and whole, with no tears in the canvas. If the canvas is torn bags must be fixed using cotton thread and not wire that can damage the fruit.

One picking bag per person is issued at the start of the day's picking. Two extra picking bags should be kept on hand to replace bags that are damaged during the day's picking. After the day's picking, bags are handed in and inspected. Bag must be clean and free of foreign matter and if there are any tears in the bag it must be fixed using thread and **not wire**.

2.4. Ladders

Ladders are used during harvesting only when needed to reach fruit in the top of trees. All fruit hanging lower in the tree must be removed before a ladder is used. Depending on the ladder being used ladders are placed alongside trees, or rested against the canopy in the case of larger trees.

Ladders are made of wood or aluminium. All ladders must be sturdy and splinter-free. Ladders can have two or three legs. Two legged ladders are leaned against a tree when picking fruit. When using a three legged ladder, the third leg of the ladder is placed under the tree canopy to stabilise it. The third leg is attached to the other two legs by a hinge at the top crossbar of the ladder.

Depending on the size of the trees being harvested a number of the picking team will be issued with ladders to pick high-hanging fruit. They will normally follow the rest of the pickers. At the end of the day ladders are inspected and cleaned. Ladders must be sturdy and have no protruding metal or wooden parts that can damage the fruit, tree or people using them.

2.5. Bulk Bins and Picking Trailers

Picking bags are generally emptied into wooden or plastic bulk bins or into picking trailers. Once these containers are full, they are covered with tarpaulin and transported to a collection point, or taken directly to the packhouse. Bulk bins would normally be transported on flatbed trailers during picking, and can be loaded onto trucks to be transported to the packhouse.

Bulk bins have a capacity of 350 to 400 kilograms and can be made of either wood or plastic. Wooden bins are constructed using wooden slats. Wooden bulk bins must be inspected before use to ensure that they are clean and free of foreign objects. Wooden bins must also be smooth and free of any screws or wooden splinters that can damage the fruit. Wooden bins must never be overfilled – at least a plank width worth of space should be left open at the top of the wooden bin to lessen pressure on the fruit at the bottom. Plastic bins must be clean and dry before use with no cracks or other damage.

Especially when varieties that are susceptible to oleocellosis are being picked, bulk bins and trailers should not be filled completely. How far the bins or trailers are filled depends on the conditions, but as a rule of thumb, it should be filled only to between 50% and 75% of the capacity of the bin or trailer.

As an added precaution, rubber or cardboard sheeting can be used as bin liners to give additional protection to the fruit. Bins can also be left in the orchard for a maximum of 24 hours before being taken to the packhouse, allowing for a degree of wilting which reduces the risk of oleocellosis.

The other option, if the farm is close to a packhouse, is to use picking trailers. Picking trailers are normally attached to a tractor, and have a capacity of 2 to 3 tons. Some trailers may also have removable bodies that can be loaded onto a truck for transport to the packhouse.

Trailers are normally serviced before the picking season starts to make sure that they are in good working order. Picking trailers should be clean, dry and rust free before they are used. The trailer tyre pressure should be adjusted to suit the roads that they are used on to ensure a smooth ride for the fruit. Trailers must not be overfilled to ensure that fruit is not placed under excessive pressure.

Enough bins or picking trailers must be available at the collection points in the orchard to handle the amount of fruit to be picked during the day. The flow of bins in and out of the orchard must be coordinated in such a way that picking teams always have empty bins available to them to ensure good productivity.

2.6. Tractors

Tractors are an integral part of any harvesting operation as they are required to haul fruit out of the orchard to the loading bay and sometimes pickers to the point of harvest. Tractors are also used to transport full bins or picking trailers to the packhouse or the collection point.

Tractors that are used during harvesting must be serviced before the picking season starts to ensure that they are in good working order throughout the season. The tyre pressure on the tractors and trailers used to transport fruit from the orchard to the packhouse must be adjusted to ensure the smoothest ride possible for the fruit.

It is recommended that at least two tractors per picking team should be available to ensure a constant flow of picking bins. If possible, an extra tractor should be available for use in case of a breakdown to any of the other tractors.

3. Reporting

In order to ensure the smooth operation of a picking team, procedures must be in place through which any equipment malfunctioning can be reported immediately to the supervisor so that corrective measures can be taken to limit the loss of productivity and damage to fruit.

In the table below is a summary of reporting procedures for equipment malfunctions.

Equipment	Responsible for Monitoring	Responsible for Corrective Measures	Corrective Measures
Clippers	Pickers	Picking Team Supervisor	Issue picker with a clipper that is not damaged and have damaged clipper fixed.
Picking Bags	Pickers	Picking Team Supervisor	Issue picker with a picking bag that is not torn and have damaged bag fixed.
Ladders	Pickers	Picking Team Supervisor	Issue picker with another ladder and have broken ladder fixed.
Bulk Bins	Picking Team Supervisor	Farm Manager	Report to bin supplier and have damaged bins replaced.
Picking Trailers	Picking Team Supervisor, Tractor Driver	Farm Manager	Have the trailer repaired.
Tractors	Tractor Driver	Farm Manager, Mechanic	Have the tractor repaired.

Table 1.1 – Reporting Equipment Malfunctions

3.1. Clippers

Pickers should inspect their clippers regularly while picking to check that blades are sharp and not overlapping. If a worker sees that his blades are overlapping he should report it immediately to his supervisor and be issued with another pair of clippers.

3.2. Picking Bags

While picking, pickers must check that their picking bags have no holes or tears in it. If there is damage to the bag he must immediately hand the bag in to his supervisor so that he can be issued with another bag.

3.3. Ladders

The members of the picking team who use ladders should check them regularly for damage. If the ladder is unstable or has protruding parts that can damage fruit or injure the worker, it must be brought to the attention of the supervisor who must issue the worker with another ladder.

3.4. Bulk Bins and Picking Trailers

Bulk bins are normally inspected by the supplier but should be checked by the picking team supervisor before use to ensure that they are in a usable condition. If any problems are noted with the bins they should not be used and the damage must be reported to the farm manager who in his turn will contact the bin supplier and have the damaged bins replaced. Tractor drivers and picking team supervisor must inspect trailers before use. Trailers that are unsuitable should not be used and any damage must be reported to the farm manager. The farm manager will take the necessary corrective actions to replace or repair the damaged trailers.

3.5. Tractors

The responsibility of ensuring that a tractor is in good working order and that the correct tyre pressure is maintained rests on the shoulder of the tractor driver. Any irregularities must be reported to the picking supervisor who in his turn will report it to the farm manager or in some instances the farm mechanic. They will ensure that the necessary corrective actions are taken to ensure that the tractors run smoothly and can perform their tasks.

4. **Problem Solving**

A picking team supervisor must be able to think on his feet and solve any problems that might arise during harvesting.

One of the picking supervisors most important functions are to ensure that injuries to fruit during harvesting are limited. In order to do this, picking injuries should be monitored. This is done by using a solution of Indigo Carmine and water. 5 grams of Indigo Carmine is dissolved in 10 litres of water in a bucket. Fruit is placed in a string bag and placed in the solution for 5 minutes. When the fruit is removed from the solution, injuries to the fruit are clearly visible and can be shown to the picking team. Excessive injuries to fruit must be addressed and the members of the picking team informed to ensure that more care is taken while handling the fruit.

5. **Equipment Maintenance**

Citrus harvesting equipment is expensive and a significant amount of equipment is needed to carry out the harvesting process successfully and cost effectively. To ensure that equipment stays in a good working order, regular and effective maintenance is needed. Maintenance must be structured and documented to ensure that it is done in a cost effective manner. A good maintenance plan will also ensure equipment longevity and thereby reduce replacement costs.

During the training period all workers must be instructed in the correct and safe use of equipment and in how equipment should be cared for. The picking team supervisor is responsible for most citrus harvesting equipment. Mechanical equipment such as tractors and trailers are the responsibility of the tractor drivers. Tractors and trailers must be stored every night in the vehicle yard.

The picking team supervisor requisitions picking equipment from the picking equipment store every day before picking and return the equipment to the store after the days picking. Picking clippers should be sanitised and oiled before being used again the next day. Other equipment, such as ladders, picking bags and gloves, is cleaned by the picking team members under the direction of the picking team supervisor before the equipment is returned to the store. The picking team supervisor must keep record of equipment issued and collected to ensure that all equipment is returned to the stores after picking.

6. **Routine Maintenance**

On all harvesting equipment routine maintenance and checks are performed on a regular basis. In some cases it is the responsibility of the picking team supervisor to perform the maintenance tasks, while in other cases maintenance is performed by employees working in the stores. In table 2.1 is an example of a maintenance schedule of citrus harvesting equipment.

Description	Part	Check for	Action Taken if Necessary	Frequency
Picking clippers	Blades	Sharpness	Sharpen blades	Daily
		Alignment	Adjust alignment	Daily
	Spring	Effectiveness	Replace spring	Weekly
	Finger loop	Effectiveness	Replace loop	Weekly
	Overall	Oil residue	Light oil blades	Daily
Gloves	Overall	Holes	Repair holes or replace	Daily
Picking bags	Overall	Holes	Repair holes or replace	Daily
	Strap	Effectiveness	Replace straps	Weekly

Description	Part	Check for	Action Taken if Necessary	Frequency
Ladder	Hinges	Stability	Replace hinge	Daily
	Overall	Smoothness (burrs, splinters)	Repair	Daily
Tractors	Tyre pressure	As prescribed	Adjust pressure	Daily
	Overall	Condition	Service	Annually
Trailers	Tyre pressure	As prescribed	Adjust pressure	Daily
	Overall	Condition	Service	Annually
Bulk Bins	Overall	Cleanliness	Clean	Daily
		Smoothness (splinters)	Repair or replace	Daily

Table 1.2: Harvest Equipment Maintenance Schedule



Chapter 1

- The tools and equipment that are used most often while harvesting citrus are clippers, gloves, picking bags, ladders, bulk bins and picking trailers, and tractors.
- Steel clippers are used to cut the stem of the fruit as close to the calyx as possible without injuring the fruit.
- For some types of citrus, a glove is also used while harvesting, worn on the hand that touches the fruit.
- Picking bags have a single strap and are slung over the shoulder of the picker, with fruit placed into the bag as it is picked, after which the bag is taken to a general collection point in the orchard where it is emptied into bulk bins or picking trailers.
- Ladders are used during harvesting **only** when needed to reach fruit in the top of trees.
- Picking bags are generally emptied into wooden or plastic bulk bins or into picking trailers.
- Tractors are required to haul fruit out of the orchard and pickers to the point of harvest, and to transport full bins or picking trailers to the packhouse or the collection point.
- In order to ensure the smooth operation of a picking team, procedures must be in place through which any equipment malfunctioning can be reported immediately to the supervisor so that corrective measures can be taken to limit the loss of productivity and damage to fruit.
- A picking team supervisor must be able to think on his feet and solve any problems that might arise during harvesting, one of which is too much damage to fruit.
- Citrus harvesting equipment is expensive and a significant amount of equipment is needed to carry out the harvesting process successfully and cost effectively.
- On all harvesting equipment routine maintenance and checks are performed on a regular basis.



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

Chapter 2

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

Demonstrate an understanding of sampling for maturity indexing

1. Introduction

Citrus fruit must be harvested at the correct time to ensure that most of the fruit is of export quality. It is critical for the farm manager and supervisors to be able to predict this optimum harvest time to do proper harvest planning and preparation.

To determine and predict the correct time to harvest the fruit we use a method called maturity indexing. By applying this method, we can determine when the external and internal quality of an orchard will be at optimum condition in order to ensure the fruit is picked at the best time.

2. Maturity Indexing

Maturity indexing should start at least eight weeks before the predicted harvesting time. Maturity indexing is done by picking a sample from a uniform block or unit, with trees of the same age, cultivar and rootstock. Ten representative, or index trees, per block are chosen and one fruit per tree, from similar positions on the trees and of similar size, are picked to make up a sample. Sampling is done weekly, from eight weeks before the predicted harvest time.

The parameters of the sample fruit are determined, and the changes in the parameters over time are plotted on a graph. Minimum and maximum standards can be added to the graph. Trends will become evident on the graph. The picking date can now be predicted and problem areas can be identified.

Maturity indexing is done to track the changes of both the external and internal quality of fruit.

2.1. External Quality Parameters

Colour is the most important external quality factor. Citrus fruit develop colour when nights cool down in autumn and winter. The difference between day and night temperatures plays the biggest role in colour development, but various methods have been developed to enhance colour development.

Fruit blemishes are also important and can determine whether a fruit is suitable to be exported or not. Fruit blemishes can be minimised by adjusting production practices and such as fruit handling and pest control.

Fruit colour and blemishes are assessed by using colour and blemish charts issued by Citrus Research International.

2.2. Internal Quality Parameters

Internal quality parameters include:

- Juice percentage
- Brix (total soluble solids or sugar content)
- Acidity
- Sugar to acid ratio

The internal quality norms for different varieties are set at different levels. These levels are set every year by agreement between overseas buyers and local exporters and growers. The minimum standards for exporting citrus are published by the Department of Agriculture, Forestry and Fisheries (DAFF), but there are in many cases special agreements with specific buyers. Please make sure that you are aware of the minimum requirements set by your markets.

Orchard practices can be adjusted during the pre-picking period to enhance internal quality development. For example, if the sugar content of the fruit is not increasing as desired, the irrigation can be decreased.

Internal quality factors are measured through laboratory analysis. Fruit samples are picked regularly during the pre-picking period and sent for analysis to monitor the development of internal quality factors.

3. **Sample Collection**

Sampling is done in accordance with the methods prescribed in Level 2 Learner Guide on Harvesting. Samples are taken from representative trees that are chosen to give a true reflection of the general state of fruit in an orchard. Sample fruit is taken from the same place in all trees to ensure uniformity. All samples from a particular block in the orchard are placed in a bag that is marked indicating the date the sample was taken as well as the orchard and block number.

Sampling is normally performed by experienced pickers and all sampling operations must be strictly supervised to ensure that it is done correctly and that sampled fruit is not mixed and clearly identified. After samples have been collected samples are taken to laboratory where the different internal and external quality parameters are measured.

4. **Recording Maturity Indexing Information**

The results of the laboratory tests are plotted on a graph along with other information, such as fruit colour. Notes on the general fruit condition, referring to factors that may have a bearing on fruit maturity such as granulation, puffiness and fruit splitting, are also made. If orchard practices need to be changed to manipulate fruit development, the maturity indexing graph is a key factor in making these decisions.

The data is also assessed relative to the management and planning schedule on the farm, and projections are made for the packing operation. It is a good idea to get the information to the packhouse, so that they are up to date on how fruit development is progressing.

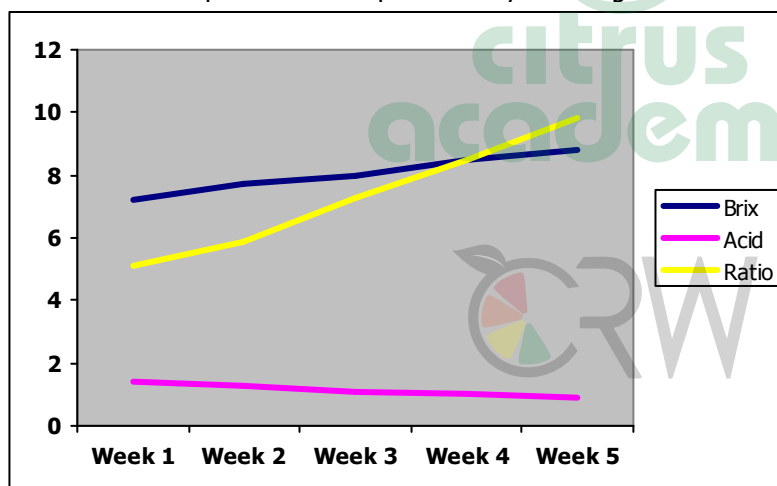


Internal Quality Monitoring Records

Minimum		1	48	9	0.8	7.5
Maximum		4			1.5	
Date	Week	Colour	Juice%	Brix	Acid	Ratio
10/04/2010	15	4	46	8.5	1.6	9.4
17/04/2010	16		47.8	8.7	1.55	9.7
24/04/2010	17		49.3	8.8	1.43	10.1
01/05/2010	18		45.8	9.2	1.44	7.8
09/05/2010	19		47.2	9.3	1.41	8.3

11/05/2010	19		50.1	9.6	1.3	9.1
16/05/2010	20		45.3	10.1	1.29	7.9
18/05/2010	20		53.5	10.3	1.26	9.8
29/05/2010	22	3	50	10.6	1.12	10.5
02/06/2010	22	3	51	11	1.11	11.3
03/06/2010	22	3	48	10.6	1.14	9.3
03/06/2010	22	3	50.5	11.2	1.1	9.1
14/06/2010	24	3		11.2	0.82	13.7
22/06/2010	25	4	55	10.6	0.83	11.5
22/06/2010	25	4	51	10.6	0.84	12.6
25/06/2010	25	3	48	10.6	0.86	12.3
25/06/2010	25	3	48	11.8	0.8	13.7
29/06/2010	26	3	47	12	0.89	13.4
02/07/2010	27	3	49	12.2	0.81	15.0
05/07/2010	27	3	49	11.8	0.84	14.0

Below is an example of how simple maturity indexing information is plotted on a graph.



Chapter 2

- Maturity indexing takes place weekly from at least eight weeks before the predicted harvesting time.
- Internal and external maturity parameters are measured and the result plotted on a graph.
- Using this information the optimum harvest time can be predicted and decision relating to production and the employment of staff can be made.
- Samples are normally collected by senior, experienced picker.
- It is important that samples are marked and kept separate from each other so that test result will be accurate.
- The results are plotted on a graph over time, and the trends that become apparent is used to predict future maturation and the expected picking date.



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



Chapter 3

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

Demonstrate an understanding of the harvesting of crops according to harvesting plan

1. Introduction

Before harvesting can start a harvesting plan needs to be drawn up detailing when and where harvesting will take place.

Factors such as weather delays and maturity indexing results must be taken into account when designing the plan. The main objectives of the harvesting plan must be to harvest the fruit cost effectively, within a given timeframe, while maintaining fruit quality and safety.

The method of harvesting must also be decided upon. Selective picking can be considered early in the season, when there may be special market opportunities for specific fruit. Generally, export fruit will be picked using clippers, with snap picking only used when trees are stripped of fruit destined for processing. **Export fruit is never snap picked.**

2. Factors Influencing Harvesting

There are different factors that can influence harvesting. Factors such as the weather, fruit quality and market conditions, must all be taken into account when harvesting is planned. Other matters that will influence the planning of the harvesting operation are the volume of fruit to be picked, the timeframe in days available for picking the fruit, and the amount of daylight hours available per day.

2.1. Weather

Harvest plan must always take short and medium term weather forecasts into account. Citrus fruit cannot be harvested if the fruit is wet. The oil glands in the rind of the fruit becomes turgid and fragile when fruit is wet, and in very cold, humid conditions. When fruit is handled in these conditions, the oil glands in the rind rupture, causing oleocellosis.

Fruit can therefore not be picked during or just after it rained, or in the early morning when there is dew on the fruit. As a general guideline, harvesting should only take place under these conditions:

- Temperature – 13-30°C
- Relative humidity – <70%

Research that was done recently also found a higher incidence of peteca spot on lemons if they are picked within two days after a cold front, especially if the cold front was accompanied by rain.

2.2. Fruit Quality

Fruit should only be harvested once all internal quality parameters are met. External parameters such as fruit colour can still be adjusted by packhouse processes such as degreening, but internal quality will not change after picking, because ripening processes, such as where citric acid is broken down and converted to sugar inside the fruit, stops after picking.

2.3. Market Conditions

Market conditions and specific market opportunities may also impact on the decisions made around harvesting. It might in some instances be worth it to delay harvesting by chemical applications in order to extend the harvesting period or to move the harvesting period to a later stage when fruit availability might be lower and thus market prices higher.

2.4. Expected Yield

The number of hectares to be picked influences when picking will start and the amount of pickers that should be employed. The cultivar spread and the expected yield, market requirements and picking practices for each cultivar are central to harvest planning.

2.5. Picking Time

As fruit cannot be picked in the early morning when it is still wet from overnight dew and the harvesting of fruit mainly takes place during the winter months when daylight hours is shorter than during the summer time, the hours during which picking can be performed per day is curtailed. This must be taken into account when planning the harvest and the time necessary when harvesting a certain section.

3. Implementing the Harvesting Plan

Once all the conditions are ready for harvesting the harvesting plan can be implemented and harvesting can start. The harvesting plan will indicate which block of fruit must be harvested and how many pickers should be used to harvest the block within the specific timeframe. Before picking begins ensure that:

- Harvesting teams are divided into groups of no more than twenty pickers per trailer – more than twenty pickers per trailer will cause too many people hanging around a trailer waiting to empty their bags and that might cause fruit injuries as pickers rush and push against each other;
- The internal quality of the fruit is at the correct specifications;
- Weather conditions are suitable for the picking of citrus fruit;
- All picking equipment is in available in the correct state and the correct numbers;
- Picking teams are informed about the method (snap picking or clipping) of picking that will be used;
- Picking teams are aware of any other decision concerning the picking of the fruit, for instance whether trees are to be stripped or whether fruit of only a certain quality are to be picked;
- Adequate ablution facilities are available for pickers during the harvesting process.

Picking can now start. Picking teams must be transported to the orchard and issued with equipment. While picking takes place in the manner prescribed in the level 2 learner guide on Harvesting, the supervisor must constantly monitor the following:

- Fruit that were dropped during the picking process or are lying on the ground must not be picked up off the ground and put with export fruit;
- Fruit that hangs low in the tree, so that water could have splashed up onto it, must not be picked and placed with the other export fruit, as it could be contaminated with soil pathogens;
- Pickers should walk with full picking bags and not run, as running will bounce and chafe the fruit, leading to the development of oleocellosis;
- To limit fruit injuries when picking bags are emptied, the bag should be placed close to or on fruit lying in the bulk bins or picking trailers before being emptied;

- Once a bag has been emptied, it must be upended and shaken to remove loose twigs, leaves and sand that might have collected during the picking process;
- Picking injuries must be monitored constantly while picking takes place using the method describe in chapter 1, section 5;
- Bins and picking trailers must not be overfilled, with bins and trailers generally filled to about 80 to 90% of their capacity (one plank width from the top for wooden bins is a good rule of thumb), and to only between 50 and 75% of their capacity when picking varieties that are susceptible to oleocellosis;
- Keep in constant contact with the farm manager or harvesting coordinator to ensure a constant flow of empty bulk bins or trailers.

Other general farming activities taking place on the farm can have an effect on the harvesting operation. All activities must be coordinated to ensure a smooth harvesting operation. Harvesting must take precedence over all other farming activities. Other tasks, such as irrigation scheduling, plant manipulation and fertiliser applications, activities must be scheduled in such a way the harvesting process will not be influenced by these activities.



Chapter 3

- Before harvesting can start a harvesting plan needs to be drawn up detailing when and where harvesting will take place.
- Factors such as the weather, fruit quality, market conditions, expected yield and harvesting timeframe, must all be taken into account when harvesting is planned.
- As a general guideline, harvesting should only take place when the fruit is dry, the temperature is between 13 and 30°C, relative humidity is lower then 70%, and for lemons not within two days after a cold front, especially if it was accompanied by rain.
- Fruit should only be harvested once all internal quality parameters are met.
- The harvesting plan will indicate which block of fruit must be harvested and how many pickers should be used to harvest the block within the specific timeframe.
- Before picking starts, the supervisor must ensure that the team is prepared and trained, the equipment is sufficient and in good working order and that all other facilities are in place.
- During picking, the supervisor must make sure that fruit safety and quality is maintained (fruit that are on the ground or hang low in the tree must not be placed with other export fruit, pickers may not run with bags containing fruit, bags must be emptied carefully, bins and trailers must not be overfilled, picking injuries must be monitored) and that there will be a constant supply of empty trailers or bins to the picking team.
- Harvesting must take precedence over all other farming activities.



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

...will be taking into account the standards set by the Department of Health and Safety in any work-related accreditation system. Before they will allow a company to work commonly on factory floors, they will ensure safe and sustainable working conditions. This is in line with current legislation and current legal requirements.

Implement a health, hygiene and safety plan during harvesting

and safety in any working conditions. The accreditation system in place is not sufficient before they will allow a product to be sold. This is most commonly on farms. The system is not safe and sustainable for the future of the living conditions.

The best approach to implementing health and safety on a farm is to formulate and document a health and safety plan, that not only puts in place procedures for protecting worker health and safety, but that is also aimed at protecting product safety.

re safe and sustainable for
the living conditions.

On most farms there is also at least on accreditation system in place. These accreditation systems are usually required by overseas markets before they will allow a producer to export fruit to them. GlobalGAP is the system that is used most commonly on farms. It includes regulations on how farming practices should be structured to ensure safe and sustainable farming and sets minimum requirements to ensure worker health and acceptable living conditions.

The requirements of accreditation systems and current legislation must be incorporated and adhered to when formulating the health and safety plan, and – more generally – the harvesting plan.

different components to the process. Generally, these components

- First aid
- Equipment
- Personal hygiene
- Protective clothing
- Emergency plan
- Reporting procedures

the member must have first-hand experience. The person will be the team's health and safety champion. If you are not in the permanent staff, you will be a part-time member. In most cases the health and safety champion will be a member of the team who is not directly involved in the work that is the focus of the team.

In every picking team at least one member must have first aid training and be in possession of a valid first aid certificate. This person will be the team's health and safety officer. Because most of the workers employed for picking are not in the permanent employ of the farm and only employed during the picking season, in most cases the health and safety officer will be the team supervisor.

It is the responsibility of the health and safety officer to ensure that a basic medical kit is available to treat any injuries that might occur during picking and that an emergency plan is in place to ensure medical help to a severely injured person.

3.2. Equipment

Workers must be trained in the correct use of all equipment used for the harvesting of citrus. Training must not only include the correct way of using equipment to minimise the threat of personal injury, but also the correct way to use equipment to ensure food safety.

Safety measures concerning the use of mechanical equipment used such as tractors and trailers must be adhered to.

3.3. Personal Hygiene

Prior to picking, all staff on picking teams should wash their hands with disinfectant soap at mobile washing facilities available in the orchard. Picker must again wash their hands after every break during picking. Picker nails must be short to minimise the risk of injuries to the fruit. Pickers that are sick must not be allowed to work. Any open sores or injuries must be covered with plaster before a picker is allowed to handle fruit.

3.4. Protective Clothing

Pickers are issued with overalls and in some cases gloves. Sorters sorting fruit at the bins must also wear gloves and a hair covering to lessen the threat of fruit injuries and contamination. Overalls must be kept clean and laundered regularly.

3.5. Emergency Plan

One of the most important components of a health and safety plan is a simple plan that can be implemented effectively in the case of emergency. An emergency plan consists of different facets to provide for different kinds of emergencies. The health and safety officer is responsible for ensuring that the rest of the team is informed on how the emergency plan works and what is expected of each of them if an emergency should occur.

In the case of fire, assembly points must be identified and marked where workers must gather. Assembly point must be easily accessible and have various escape points. At the assembly point, the health and safety officer must account for all members of the picking team before leading workers to safety. Assembly points must be identified all over the farm before the picking season and marked on a map. This will help authorities to render assistance to workers if required.

In the case of serious injury, the health and safety officer must contact the harvesting coordinator or farm manager immediately, who will contact the emergency services immediately to ensure rapid response. The health and safety officer must render all help he can to the injured worker whilst they are awaiting help.

3.6. Reporting Procedures

Should any of the picking staff injure themselves while picking, it must be reported to the health and safety officer and an incident sheet should be filled in and signed before the injured person can return to the picking team. All other unusual incidents must also be reported to the supervisor or harvesting manager to enable them to assess the possible risk to food safety and worker health and safety.

4. Health and Safety Plan Implementation

To ensure the effectiveness of the health and safety plan, critical areas that must be managed and monitored must be identified.

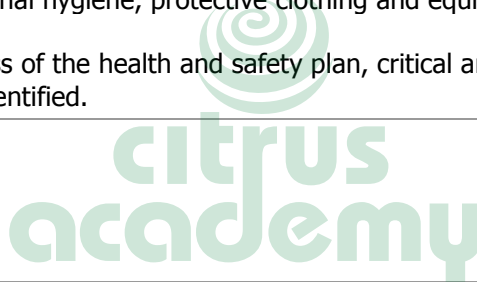
These areas include setting up regulations and procedures to manage:

- The picking process
- Use of picking equipment
- Availability of adequate ablution and sanitation facilities
- Availability of a emergency plan in case of serious injury
- Training of staff to ensure good a knowledge and understanding the health and safety plan
- Recordkeeping procedures



Chapter 4

- The best approach to implementing health and safety on a farm is to formulate and document a health and safety plan.
- The requirements of accreditation systems and current legislation must be incorporated and adhered to when formulating the health and safety plan, and – more generally – the harvesting plan.
- A health and safety plan incorporates different components, generally including reference to first aid, equipment, personal hygiene, protective clothing and equipment, emergency plan, and reporting procedures.
- To ensure the effectiveness of the health and safety plan, critical areas that must be managed and monitored must be identified.

The logo for Citrus Academy, featuring the words "citrus academy" in a green, lowercase, sans-serif font, with a stylized green swirl above the word "citrus".



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



Chapter 5

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

Implement the waste collection and disposal plan

1. Introduction

Effective waste disposal is essential in ensuring that spore-load in the orchard is kept low, so that pathogens that cause postharvest diseases are not allowed to stay there and spread to uninfected fruit. It is also critical in ensuring that pests and diseases are not given breeding ground and the opportunity to survive from one season to the next.

Waste disposal must also be carried out in such a way that fruit and other waste products are not allowed to remain in the vicinity of the orchard, and so that the impact on the environment is lessened.

Pathogen

A pathogen is anything that can cause a disease, such as bacteria, a virus or a fungal organism. Most postharvest diseases are caused by fungi, and we are therefore here mostly concerned with fungal pathogens.

Spore

A spore is the small, usually one-celled reproductive structure produced by amongst others seedless plants, algae and fungi. In other words, fungal pathogens that cause postharvest diseases use spores to spread, which means that if we can keep the number of spores in the orchard – the spore-load – low, we can control the spread of diseases.



2. Classifying Waste

It is important for us to be able to identify and classify waste correctly so that we are able to handle and dispose of it correctly.

During harvesting, most of the waste that is produced is biodegradable waste, which is waste consists of parts of plants and fruit. Other waste produced during harvesting is from things that were brought into the orchard by people – in this instance most likely by pickers. This waste is mostly non-biodegradable, and would probably include things such as plastic or glass bottles and lunch wrappers.

Biodegradable

Biodegradable means made of substances that are able to decompose naturally.



Biodegradable waste and non-biodegradable waste must not be mixed and kept and handled separately. Non-biodegradable waste must further be sub-divided into waste that can be recycled, such as paper, glass and metal, and waste that must be destroyed, such as plastic.

3. Implementing Waste Disposal

During training before the picking season starts pickers must be made aware of the waste disposal plan that are in operation on the farm. Pickers must be made aware of the effect that their waste can have on the environment and what the correct way is of dealing with that waste.

Areas where pickers are allowed to eat must be identified and bins must be made available for pickers to put their waste in. Most of the non-biodegradable waste are collected by the pickers and placed in bins in the picking area. These bins must be marked to indicate what type of refuse should be placed in the bin.

On each farm, cleaning teams must be appointed to remove all biodegradable waste from the orchard after harvesting has taken place. These cleaning teams remove the fallen and rotten fruit and all other biodegradable waste to designated areas. At these designated areas the biodegradable waste are destroyed according to the farm practices.

Two methods are used for disposing of waste fruit, being chopping and burying waste fruit. Chopping or breaking the fruit up in a thrasher and leaving it on the orchard floor to dry up is the easiest method, and generally acceptable in dry climates. Pathogens may however develop on this chopped waste in more humid climates. Burying waste fruit under at least 30cm of soil at a place away from the orchard is considered the most safe and effective method of waste disposal.

4. Monitoring the Waste Disposal Plan

To ensure that the waste disposal plan is effective and do what it is designed to do it is important to monitor the facets of the plan. A waste disposal form should be used to keep track of areas that have been cleaned and the effectiveness of the waste removal.

For biodegradable waste, monitoring must be done to ensure that all waste is collected and removed from the orchard. All areas must be checked to ensure that no fallen fruit remains in the orchard that can carry pests and diseases. At the area where biodegradable waste is destroyed, recordkeeping should show the method used as well as how much waste is destroyed. It is important to make sure that the destruction method that is used is thorough and complies with any regulations that might apply.

For non-biodegradable waste, monitoring should include making sure that the right type of refuse is placed in the correct bin. Waste bins are collected at the end of each harvesting day by the waste disposal team. This activity must be monitored and strictly controlled. Waste that can be recycled is sent to a recycling plant. Records must be kept of where how much waste is sent for recycling.

5. Recordkeeping

It is essential to keep records of all the separate activities that take place while waste are removed and disposed of. If waste disposal is not done correctly, it can be financially taxing for a farming operation and also cause environmental damage.

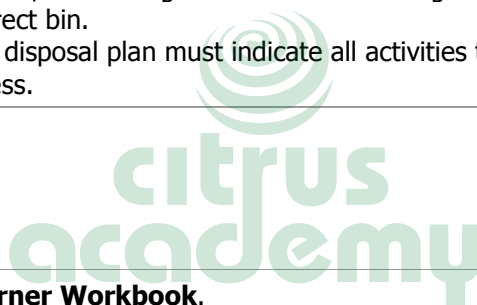
Records kept of the waste disposal plan must indicate all activities that form part of the plan as well as their effectiveness.

These records can be used every season to determine the costs involved in waste disposal and the effectiveness of the different operations. Area where improvements can be made or money can be saved can be identified and given the necessary attention.



Chapter 5

- Effective waste disposal is essential in ensuring that spore-load in the orchard is kept low, and that pests and diseases are not given breeding ground and the opportunity to survive from one season to the next.
- It is important for us to be able to identify and classify waste correctly so that we are able to handle and dispose of it correctly.
- During training before the picking season starts pickers must be made aware of the waste disposal plan that are in operation on the farm.
- Most of the non-biodegradable waste are collected by the pickers and placed in bins in the picking area.
- Cleaning teams must be appointed to remove all biodegradable waste from the orchard after harvesting has taken place.
- For biodegradable waste, monitoring must be done to ensure that all waste is collected and removed from the orchard.
- For non-biodegradable waste, monitoring should include making sure that the right type of refuse is placed in the correct bin.
- Records kept of the waste disposal plan must indicate all activities that form part of the plan as well as their effectiveness.



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



Bibliography

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