

Workflow: Packhouse Management

Toolkit 4.6

Sorting and Grading

target audience

Packhouse managers, quality managers, and supervisors.

what it is

Sorting, grading, and sizing are activities that aim at ensuring that fruit of a specified quality is packed according to the standards set by DALRRD (minimum standards), a target market (EU), or specific clients (retail).

- **Sorting** is the action of separating out fruit that is not fit for export, and directing this fruit to the local market line, processing fruit bins, or waste fruit bins. This is done by hand.
- **Grading** is the action of separating fruit that passed through sorting into different grades, or classes. During grading, some fruit may still be directed to processing, local market, or waste, but this should be minimal. This is now almost always done by automated grading systems.
- **Sizing** is the action of separating fruit of a particular grade into size categories, also called counts. Automated grading systems size the fruit at the same time as grading them.

why it is important

Sorting and grading ensure that the product delivered meets the quality standards, i.e., the expectations of the client. Suffice to say, that citrus for export has to meet increasingly demanding standards, and that compliance is not merely important, it is mandatory.

Four key elements in the sorting and grading activity are important:

- **Process** – Best practice across the whole process determines the final result (quality delivered, no rejections, best price). Therefore, it is important that packhouse management has a strong process focus ([Toolkit 1.4 – Leader Standard Work](#)).
- **Quality standards** – Clearly defined standards and the ability to translate those into the decisions and actions your teams and machines need to take to deliver the standard.
- **Skills** – The skill, knowledge, behaviour, and attitude of your employees.
- **Assets** – Modern equipment such as optical readers and automated grading and sizing systems are the norm and are becoming a competitive imperative.

success factors

- **A reliable and efficient process** – There may be slight variations between packhouses in how the sorting process is set up. However, in general the following should be well established:
 - **Pre-sorting** – The first sorting station is pre-sorting, and will be positioned after the tip, before or after the washing system. There are advantages and disadvantages to both options, since pre-sorting before the washing system reduces the risk of green bombs and really damaged fruit going into the wash and contaminating the system but pre-sorting for less visible defects is difficult because the fruit has not been washed yet.
 - **Main sorting station** – The second sorting station, generally called the main sorting station, is positioned before or after the fungicidal wash and the waxing process and aims to remove fruit that has pest or disease damage, with special attention to false codling moth, fruit fly and black spot infestation symptoms, as well as other fruit that is clearly not fit for export. It is always better to err on the side of the grower, meaning that one should rather let fruit through when there is a small chance that the fruit can be exported. Only remove fruit that you are sure cannot be exported.
 - **Third sorting station** – A third sorting station is sometimes positioned right before the automated grading system, or after the system by the packing tables, for a final verification that the fruit that is going onto the packing tables meets the required standard.
- **Clear quality standards** – Meeting the following quality standards is a key success factor:
 - **External fruit quality standards** – External quality factors use the *Colour Prints for Blemish and Appearance Standards* as a measuring tool. The Colour Prints are issued by CRI and contain a set of graded colour prints for each external quality factor for each citrus type and variety. They are used to define the standards for fruit of specific grades. They are used at sorting stations to assist sorters with distinguishing between fruit that meets the minimum export standard and fruit that does not. They are also used in control rooms for automated grading systems, to manage the settings that differentiate between grades of fruit. External quality standards include factors such as:
 - Fruit colour, which is a very noticeable external quality factor, and the Colour Prints contain sets for each citrus type and many cultivars.
 - Damage caused by pests and diseases includes damage from insects such as thrips, red scale, rust mite, bollworm, mealybug, and leaf hopper. Pest insects also causes the growth of sooty mould, which is also considered pest damage. Disease damage of significance is caused by citrus black spot and alternaria brown spot. Wind scars, hail damage and frost damage are external quality factors caused by the weather, although frost damage is likely to cause more internal than external damage to fruit. Chemical burns, stem-end browning and oleocellosis are other damage factors that are regulated.
 - Standards are set for fruit malformations such as sheep nose, high shoulders, flat fruit and protruding navels, as well as skin defects such as rough texture, ribbing, ridging, rind pitting, and peteca.
 - **Internal fruit quality standards** – Internal fruit quality factors determine the taste and eating quality of the fruit. There is a separate measurement for each internal fruit quality factor. These include:

- Juice content is measured by selecting a sample of fruit, weighing the fruit, extracting all the juice, separating the juice from the pulp, and weighing the fruit rinds and pulp. The juice percentage is then calculated based on these two weight measurements.
 - Degrees Brix is a measurement of the sugar content of the fruit. It is expressed as °B, with one degree Brix meaning one gram of sucrose per hundred grams. Brix is measured with the help of a refractometer.
 - The percentage acid content of the fruit is determined by titration. A sample of 20ml juice is placed in an Erlenmeyer flask and five drops of phenolphthalein indicator are added. A sodium hydroxide solution is then titrated into the flask, using a burette with precise measurements, until the juice in the flask turns completely orange, which is when the acid is neutralised. The volume of sodium hydroxide solution that was necessary to neutralise the juice is used to calculate the percentage acid content of the fruit.
 - The degrees Brix:acid ratio determines the tastiness of the fruit – if the ratio is too low, the fruit will be very sour, and if the ratio is too high, the fruit will taste bland. The ratio is calculated by dividing the degrees Brix, which is the sugar percentage of the fruit, by the acid percentage.
 - Seediness and granulation are two further internal quality factors that are regulated, as is internal fruit colour for pigmented grapefruit. Standards are also set for over-ripeness, which can also be considered as an internal quality factor.
 - **Minimum export standards** – The *Standards and Requirements Regarding Control of the Export of Citrus Fruit* document is published every year by the Department of Agriculture, Land Reform and Rural Development, or DALRRD, and empowered by the Agriculture Product Standards Act of 1990. This document sets out the minimum standards for the quality of export citrus fruit, and the requirements for the packing, marking, and labelling of the fruit. The Standards and Requirements document describes, in detail, the minimum requirements of the colour, blemishes, shape, skin texture and other characteristics of each fruit type that can be exported as different grades, or classes, as they are called in the document. This is the minimum standard that all export fruit must comply with, and the standard PPECB will apply when inspecting fruit.
 - **Specific target market and client standards** – On top of the minimum standard, export markets and specific clients, such as overseas supermarket groups, may set their own standards and requirements to meet the specific demands of their customers. These standards and requirements are negotiated between the export agent on behalf of the grower and packhouse, and the overseas client. Often, they are already agreed upon at the start of the season, and clients are not generally tolerant of deviations from the agreed standards. PPECB does not inspect according to these private standards.
- **Communicating standards** – It is important that you effectively communicate the set standards:
- **Packing and process guides** – Ensuring that the packing guides and standards, including all process related standards are available and communicated in such a way that they are correctly operationalised.
 - **Visual management systems** – Making use of charts, e.g., colour charts, and other visual aids to communicate effectively.
 - **Shift starters and daily meetings** – Maintaining effective and efficient shift starters and daily meeting schedules, which allow for regular communication, feedback and problem solving.

- **An effective pack planning and communication process** – The backbone of effective communication is the pack planning process and documentation. (See [Toolkit 4.2 – Pack Planning](#)).
- **Accountable and well-trained staff** – Success depends on the appointment of the right people, who are fully competent and accountable, at the sorting and grading stations (if still done manually).
- **High-intensity/high-frequency observation** – Sorting is a high-intensity/high-frequency observation skill. Although some people just have the talent and predisposition for this activity, it can be enhanced by training. According to research (by QinetiQ largely aimed at X-Ray screening operators in high security systems, e.g., airports) there are 6 cognitive factors, which can be measured, that determine the performance of people doing such activity:
 - **Perceptual speed** involving the ability to make quick and accurate comparisons between objects,
 - **Perceptual closure** which facilitates identifying specific objects that are partly hidden or concealed,
 - **Deducing** involving the ability to apply existing rules and procedures,
 - **Visualising** which relates to the ability to imagine how something would look once changes have been made to it,
 - **Decision making** which involves the ability to make a decision where there is no absolutely clear answer or information is incomplete., and
 - **Reaction time** as reflected in the ability to respond quickly.Another key factor is the quality and timing of feedback to the sorters.
- **Fruit handling** – It goes without saying that the manual handling of fruit is a best practice that is applied throughout the whole packhouse process, and even extends to the logistics processes.
- **Grading and sizing** – This process is now almost exclusively automated because clients' requirements are so discerning, sometimes with only minor differences, e.g., length of lemons, or colour preferences which the human eye cannot select at speed. The required level and capability of automated grading and sizing technology, often integrated with labelling and control sampling functionality, is a key success factor.
- **Machine and systems management** – Since automation, technology and integrated software systems are the norm, the ability to manage the machinery, technology, and software. (See [Toolkit 4.9 – Systems Management](#), and [Toolkit 9.3 – Technology and Automation](#)).
- **Quality assurance systems** – Sorting and grading is part of your whole quality assurance and control programme. A key success factor is that:
 - Your whole quality assurance and control system works.
 - You have a defined process approach (not just a control or outcomes approach) that delivers results, i.e., you know exactly why things work well and can therefore pinpoint when they don't.
 - You have embedded a culture of accountable quality at source. (See [Workflow 6 – Product Quality](#)).

execution steps

See the success factors above.

assessment questions

Please Note: There is no minimum / maximum number of questions you can add.

1.	Is the placement of and process applied at your sorting tables ideal?
2.	Do you apply the minimum export standards set by DALRRD?
3.	Do you have the means and the correct process to assess external and internal fruit quality?
4.	Do you know and apply the specific standards set by target market and clients?
5.	Do you have skilled and trained staff?
6.	Do you have a highly effective feedback system to and from the sorting staff so that non-compliance, and the root causes, can be quickly communicated and corrected?
7.	Is your fruit handling throughout the packing process up to standard?
8.	Do you use visual management and feedback systems to enhance information, standards, and feedback to your sorting teams?
9.	Do you employ the technology required to grade and size fruit in a way that ensures your competitiveness in the market?
10.	Do you have the specialised staff to manage the technology you use optimally?

resources

1.	Colour Prints for Blemish and Appearance Standards (Citrus Research International)
2.	Sour rot and Brown rot warnings (CRI - Cutting Edge 317/2021)
3.	Citrus Packhouse Module 6 – Sorting and Grading (Citrus Academy)
4.	Citrus Packhouse – Sorting and Grading (Citrus Academy)