Provar

Cultivar Evaluation Manual

Cultivar Evaluation Data Structures, Protocols and Standards

2017

Evaluation Manual

Cultivar Evaluation Data Structures, Protocols and Standards

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Who is Provar ?

Provar is a privately-owned, independent new fruit cultivar and rootstock evaluation company and data centre with new product development intelligence. The company places a high value on transparency and objectivity of fruit evaluation for its clients: Breeders, Nurseries, IP Owners, Producers, Exporters and other fruit industry related entities.

Provar's driving goal is to provide an independent evaluation service through the application of standardised protocols using the latest technology and international best practices. Data collection is objective, credible and transparent, in order to supply reliable results to minimise risks when planting new cultivars.

We see our clients as "Evaluation Partners", complimenting their in-house evaluation through a thorough screening and advanced evaluation strategy that verifies the commercial potential of new cultivars. Provar offers three main elements or services, i.e., fruit evaluation (screening), fruit and tree evaluation (advanced screening) and evaluation of the commercial potential of new cultivars (advanced full evaluation).

Tree Evaluation

Provar performs **Tree Evaluation** by monitoring, distinguishing and noting horticultural characteristics at every stage during the season, providing clients with a full phenological sequence from bud-break stage up to harvest. Various tree characteristics like optimal harvest time, yield potential and all possible disorders and inherent limitations that may affect adaptability to the specific planting area are qualified, using an innovative software platform to record and compare plant samples and climate data between years and between planting areas.

Fruit evaluation

When it comes to the harvested product, Provar performs Visual and Sensory **Fruit evaluation** with great attention to detail. Storage potential of cultivars and selections is evaluated and shelf life performance is assessed together with the identification of any fruit disorders.

Advanced Screening Evaluation is performed to identify superior cultivars and selections, by means of tree evaluation on 3 to 5 trees per evaluation block and harvesting fruit at random for each harvest sample. A four-stage visual and sensory fruit evaluation is performed on each selection or cultivar to characterise fruit quality and keeping ability on an annual basis.

Full trial Evaluation is performed to characterise the adaptability and commercial potential of fruit selections or cultivars on at least 10 adult trees per area and per harvest sample. In this procedure we harvest all fruit from the trees to estimate production potential and quantify visual and sensory characteristics at four stages during and after storage and including shelf life evaluation. During advanced evaluation, we characterise fruit according to total weight and size distribution per tree and include **Harvest Indexing** and **Maturity Indexing**. A stamped and signed **Provar Certificate** will verify the authenticity of data collected in the full trial.

Other services

Other services include external benchmarking of the Client's selections and cultivars, comparative reporting, harvest indexing, maturity indexing, panel evaluation, market scoring or benchmarking, identification of cross pollinators, testing of cultivar authenticity and determining chilling requirements of selections and cultivars. The Provar team also manages rootstock evaluation and we host **Industry Tastings** at our laboratory facilities.

Technology

To support an effective evaluation process, in-house software applications ("Apps") are being developed on an ongoing basis. These applications will be used for tree characterisation, visual and sensory fruit evaluation in the laboratory and for industry tasting opportunities. Evaluators will be able to use these applications to encourage delivery of favourable cultivars for next step evaluation by Provar.

Evaluation Blocks

Provar manages industry based evaluation orchards and calls for early tree allocation from Clients supporting representative planting in different areas and ensuring optimal fruit quality for evaluation. It is recommended that planting be performed as soon as plant material is released from quarantine, to reduce time before independent evaluation starts. At present Provar manages 12 evaluation orchards in South Africa in association with specific producers and their evaluation Block managers. New evaluation blocks are in developmental phase with the goal to centralise evaluation in specific geographical areas. Provar allocates a cost to Clients in South Africa for managing trees in the centralised evaluation Blocks to achieve optimal fruit quality for evaluation.

Provar performs evaluation at Clients' own evaluation blocks if contracted to do so. Provar cannot, however, in these cases guarantee or be responsible for orchard management, the health of the specified trees or the quality of harvested fruit samples. Provar will report timeously on any deviations observed in the course of evaluating the trees or fruit to the contracting IP owner.

Clients design their own Evaluation Package

Provar is flexible in their approach and offers a tailor made "package" to the Client to select evaluation sites (more than one site preferred), the period for evaluation (three years recommended) and the number of cultivars to be evaluated. The standardised screening evaluation will identify the front-runners from a selection of cultivars, and this is then followed by a standardised advanced (full) evaluation trial to test commercial potential.

Disclaimer

Provar has compiled this document as an aid for the Client and in support of the independent evaluation protocol and procedures applied in combination with the evaluation technology. Provar does not accept any responsibility for any loss or harm from the use of this document and / or any information related to this document in the event that any of the information may be incorrect or incomplete. It is Provar's endeavour to use the manual as a working document and to add information every year improving on its contents and accuracy. This evaluation Manual will be updated with a new addition annually to be supplied to Provar Clients.

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Premises and contact details

Provar operates from their laboratory in Zandwyk Park (off the R101), Paarl, South Africa. For more information visit our website, *provar.co.za*.

Section 1: Introduction to Cultivar Evaluation

Selections, Cultivars, Varieties and Clones

A "**Selection**" is a term used to describe a selected plant (seedling or sport or mutation) with potential to become a new commercial cultivar. Some selections originate as sports or mutations on plants, but normally new selections originates by crossing two parental plants through conventional breeding. Usually a selection number (selection ID) is allocated to such a plant. When the selection is registered as a new cultivar, a **Cultivar Name** is chosen and **Plant Breeder's Rights** (PBR) application is filed.

A "**Cultivar"** is most commonly referring to a "cultivated variety" as a cultivar was artificially bred and selected for desirable characteristics and then cultivated. The term "Cultivar" is the preferred name when we discuss cultivated varieties or selections by breeding and not "variety". Only once a selection is registered (for commercial purposes), a registered Cultivar Name name is allocated to the cultivar, but in most cases and mainly for plant protection purposes, a selection may already have a registered Cultivar Name before commercially planted. IP Owners may also allocate trade names (**Trademark name**) to a cultivar for marketing purposes. Cultivars are normally associated with a Breeder, IP Owner organization or License.

In contrast with a cultivar, a "**Variety**" (abbreviated as var.) can be found growing and reproducing naturally in the plant kingdom. Plants grown from seeds from varieties will normally deliver true to type seedlings.

A **Sport** or **Bud mutation** (also referred to as "clones") is part of a plant that shows differences from the rest of the plant due to mutations developed in developing buds. Sports with desirable characteristics can be propagated vegetatively to form new cultivars that may retain the characteristics of the newly mutated type. Such selections are often prone to "reversion", meaning that part or all of the plant can be genetically unstable and can revert to its original form. Various new Fuji and Gala apple cultivars with improved colour potential are bud mutations from the original Fuji and Gala cultivars.

Crop Types

The crop 'type' serves to provide the specific Family a Cultivar belongs to. At present the following crops are supported by the evaluation data structures and procedures described in this manual:

Code	Fruit Type	Fruit Group	Scientific name
APL	**Apple**	Pome Fruit	*Malus domestica*
PYR	**Pear**	Pome Fruit	*Pyrus communis*
NEC	**Nectarine**	Stone Fruit	*Prunus persica*
PEC	**Peach**	Stone Fruit	*Prunus persica*
PLM	**Plum**	Stone Fruit	*Prunus salicina*
APR	**Apricot**	Stone Fruit	*Prunus armeniaca*

Cultivar Naming Convention

A **Selection ID** is a number or code given to the new selection identified by a breeder or discoverer.The **Cultivar Name** (Common name) is an unique name registered and published by the discoverer or breeder of the cultivar. Many plants have registered '**Trade names**' or '**marketing names**' as well as a cultivar name. The **Import ID** is a number allocated to a selection or cultivar imported to a country (e.g. in South Africa : I 2715). The **Licensee** is the person or company involved in management and commercialisation of the cultivar or selection for a specific country.

Harvest Windows

Cultivars are allocated to a specified harvest window according to their harvest dates and will fall into a broadly defined period of *early*, *mid* or *late* relative to other cultivars or selections.

In the Southern hemisphere, early-, mid- and late-cultivars are harvested during the following periods:

Crop	Early Period	Mid Period	Late Period
Apple	< 1 February *Before < 'Gala'*	1 February - 15 March 'Gala' < 'Cripp's Pink'	> 15 March 'Cripp's Pink' < onwards
Pear	< 1 February Before < 'Abate Fetel'	1 Feb - 15 March 'Abate Fetel' < 'Forelle'	> 15 March 'Forelle' < onwards
Peach	< 1 December Before < 'Jim Dandy'	1 December - 1 January 'Jim Dandy' < 'Fairtime'	> 1 January 'Fairtime' < onwards
Nectarine	< 1 December Before < 'Margaret's Pride'	1 December - 1 January 'Margaret's Pride' < 'August red'	> 1 January August Red' < onwards
Plum	< 1 December Before < 'Fortune'	1 December - 1 February 'Fortune' < 'Laetitia'	> 1 February 'Laetitia' < Southern Bell'
Apricot	< 1 December Before < 'Soldonne'	1 December - 1 February 'Soldonne' < 'Bebeco'	> 1 February

Cultivar Attributes

The following details are recorded for new and existing Cultivars:

- **Common Name** (Cultivar name) - A commonly used name to refer to the cultivar
- **Crop** - A crop type as from the list above.
- **Harvest Window** - Early, Mid or Late harvest window
- **Rootstock/Scion** - Indicate whether the cultivar is mainly used as a Rootstock or Scion
- **Breeder** - The name of the company that bred or developed the Cultivar or selection
- **Licensee** - The name of the company that manages the selection or cultivar for evaluation and possible commercialisation
- **Trade/Registered Names** - A list of known registered trade designations
- **Selection ID** - The selection identity initially allocated to the cultivar in the selection phase, eg. SE-01-05 and used if a name has not been allocated.
- **Import ID** - The import identity allocated to the selection or cultivar during importation to the country where evaluation is performed.

Sensory Evaluation

Sensory analysis is a scientific discipline that applies principles of experimental design and statistical analysis to the use of human senses (sight, smell, taste, touch and hearing) for the purposes of **evaluating** products like fruit.

The discipline normally requires larger panels of human assessors or evaluators who test the products and the responses made by them are then recorded. By applying statistical techniques to the data recorded during sensory evaluation, it is possible to make inferences and collect insights about the products under testing. Numerous definitions and applications are published in the sensory science domain and at this stage we apply simplified *Wikipedia* descriptors to fruit sensory evaluation:

A. Effective testing

This type of testing is concerned with obtaining ***objective facts*** about selections and / or cultivars under evaluation. We can compare cultivars by **discriminative testing** (e.g. do two or more peach cultivars differ from each other for specific characteristics) and by **descriptive profiling** (e.g. what are the distinguishable characteristics of two or more cultivars). A **trained panel** or **trained evaluators** would normally be required for this type of testing and then adding measurements of certain characteristics like diameter of fruit, firmness, sugar content, etc.

There are several types of sensory tests. The most classic is the **sensory profile test**. In this test, each taster or evaluator describes each product by means of a questionnaire and / or evaluation sheet. The evaluation sheet includes a list of descriptors or characteristic (e.g. aroma, acidity, etc.). The evaluator rates each characteristic for each cultivar depending on the intensity of the character perceived in the product (e.g., 0 = very weak to 100 = very strong).

B. Affective testing

Other methods of testing is known as ***holistic testing,*** as they are focused on the **overall** appearance or experience of certain characteristics of the product and then they are categorised. This type of testing is concerned with obtaining ***subjective*** data, i.e., how well products are likely to be accepted. Usually large (50 or more) **panels of untrained personnel** are recruited for this type of testing, although smaller focus groups can be utilised to gain insights into products. The range of testing can vary from simple **comparative testing** (e.g. Which apple cultivar do you prefer, A or B ?) to **structured questioning** regarding the magnitude of acceptance of individual characteristics (e.g. rate the "fruity aroma": as dislike / neither / like). Also known as ***consumer testing***. In Provar evaluation protocol the Overall rating for certain characteristics fall in this category. Tasting sessions in industry also apply here.

[14]

Evaluation Field Types

Range Characteristics (Ordinal Scale)

Ordinal scales are used to order the values of characteristics, but where the differences between the values are not clearly defined or observable. [27] With *Range Fields* we quantify characteristics that are normally scored with ordinal data by using 0-100% **Line scales**, combined with **Interval descriptors**. As example:

Class Characteristics (Nominal Scale)

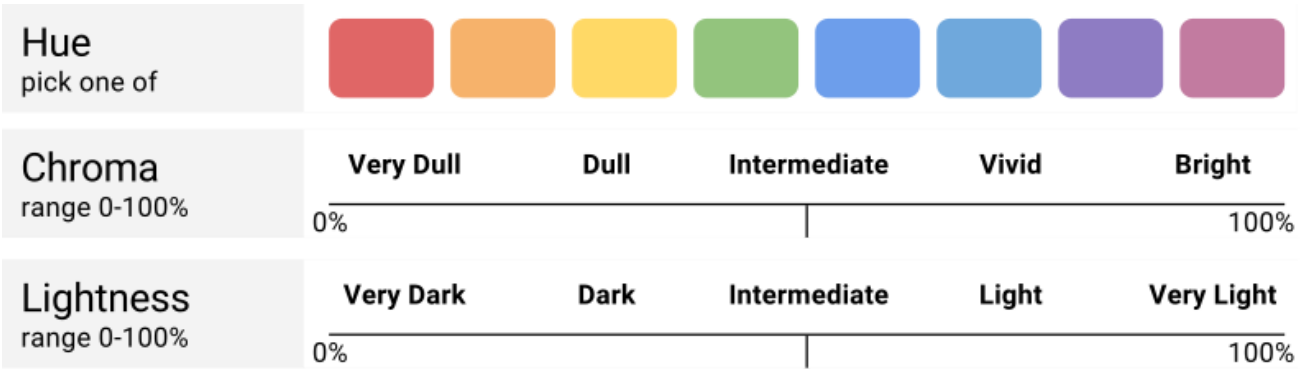
Class fields provide a way to label variables, without any quantitative value, by selecting one to many labels out of a selection of options. Example:

Diagrams and / or images may be included to help the evaluator decide in what class a specific characteristic should be placed, for example, tree growth type and fruit forms.

Colour Characteristics (Ordinal Scale)

Colour fields provide a way to characterize colour using the HSL model, with values for Hue, Saturation (Chroma) and Lightness. Every colour characteristic is therefore a three-step recording.

1. **Colour Hue:** Select colour which best matches the hue you are attempting to define from a palette or colour name provided, independent of its lightness or saturation.
2. **Colour Chroma (saturation):** Next, define the chroma of the selected hue. Chroma describes the purity, intensity or saturation of the colour, or its freedom from white or gray. Chroma varies from 0% (very dull, grey) to 100% (very bright).
3. **Colour Lightness:** Next, define the lightness of the selected shade. Colour Lightness measures the relative degree of black or white that has been mixed with a given hue. Adding white makes the colour lighter (creates tints) and adding black makes it darker (creates shades). The lightness of the colour is indicated using interval descriptors from very dark to very light.



Section 2: Evaluation Locations

Site Identification

A ***Site*** identifies a geographical area or region where the farm or production unit on which the ***Evaluation Block*** is situated. Sites are subdivided into Blocks (with border paths or roads), which defines an accurate geographical area within the Site and allocated to the trees (Plant Samples) under evaluation. Blocks are well established units were the producer and / or evaluation block manager will allocate specific commercial cultivars and or evaluation orchards. The Evaluation Block refers to the plot on which the Plant Sample is planted and where the evaluation of the plant sample is performed and from where the fruit sample (Harvest sample) is harvested. A ***Plant Sample*** represents a group of trees of a distinct cultivar or selection of which the trees are genetically identical and the ***Harvest Sample*** represents the fruit that is harvested from the Plant Sample for fruit evaluation.

For Block attributes and associated environmental data to be representative of the contained Plant Samples, the following must hold true:

- **Environmental conditions** (soil, weather and management practices) is **identical** for Plant Samples planted within the Block.
- **Total Block area** for an Evaluation Block should be more or less **1ha**, depending on the agreement with the producer and / or Client.
- **Rows** are **evenly spaced.**
- Plant Samples within rows are evenly spaced.

Site Attributes

The following locational details are recorded for Sites and containing Evaluation Blocks:

- **Site Name** - The name of the farm/site or simply a common name used to refer to the site
- **Block Name** - The name or number of the block/orchard contained within the site, usually a a Block number will apply
- Address - Street Address, City, Region, Country and Postal Code of the farm/site
- **Latitude [°N]** - Geographical latitude coordinate of the block/orchard center point in degrees North (negative value indicates South)
- **Longitude [°E]** - Geographical longitude coordinate of the block/orchard center point in degrees East (negative value indicates West)
- **Altitude [m]** - Altitude of block center point in meters above sea level
- **Row Spacing [m]** - A commonly used distance between rows within the block
- **Planting/Column Spacing [m]** - A commonly used distance between trees within the block.
- **Exposure Type** - Valley / Hillside / Level
- **Exposure Direction [cardinal direction]** of the exposure type
- **Planting Direction [cardinal direction]** - Direction of rows
- **Environmental Risks** - Commonly occurring environmental events/risks: Frost / Hail / Heat stress / Light stress / Wind exposure / Drought / Flooding / Animal and or Bird damage.
- **Risk Mitigation Measures -** One or more of the following risk mitigation / management measures: Overhead irrigation / Hail nets / Shade nets / Windbreaks / Special irrigation / Special drainage / Bird & Animal deterrents
- **Irrigation Type** - The irrigation type used to artificially supply the plants with water: Drip / Microjet / Overhead / Dryland /Other

Orchard Establishment and Plant Maintenance

Standard orchard practices on the farm are applied in the Evaluation Block. Soil preparation, planting, irrigation, fertilization, Plant Sample training and other management practices are inherent to the farm or production unit.

Evaluators perform planning of planting schedules and placement of Plant Sample orders with Nurseries and coordinate planting actions with the farm manager and / or technical manager in association with Clients.

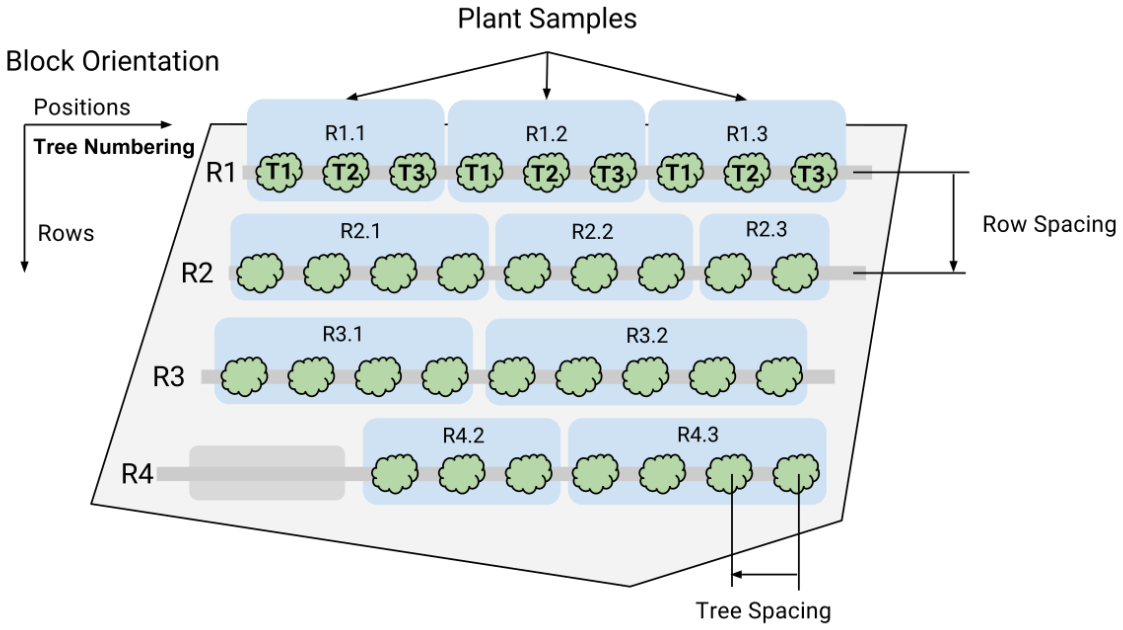
Technical advice from **Industry Specialists** may be contracted for specialised advice re. Plant Sample training and management.

Row-Position Identification

Evaluation Blocks are subdivided to provide Plant Sample **Row** and **Position** locations. When the Block is first established, the orientation in which rows and positions (columns - tree positions within rows) are allocated, is identified. Trees within the Plant Sample are numbered, in sequence, in the same direction as positions.

Row allocations remain static for the lifetime of the Block and the space between rows is uniform for all rows within the Block. Plant Samples may be replaced, added and removed during the lifetime of the evaluation Block, and in some cases, positions of Plant Samples within the row must be

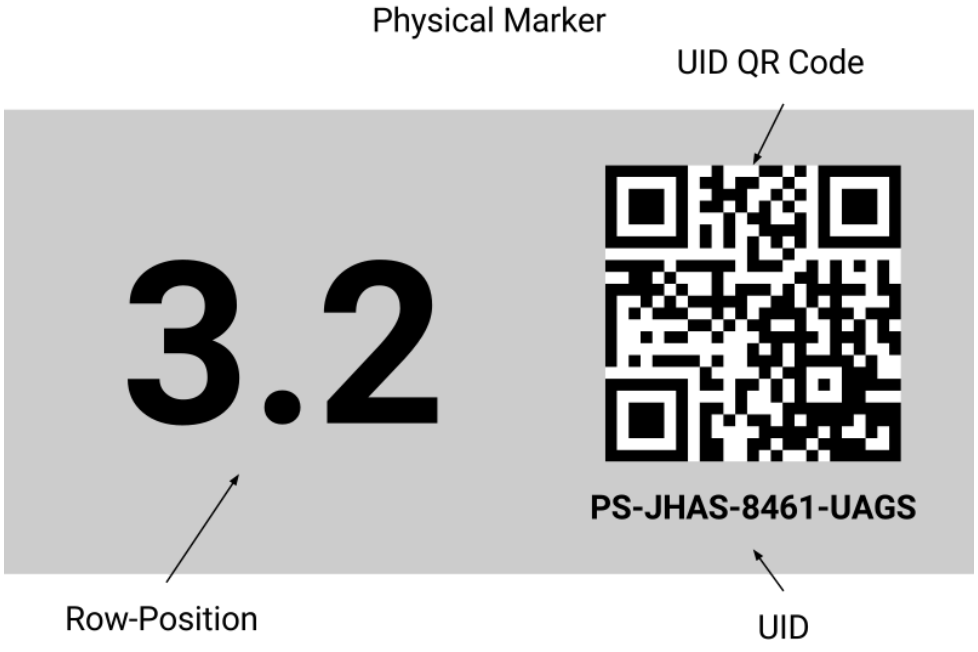
re-allocated. Between tree distance is formalized according to production practice per fruit type, but also according to the producers' preferences.



Ideally, different fruit types (apples, pears, nectarines, plums, etc.), will be planted within the same row or adjacent rows for best management results, including spraying, pruning, thinning and harvesting. Harvest week (if available), should be used to allocate Plant Samples within the row from early to late.

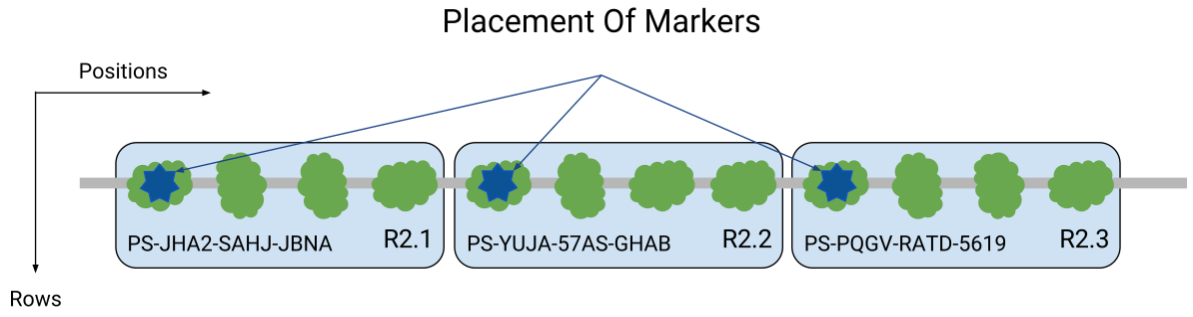
Plant Sample Markers

Physical markers in the Block are used to identify the UID of the Plant Sample as well as the row-position when the evaluator is present at the Plant Sample. If a marker is lost or destroyed, the Plant Sample may be allocated to a new UID to replace the lost marker.



Unique identifiers (UIDs) are allocated to each Plant Sample, allowing evaluators to accurately allocate the data associated with the sample. These UIDs are also expressed in a QR Code format to be scanned by a camera for quick access to the sample's data. To protect the data associated with the Plant Sample, the UID is randomly generated to not expose the identity of associated selections or cultivars or any other characteristics the the sample.

Markers should be positioned at the **first tree of the Plant Sample** within the row. This helps to visually identify the barcode markers when one Plant Sample ends and the next Plant Sample starts.



Section 3: Plant Sample Evaluation

Before a new selection or cultivar is planted on commercial scale, it should be thoroughly evaluated for stability, adaptability to different environmental conditions in the production area and fruit quality and keeping quality attributes. Evaluation of selections or new cultivars is performed to describe and quantify the characteristics and determine the variation between localities and seasons. The interaction between cultivar (**Genotype**) and **Environment** is quantified according to its visual characteristics (**Phenotype)** to describe the intrinsic traits of the Plant Sample and to understand and verify the commercial potential of the Fruit Sample of the cultivar, thus limiting the risk associated with planting non-adapted and poor quality selections and cultivars in a specific production area. In consequence, this limits risk and prevents possible financial losses by producers.

Plant Sample Evaluation Procedures

A Plant Sample represents a group of trees of a distinct selection or cultivar that are genetically identical. For a Plant Sample to be representative of the specific selection or cultivar under evaluation, the following rules must hold true for plants within the Plant Sample:

- **Scions** are of true origin and distinguishable, **identical** (clonal) and **uniform**
- **Clonal Rootstocks** are distinct and of **identical** genetic origin
- **Seedling Rootstocks** are specified as developed from seed resulting in more heterogeneous trees after budding compared to trees developed from clonal rootstock origin
- Planted in **close proximity** in the **same row** or next row as near as possible and experience **identical environmental conditions**
- Planted at the **same season** and time (ideally the same week)
- Plant **spacing is even** between rows and between trees (columns) in the sample

Plant Samples are visually inspected at regular intervals to record characteristics and take measurements. Records can be divided into 3 main types:

- **Plant Sample Attributes** are information related to the Plant Sample which do not change over time. These attributes are recorded once, before evaluation starts, and never changes during the lifetime of the sample and include the following:
    - **UID** - A unique barcode identifier in the format, *PS-XXXX-XXXX-XXXX*. This barcode in no way exposes any details of the plant sample and is used to identify the sample in the orchard and to link the Plant Sample with the Harvest Sample during all stages of evaluation.
    - **Sample Size [# trees]** - The number of trees in a Plant Sample
    - **Leaf Date [YYYY-MM-DD]** - Date when the Plant Sample was planted in the Evaluation Block
    - **Site and Block Location** - Where the Plant Sample is located. (See *Site Attributes* for specific details recorded)
    - **Row-Position [R#.#]** - The physical address of the Plant Sample within the Block according to row and position in the row (e.g. “R5.12” represents row 5, 12th plant sample in the row)
    - **Row Spacing [m]** - Distance between rows in meters
    - **Planting (Column) Spacing [m]** - Distance between trees in rows in meters
    - **Scion Cultivar** - The associated scion cultivar name (See *Cultivar Attributes* for specific detail recorded)

    - **Rootstock Cultivar** - The associated rootstock cultivar name (See *Cultivar Attributes*)
- **Plant Sample Characteristics** represent 'overall' **observations** of a Plant Sample under evaluation and recorded during visual inspection of the plant material on a seasonal basis. The characteristics recorded differ based the crop type under evaluation. These characteristics are divided into the following categories:
    - Phenological Sequence
    - Growth and Architecture
    - Trellis and Training System
    - Flowering
    - Fruit Set
    - Pests, Diseases and Disorders
    - Adaptability
- **Plant Sample Measurements** can be recorded for each tree in the sample and represent concrete physical attributes of a single plant and is usually recorded with a measurement tool.

The following steps are followed for the evaluation of plant samples:

1. Ordering and planting of trees. Planning of planting schedules and placement of tree orders with nurseries in association with Clients and coordinate planting actions with farm manager / Block manager.
2. Labelling of trees with physical barcodes and row and position labels and compiling a planting plan or map with row and position numbers and Plant Sample bar-codes.
3. Orchard management practices as performed on farm - farm manager / Evaluation Block manager will apply normal procedures that he / she is applying on commercial units on the farm.
4. Evaluators perform weekly visits to Evaluation Blocks to monitor and note general condition of orchards and trees, note stress related factors e.g. diseases, insects, etc. and report accordingly to farm manager / technical manager.
5. Perform Plant Sample and visual fruit evaluation on tree of all selections and cultivars during different phases of fruit development.
6. Manage placement of climate loggers, climate data collection and processing of collected climate data per area and per Block.
7. Harvest fruit at optimal picking stage and collect Harvest Samples according to protocol.
8. Take photographs as described under section "Photographs".

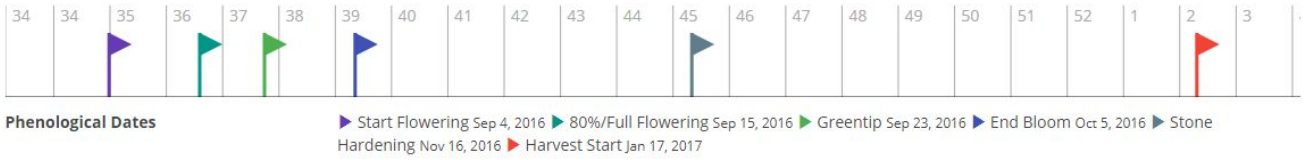
Plant Sample Characteristics

Each of the characteristics described in the following section is recorded every season the Plant Sample is undergoing evaluation.

Characteristics: Phenological Sequence

Each tree within the Plant Sample is visually inspected throughout the growing season, starting at bud break, to log the dates on which vegetative, flowering and fruit growth stages are reached. Monitoring and dating annual tree development stages as well as tree characteristics are included in this evaluation step. Here characteristics are monitored and noted to fully understand all the stages of tree phenology and the tree growth responses to the environment.

Example of phenological stages mapped on a timescale (Week number).



The optimal harvest window is recorded ensuring most optimal after harvest life of the fruit and most optimal eating quality. The maturation cycle of fruit can differ from season to season. Depending on fruit type, several maturity indicators, such as firmness, fruit colour, seed colour, total soluble solids, acid and starch conversion, are used on a seasonal basis to determine fruit ripening and release dates.

For each season during the lifetime of a tree the following events are recorded, in order:

Pome Fruit Events

1. **Initial Reproductive Budbreak (IRB):** Recorded date at the first sign of flowers in the "Bud burst" stage on the Plant Sample.
2. **Initial Vegetative Budbreak (IVB):** Recorded date as the time of the first sign of green leaves emerging from any vegetative bud.
3. **Balloon Stage:** Recorded date when most of the flower buds are swollen to a point just before opening, forming a balloon-like structure.
4. **80% Flowering / Full Bloom:** Recorded when 80% of flowers are open stage also known as full bloom.
5. **End Flowering:** Recorded when no more flowers are visually found in an open stage.
6. **Flower Thinning:** The date when active flower thinning is performed in the orchard according to on-farm practices. This is usually done during flowering, to achieve maximum marketable fruit size and optimum fruit quality.
7. **Fruit Thinning:** The date when active fruit thinning is performed in the orchard according to on-farm practices. This is usually done after fruit set to achieve maximum marketable fruit size and optimum quality. Peaches should be thinned before the pit hardening phase.
8. **Harvest Start:** Date when first fruit are harvested from the tree at specified harvest stage (See Ideal Picking Ripeness parameters in section 4).
9. **Harvest End:** Date when last fruit are harvested from the tree.
10. **Flowering period** and **Harvest period** calculated according to the above dates. These attributes are not recorded as such, but form part of the Report.

Stone Fruit Events

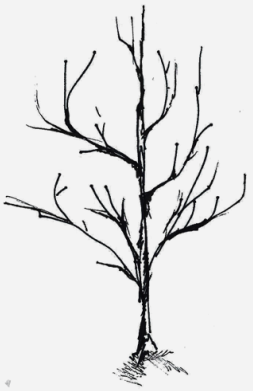
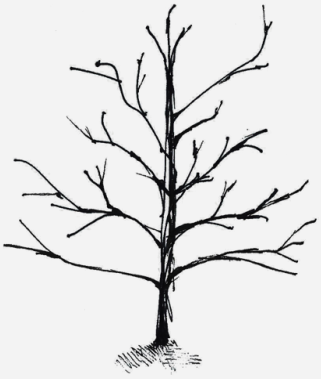
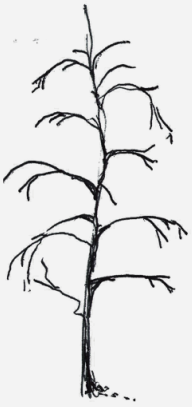
1. **Initial Vegetative Budbreak (IVB):** Recorded date at the first sign of flowers in the “Bud burst” stage on the Plant Sample
2. **Swollen Bud:** Recorded when buds are starting to develop into a swollen stage, between dormant stage and initial reproductive budbreak.
3. **Initial Reproductive Budbreak (IRB):** recorded at the first sign of flowers in the tight cluster stage.
4. **10% Flowering** (*aka Start Flowering)*: Recorded when at least 10% flowers are open.
5. **80% Flowering** (*aka Full Bloom)*: Recorded when 80% flowers are open.
6. **Petal Fall:** Recorded when first petals detach from flowers.
7. **End Flowering:** Recorded when no more flowers are visually found in open stage.
8. **Flower Thinning:** The date when active flower thinning is performed in the orchard according to on-farm practices. This is usually done during flowering to achieve maximum marketable fruit size and optimum quality.
9. **Fruit Thinning**: The date when active fruit thinning is performed in the orchard according to on-farm practices. This is usually done after fruit set to achieve maximum marketable fruit size and optimum quality. Peaches should be thinned before the pit hardening.
10. **Stone Hardening:** Date when the stone (pit) of the fruit cannot easily be cut through by a sharp object - indicating hardening of the stone has been reached. If the fruit can be cut completely through the pit area, then pit hardening has not occurred.
11. **Harvest Start:** Date when first fruit are harvested from the tree at specified harvest stage. (See Ideal Picking Ripeness parameters in section 4)
12. **Harvest End:** Date when last fruit are harvested from the tree.
13. **Flowering period** and **Harvest period** calculated according to the above dates.

Characteristics: Growth and Architecture

Branching Habit (Pome Fruit)

ID `tree_branch_habit_pome`
Record one or more class labels.

** Applies to Pome Fruit trees.*
** Also known as 'Tree Form', 'Plant Form'.*

Columnar	Upright	Intermediate
		
Spreading	**Drooping / Weeping**	
		

Branching Habit is the natural characteristic shape, appearance, or growth form of the Plant Sample. It develops from specific genetic patterns of growth in combination with environmental factors and is part of the structural organization of every Plant Sample. Some apple cultivars like "Telamon" for example, has a columnar tree form and "Braeburn" has a more standard, "spreading" growth habit. Tree architecture is related to inherent Plant Sample branching habit and crotch angles of branches and shoots and is naturally very diverse. For fruit production, certain growth habits are more desirable than others. Here general descriptors are used to qualify the natural and basic growth habit of the tree.

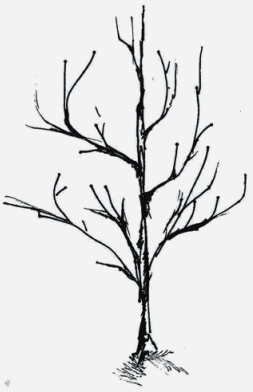
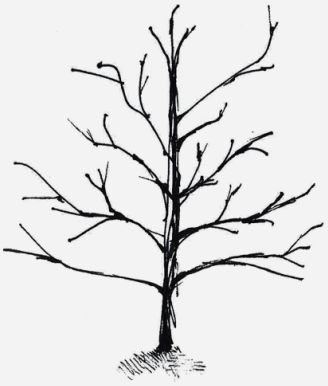
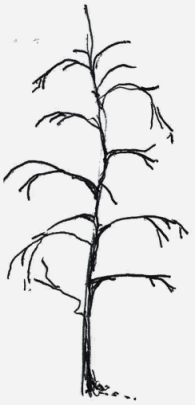
Columnar refers to trees that grow upwards instead of sidewards, giving the tree a spire shape and an elongated appearance.
Upright branching refers to narrow branch angles on an erect main stem that grows in a semi-upright and upright position.
Intermediate refers to an inherent tendency of the tree to grow neither fully upright, nor fully spreading.

Spreaded branching exhibit a sprawling type of growth, resulting from profuse lateral branching and wide crotch angles.
Drooping / Weeping refers to a branching habit where the side branches tend to grow in a downwards direction.

Branching Habit (Stone Fruit)

ID `tree_branch_habit_stone`
Record one or more class labels.

** Applies to Stone Fruit trees.*
** Also known as 'Tree Spread', 'Tree Architecture'.*

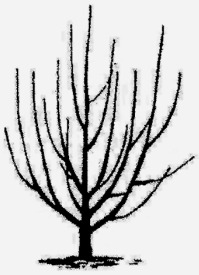
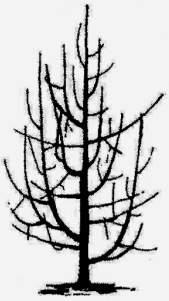
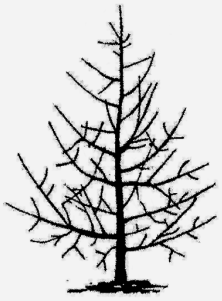
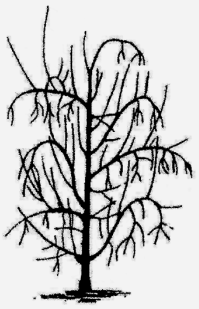
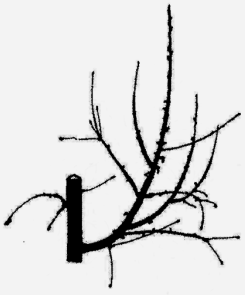
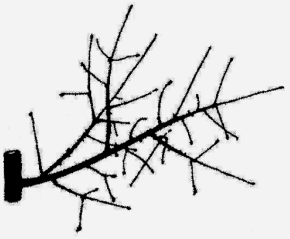
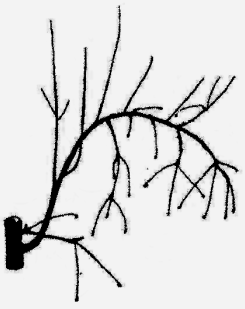
Upright	Semi-Upright	Intermediate
		
Semi-Spreading	**Spreading**	**Drooping / Weeping**
		

Upright branching refers to narrow branch angles on an erect main stem that grows in an upright position.
Semi-Upright refers to an branching habit between Upright and Intermediate.
Intermediate refers to an inherent tendency of a tree to grow neither fully upright, nor fully spreading.
Semi-Spreading refers to a branching habit between Intermediate and Spreading.
Spreaded branching growth exhibit a sprawling type of growth, resulting from profuse lateral branching and wide crotch angles.
Drooping / Weeping refers to a branching habit where the side branches tend to grow in a downwards direction.

Growth Type Lespinasse (Apple)

ID `tree_grow_type_apple`
Record one or more class labels.

** Applies to Apple trees.*
** Also known as `Lespinasse` Types.*

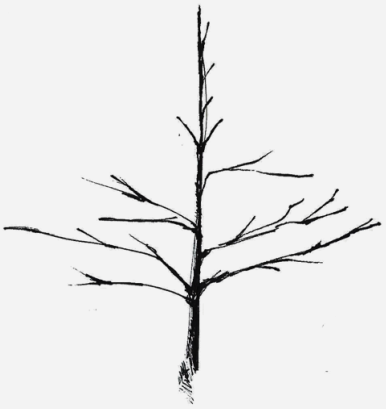
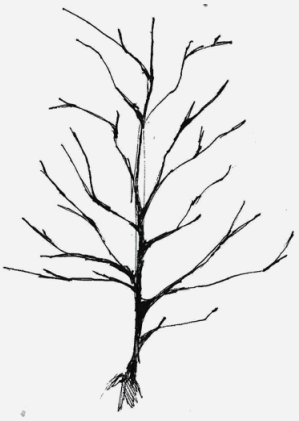
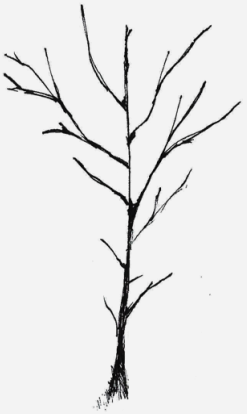
I	II	III	IV
			
			

Type I - "Spur" ('Starkrimson') - bear fruit on spurs and have a compact tidy appearance and fruit is distributed fairly evenly along the branch. Main branches tend to develop side branches on their lower parts and the trunk is not very strong.

Type II - e.g. 'Reine des Reinettes', 'King of the Pippins'. Easy to manage with main branches having wide angles to the trunk. The central leader is normally dominant. Strong basitony is normally associated with type II.
Type III - e.g. 'Golden Delicious' Dominating trunk and suited for vertical shoot management. Numerous short shoots.
Type IV - e.g. 'Granny Smith'. Rarely develop lateral shoots in lower parts of the shoots and branching normally in upper third of the trunk - acrotonic tendency and elongated arched main branches. Fruiting towards outside of the tree. [13]

Growth Form

ID `tree_grow_form` ** Applies to all fruit trees.*
Record one or more class labels.

Basitonic	Mesotonic	Acrotonic
		

Inherent character of the tree as well as environmental stimuli affect the phenotypic tree growth form. Acrotony or basitony are frequently considered as two fundamental phenomena underlying, respectively, the *bushy* growth habit. [24]

Basitony is the privileged development of lateral axes in the lower/base or proximal part of the main growth unit or annual shoots.
Acrotony is the prevalent development of lateral axes in the upper (distal) part of the main growth unit or annual shoots.
Mesotony is the term used for the preferred development of shoots and branches from the median (nearest to the middle) part of a tree or annual shoots. [25][20]

Growth Potential

ID `tree_grow_potent` ** Applies to all fruit trees.*
Record a value within the range. ** Also known as 'Growth Vigour' or 'Tree Vigour'*

Very Weak	Weak	Intermediate	Strong	Very Strong
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

In relation to trees planted in the same year and in the same Evaluation Block, it is possible to visually distinguish between cultivars because of differences in height and circumference of the tree canopy. The way a tree fills and the time-span for the tree to fill its allocated "space" in the row also is an indication of tree vigour. Here we distinguish differences in growth potential in relation to trees planted in the same year or season.

Branching Density

ID `tree_branch_dense` ** Applies to all fruit trees.*

Record a value within the range.

Very Weak	Weak	Intermediate	Strong	Very Strong
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

In relation to trees planted in the same year and in the same Evaluation Block, it is possible to visually distinguish between branching density of trees. A Weak branching density indicates a low number of side branches and / or shoots developing from the main stem/trunk while a strong branching density is documented if the tree develops numerous side branches form the main stem.

Feather Density (Stone Fruit)

ID `tree_feather_dense_stone` ** Applies to Stone Fruit trees.*

Record a value within the range.

Rare	Few	Intermediate	Numerous	Plentiful
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

When new shoots grow in spring, some of the buds are not inhibited by apical meristems resulting in buds that produce side shoots during summer. These shoots are called “feather shoots” in stone fruit. Based on a 0-100% line-scale, where Rare indicates no or very low number of side shoots visible on the tree and Plentiful indicates a bushy tree form.

Leaf Color

ID `tree_leaf_color` ** Applies to all fruit trees.*

Record one or more class labels.

Red	Green

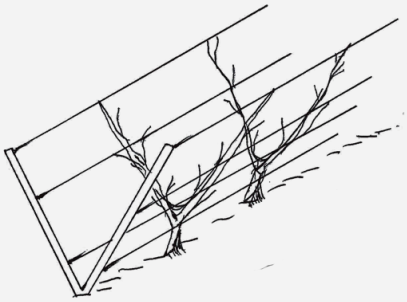
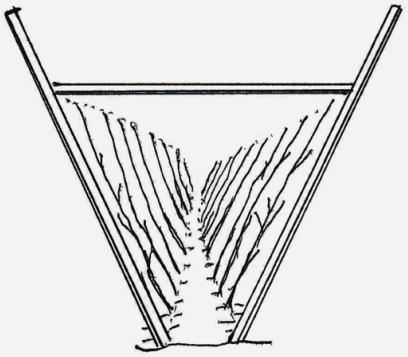
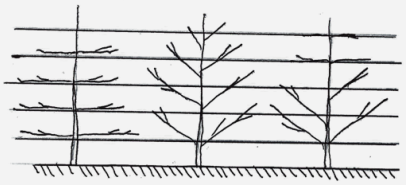
Leaf colour refer to the pigments visible on the leaf lamina and described in hue format, i.e., normally observed as green or red.

Characteristics: Trellis and Training System

Trellis System

ID `tree_trellis_system`
Record one or more class labels.

** Applies to all fruit trees.*
* Also known as 'Espalier'

Y-Tatura	V-Tatura	Palmette
		
Basic Support	Other	None

Espalier training on structures using different trellising systems when the main trunk of the tree and branches are tied to wires and setting a firm structure to become productive early. Trellising systems are used to support trees against wind and for maximum sunlight interception and higher fruit yields and quality.

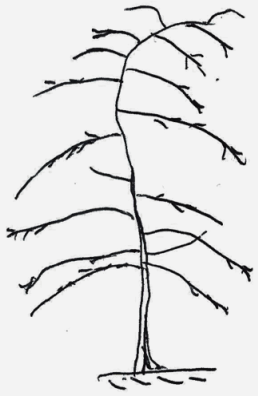
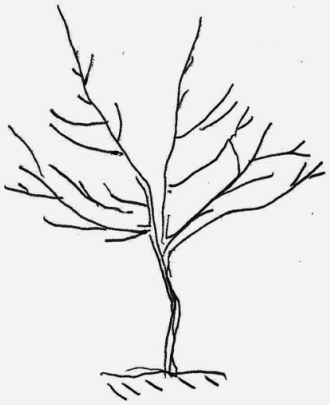
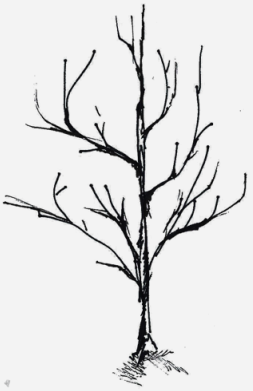
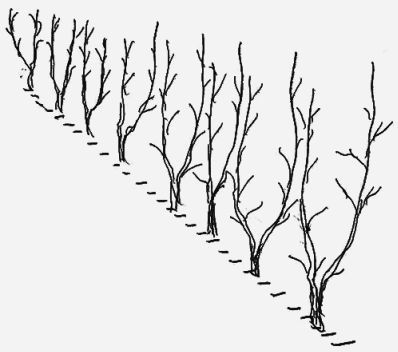
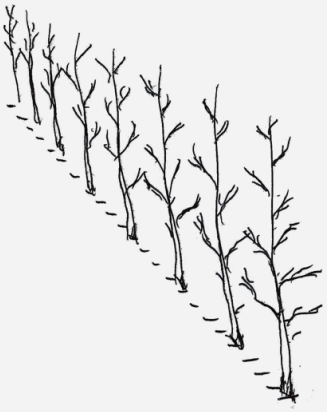
Tatura trellis is a close-planting system, in which trees are trained to form a V-shaped canopy. A trellis structure is needed to train the trees in forming a V-shape, and to provide support for the tree when carrying the crop. The tree structure is created in two dimensions by using tatura trellis systems. Main trunks are tied to the wires. Buds are selected to form branches, and shoots are fastened to training wires. There are two basic shapes of Tatura canopies – Y shaped trees which have a vertical trunk and two opposing arms of the tree trained to either side of the trellis, and V shaped trees where the whole tree is leaned to one side of the trellis while the next tree in the row is leaned to the other side.
Palmette: There are a number of palmette training types, all with a central leader with scaffolds in the plane of the row only. Tiers of scaffolds are chosen each season and tied to wires to reduce vigour and promote spurring and fruiting. These systems have been popular because the bending of branches on trellises controls growth and provides a balance of fruiting and vegetative growth.
None: Indicates that no trellising or structure is used.
Other: Uses a trellis system not listed above.[9]

Training System

ID `tree_train_system`

** Applies to all fruit trees.*

Record one or more class labels.

Solaxe	Open Vase	Central Leader
		
Bi Axis	**Spindle**	**Other**
		
None		

Tree training systems were developed to suite the best way in optimising fruit production, tonnage and pack-out and may differ from fruit type and area of production. In some Evaluation Blocks specific training systems are preferred and implemented by the Block manager. Here we note the type of training system adding to interpretation of the data. [9]

Many modern tree fruit orchards are planted ta high-density using dwarfing rootstocks and training systems designed for maximum sunlight interception, higher fruit yields and quality, and easier worker access. As a result, growers are seeing increased profitability and greater potential for enhanced mechanization of operations. Choosing the correct scion and rootstock combination is essential to ensure that trees will have the appropriate vigor and perform properly for the training methods used. The soil type, irrigation system, tree spacing, and management practices will also contribute to the success of a rootstock and training system combination. [10]

Central leader: Is used to describe a tree trained to develop one central vigorous shoot or branch near the center of the tree as scaffold to side branches and shoots. Competing upright shoots are

removed during tree development. This is the predominant system currently used in South Africa. Similar to the Solaxe, “Whip” trees are not headed and supported by a simple trellis.

Open vase: Three or four shoots are chosen to form the main architecture during the first year, while competing limbs are removed. Other systems have developed from this basic tree architectural system.

Spindle systems are planted using well feathered two-year old nursery trees where lateral shoots are selected to form part of the permanent scaffolds in the bottom third of the tree. Competing laterals that develop at the end of the unpruned central leader have to be removed in a very early stage.

Solaxe: Is a French training system allowing the trees to grow with little pruning during early years of growing and where the branches are bent horizontally for optimal fruit production. Maximum light exposure is achieved and distance between trees are normally 1.5m between trees and 4.5m between rows

Bi-Axis The double tree or Bibaum® system is a double leader system that was developed in Italy, planting pre-formed trees with two axes in the nursery. Trees are planted at 3.3m x 1 to 1.25m spacing in a single row giving 3,000 trees/ha, with a leader density of 6,000/ha. Leaders are trained parallel to the row and are spaced at about 50 to 60cm apart.

Other: Other training system not listed above.

None: No training system used.

[9][10][26]

Characteristics: Flowering

Flower Type (Stone Fruit)

ID `tree_flower_type_stone`

** Applies to Stone Fruit trees.*

Record one or more class labels.

Showy	Non-Showy
	

Stone fruit flowers can be identified as either **showy**, or **non-showy**, where showy flowers are well formed, attractive, with larger fruit compared to non-showy flowers with small, less attractive petals.

Flower Density

ID `tree_flower_dense`

** Applies to all fruit trees.*

Record a value within the range.

No Flowering	Very Low	Low	Intermediate	High	Very High
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Flower density relates to the number of flowers on the Plant Sample during full flowering period before thinning and can be very low or even no flowers developing or high number of flowers for the given season. In relation to trees planted in the same year and in the same evaluation block, differences between cultivars or selections can be easily distinguishable for quantification of flower density.

Flower Distribution

ID `tree_flower_distrib` ** Applies to all fruit trees.*
Record a value within the range.

Very Uneven	Uneven	Intermediate	Even	Very Even
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Flowers can be distributed on the whole tree in an Even distribution pattern or flowers can be concentrated in certain areas of the tree or even certain positions on the shoot (Uneven).

Flower Position

ID `tree_flower_pos` ** Applies to all fruit trees.*
Record one or more class labels.

Base	Middle	Tip	Whole Branch

Flower buds can form on various positions on the shoot, i.e., at the base nearest to attachment to the older shoot or branch preceding development of the bearing shoot, middle, tip of shoot or evenly spaced across the whole shoot.

Flower Thinning Required

ID `tree_flower_thin` ** Applies to all fruit trees.*
Record a value within the range.

None	Very Little	Little	Intermediate	Intensive	Very Intensive
0	[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Depending on the flower density, flower thinning can be necessary to reduce the amount of fruit on the tree. [11]

Secondary Flowering

ID `tree_flower_second` ** Applies to all fruit trees.*
Record a value within the range.

None	Very Little	Little	Intermediate	Intensive	Very Intensive
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Secondary flowering can occur in most fruit types due to environmental stimuli and some cultivars are more prone to this occurring due to their inherent genetic make-up. The secondary flowers open later than the primary flowers and also tend to produce lesser quality fruit with a shorter storage life.

Characteristics: Fruit Set

Precocity

ID `tree_bear_precocity`
Record a value within the range.

** Applies to all fruit trees in first years of planting.*
** Also known as 'Early Bearing'.*

Late	Intermediate	Early
[0 - 33)	[33 - 66)	[66 - 100]

Precocious cultivars and selections have an inherent tendency to produce a crop of fruit early in the life of the tree after planting.

Bearing Position (Pome Fruit)

ID `tree_bear_pos_pome`
Record one or more class labels.

** Applies to Pome Fruit trees.*

Tip Bearing	Lateral	Spur

Tree fruit have two types of buds, terminal and lateral buds. Apples and pears flower and fruit primarily on terminal buds. A terminal bud, also called the apical bud, is one located at the tip of a shoot. Lateral buds develops along the developing shoot at the base of the leaf blades.

The flower/fruit buds in apples and pears can be terminal on long shoots (greater than 4 inches) or more commonly on short shoots called spurs. A spur is a short shoot (4 inches or less) that only grows a very small amount each year. Spur types tend to have closer internodes and can produce smaller trees. [12]

Bearing Position (Stone Fruit)

ID `tree_bear_pos_stone`
Record one or more class labels.

** Applies to Stone Fruit trees.*

Base	Middle	Tip	Whole Branch

Fruit buds can form on various positions on the shoot, i.e. evenly spaced across the whole shoot or at the base nearest to the attachment of the older shoot or branch that precedes development of the bearing shoot, middle, tip of shoot.

Bearing Habit

ID `tree_bear_habit`
Record one or more class labels.

** Applies to all fruit trees.*

Spur	Short Shoots	Medium Shoots	Long Shoots	All Lengths

Reproductive buds are lateral, borne on one-year-old shoots. Bearing can be on various shoot lengths from very short (Spur-type) to Long shoots. In most cases bearing can be on all lengths of shoots.

Fruit Set Potential

ID `tree_bear_potent`
Record a value within the range.

** Applies to all fruit trees.*
** Also know as 'Crop Load'*

Very Low	Low	Optimal	Overcropped	Heavily Overcropped
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Fruit set relates to the number of fruit that develops on the tree **before fruit thinning** and can be Low or even No fruit developing or High number of fruit in relation to other Plant Samples planted in the same year and in the same evaluation Block. Differences between selections or cultivars can be easily distinguishable within a Block and within harvest year.

Colour Potential Inside Tree

ID `tree_color_inside`
Record a value within the range.

** Applies to all fruit trees.*

Very Poor	Poor	Average	Good	Excellent
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Over-colour development varies according to environmental conditions, i.e., light and temperature are key factors. Anthocyanin production in apples is light dependent; not only the intensity but also the quality of light influences anthocyanin formation. Low temperatures increase and high temperatures reduce anthocyanin concentration in apple peels. This is an important characteristic determining commercial potential and specific pack-out percentage of a new selection or cultivar. Good fruit colour inside trees will ensure high pack-out potential.

Fruit Thinning Required

ID `tree_fruit_thin` ** Applies to all fruit trees.*

Record a value within the range.

None	Very Little	Little	Intermediate	Intensive	Very Intensive
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

For high and very high fruit set, fruit thinning needs to be applied to reduce the amount of fruit on the tree. Thinning is done for two reasons. Firstly, a certain portion of the fruit is removed so that the remainder will develop adequate size and quality and second, the thinning process serves to increase the tree's ability to form flower buds for the next year - provided the fruit thinning is done early enough. Thin excess fruit when the fruits are the size of the end of little finger. Unlike apples and pears, no chemicals are labeled for thinning stone fruits at this stage. Thinning is started at one end of a branch and systematically remove fruit, leaving one fruit every 6 to 10 inches, but depending on the cultivar and other managing practices. Double fruit can host insects and if the stem of the fruit are short fruit may drop when becoming larger. [11]

Pre-Harvest Drop

ID `tree_preharvest_drop` ** Applies to all fruit trees.*

Record a value within the range.

None	Very Low	Low	Intermediate	High	Very High
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Early dropping of fruit from the tree due to an ineffective stem attachment mechanism (or short stems) to the shoot may be inherent to the cultivar or selection. This is a negative characteristic and especially in windy areas not acceptable. Pre-harvest drop may not occur (Low / none) or may be severe (High - very high).

Number Of Picks

ID `tree_pick_count` ** Applies to all fruit trees.*

Record one or more class labels.

1	2	3	4	5+

The number of picks may be required to achieve a full commercial harvest. With some cultivars a prolonged ripening period requires more than one harvest (normally associated with adaptation to the specific planting area).

Alternate Bearing

ID `tree_bear_alternate` ** Applies to all fruit trees.*

Record a value within the range. ** Also know as 'Biennial Bearing'*

Very Consistent	Consistent	Intermediate	Alternating	Very Alternating
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Biennial bearing occurs when a cultivar or selection produce a very heavy crop of fruit in one season followed by a light or no crop in the following season.

Characteristics: Pests, Diseases & Disorders

During Plant Sample evaluation in the orchard, symptoms of diseases and pests on susceptible selections and cultivars are normally easily distinguishable from resistant genotypes. During the evaluation process attention is given to any abnormalities in growth patterns, fruit development and general tree health that can be associated with pests and diseases. Each fruit type has its own specialized pathogens and disease symptoms.

Pests Detected (Stone Fruit)

ID `tree_pest_detect_stone` ** Applies to all fruit trees.*
Record one or more class labels.

Fruit fly	Aphids	False Codling Moth	Spider Mites
Other	None		

Pests Detected (Pome Fruit)

ID `tree_pest_detect_pome` ** Applies to all fruit trees.*
Record one or more class labels.

Woolly Apple Aphids	Aphids	Codling Moth	Spider Mites
Other	None		

Woolly apple aphids (*Eriosoma lanigerum*) and aphids as well as codling moth and bollworm are the most problematic insects. Presence of insects and diseases is noted in evaluation Blocks. [18]

Fruit Scab Presence (Pome Fruit)

ID `tree_fruit_scab_pome` ** Applies to Pome Fruit trees.*
Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Apple Scab (*Venturia inaequalis*) and Pear scab (*Venturia pirina*) symptoms on fruit are the most common diseases of apple and pear occurring world-wide. The presence of these symptoms should be noted during Plant Sample evaluation.

Leaf Scab Presence (Pome Fruit)

ID `tree_leaf_scab_pome` ** Applies to Pome Fruit trees.*
Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Apple Scab (*Venturia inaequalis*) and Pear scab (*Venturia pirina*) symptoms on leaves are the most common diseases of apple and pear occurring world-wide. The presence of these symptoms should be noted during Plant Sample evaluation.

Mildew Presence (Apple)

ID `tree_mildew_symptom_apple` ** Applies to Apple trees.*
Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Apple mildew (*Podosphaera leucotricha*) on leaves is one of the most common diseases of apple occurring world-wide. The presence of this disease should be noted during Plant Sample evaluation.

Diseases Detected (Stone Fruit)

ID `tree_disease_detect_stone` ** Applies to Stone Fruit trees.*
Record one or more class labels.

Leaf Curl	Stem Cankers	Bacterial Infection (*Pseudomonas*)	Bacterial Infection (*Xanthomonas*)	Fruit Infection
Other	None			

Peach and nectarine curly leaf (*Taphrina deformans*), Bacterial cankers (*Pseudomonas* and *Xanthomonas*) on stone fruit and stem fungal diseases are amongst the most common diseases in the Western Cape fruit production areas.

Overall Disease Presence

ID `tree_overall_disease` ** Applies to all fruit trees.*
Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Characteristics: Adaptability

Prolonged Dormancy Symptom

ID `tree_dormant_symptom`
Record a value within the range.

** Applies to all fruit trees.*
** Also associated with 'Delayed Foliation'*

None	Very Low	Low	Intermediate	High	Very High
0	[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Abnormal growth characteristics observable under mild winter conditions, i.e., temperatures not low enough to meet the chilling requirement (CR) of the Plant Sample, have been associated with symptoms of **Prolonged Dormancy** (PDS), delayed foliation (DF) or extended rest. PDS include reduced break of vegetative and reproductive buds, prolonged flowering duration, lower fruit set and uneven fruit size and fruit ripeness at harvest. The most prominent prolonged dormancy symptom is the absence or extended delay of lateral vegetative budbreak developing bare shoots and also called **Bare Wood**. Prolonged dormancy symptoms occur as a result of an unmet chilling requirement at temperatures in the range between 4 and 9°C during the rest period, or as a result of unfavorable temperatures during the period of normal budbreak.

Flower Burst Span

ID `tree_flower_span`
Record a value within the range.

** Applies to all fruit trees.*
** Also known as 'Flowering Duration'*

Brief	Prolonged	Extended
[0 - 33)	[33 - 66)	[66 - 100)

This characteristic is important in view of adaptability of the cultivar or selection to the specific growing area and also relates to the inherent chilling requirement of the Plant Sample. Normally when flowering is brief (short period), the fruit will be of equal size and maturity. When the flowering period is extended, fruit size and maturity will be variable and thus less acceptable. Flower burst span can be directly associated and calculated from start flowering date (IRB) and end flowering date.

Uniform Ripening

ID `tree_uniform_ripe`
Record a value within the range.

** Applies to All Fruit trees.*

Very Uneven	Uneven	Intermediate	Even	Very Even
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Uniform ripening of fruit within a tree is directly linked with the flowering period and the adaptability of the cultivar or selection to the specific environmental conditions. If chilling requirements of the selection or cultivar are not met, prolonged dormancy symptoms will result and extended flowering periods as well as variability in ripening between fruit will occur.

Productivity

ID `tree_overall_product`
Record a value within the range.

** Applies to all fruit trees.*
** Also known as 'Production Potential'*

Very Weak	Weak	Intermediate	Strong	Very Strong
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

General observation re. the inherent ease of fruit set and ability of the tree to fully develop all fruit to optimal harvest stage without loss of size and fruit quality.

Sunburn Presence

ID `tree_sunburn_symptom`
Record a value within the range.

** Applies to all fruit trees.s.*

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Bleached, or brown areas on the side of the fruit that was exposed to the sun, sometimes occurring with water-soaked subsurface tissues. Often darkening after storage, with the cortex tissue below the lesions having a bitter and taste and a brown discolouration.

Overall Adaptability

ID `tree_overall_adapt`
Record a value within the range.

** Applies to all fruit trees.*

Poorly adapted	Intermediate	Well Adapted
[0 - 33)	[33 - 66)	[66 - 100]

Fruit cultivars and / or selections can be area-specific in their adaptability to the environment and when strongly influenced by environmental conditions, micro-climates will have an effect on the performance of the cultivar. Plant Sample adaptability is an Overall score to describe the phenotypic response of the cultivar or selection to the environmental conditions. Poor adaptability will normally be associated with abnormal growth and production characteristics, including stunted or limited growth, poor morphological development of leaves and of shoots, occurrence of small and blemished fruit and may also include all aspects related to prolonged dormancy.

The presence of prolonged dormancy symptoms is also an indication of poor adaptation to mild winter climates or to unfavourable weather conditions during budbreak. If no PDS are observable and the tree is evenly and densely foliated, the tree can be described as "**Well Adapted**". A Cultivar or selections can have no prolonged dormancy symptoms and be poorly adapted to the planting area and climatic conditions due to other inherent limitations. A well adapted cultivar may be described as "**Well-balanced**" in all growth and fruiting characteristics.

Plant Sample Measurements

The following measurements may be recorded for each tree in the Plant Sample:

Measurement	Unit	Description
Trunk Diameter	mm	Measured 5cm above soil level and / or 5cm above interstem-scion graft level if inter-stems apply
Tree Height	m	Trunk measured from soil level to the top of the tree
Tree Depth	m	Deepest point in canopy of tree, (perpendicular to row)
Tree Width	m	Widest point in canopy of tree (parallel to row)
Number of Fruit	# fruit	Total number of fruit on tree
Total Yield	kg	Total fruit mass harvested over harvest period

Productivity & Yield Efficiency Estimation

When determining productivity, stripping of all fruit on at least 10 full bearing trees, the **Total Yield** per tree is weighed in order to calculate a productivity estimation:

Productivity

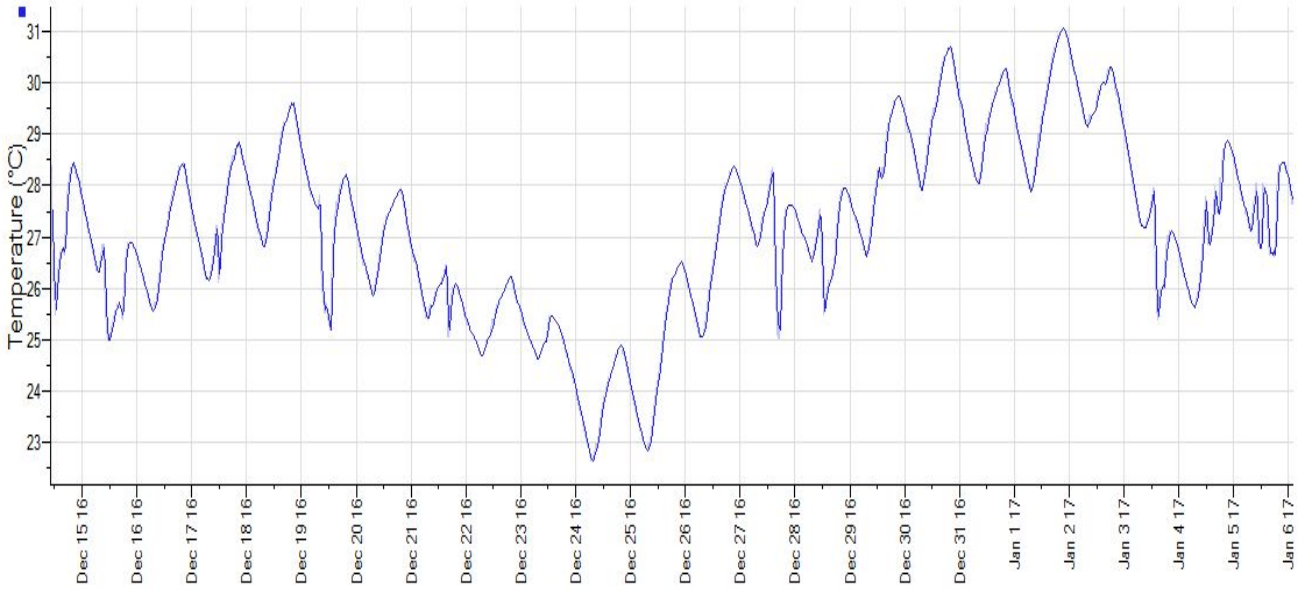
Productivity avg [kg/tree] = Total harvest weight [kg] / # of trees
productivity [ton/ha] = [kg/tree] * [planting density]

$$Productivity\ Average\ [kg/tree] = \frac{Total\ Harvest\ Weight\ [kg]}{Plant\ Sample\ Size\ [\#\ of\ Trees]}$$

Yield Efficiency

Total yield [kg] / trunk cross-section area [cm^2]

Temperature Data



Evaluation Blocks are monitored with temperature sensors to record temperature readings including:

1. Minimum temperatures
2. Maximum temperatures
3. Mean temperatures

These readings can be used to report on-site historical temperature data and to calculate **Cold-unit** and **Heat-unit** accumulation per season.

To log the historical temperature readings for a Plant Sample, the closest sensor module should be used. Under local planting conditions one sensor per block is sufficient to collect temperature data to get accurate temperature readings for all the Plant Samples under evaluation in the given Evaluation Block.

Evaluators manage placement of climate data loggers, climate data collection and processing of collected climate data per area and per Block.

Chilling Requirements

The chilling requirement of a Plant Sample is the minimum period of cold weather required for the specific selection of cultivar to exit the dormancy period and to start with the new growth cycle. Chilling requirement is expressed in cold units (also known as `chilling hours`) which can be calculated using different models by adding up the total amount of hours accumulated in winter at certain temperatures. Different models may apply, i.e., the Richardson and the Infruitec (Daily Dynamic Model developed in South Africa).

Temp Range [℃]	Cold Unit Accumulation [Chilling Hours]	
	Richardson (Utah)	Infruitec (Daily Dynamic Model)
< 1.4	0	0
[1.4 - 2.5)	0.5	0.5
[2.5 - 9.2)	1.0	1.0
[9.2 - 12.5)	0.5	0.5
[12.5 - 16)	0	0
[16 - 18)	-0.5	0
>= 18	-1.0	0

As seen in the above table, the Richardson model argues that temperature above 16℃ has a negative influence on the cold units accumulated and therefore subtracts units at this temperature. According to the Infruitec Model (that was developed for the warm winter conditions occurring in most production areas in the Western Cape, South Africa), cold units accumulated by the Plant Sample are not lost at winter temperatures reaching higher that 16°C values during the day time. The difference between the models relates to the above 16 °C temperatures during winter. Cold units are logged between 1 April en 31 August in South Africa.

[28][29][30][20] [22]

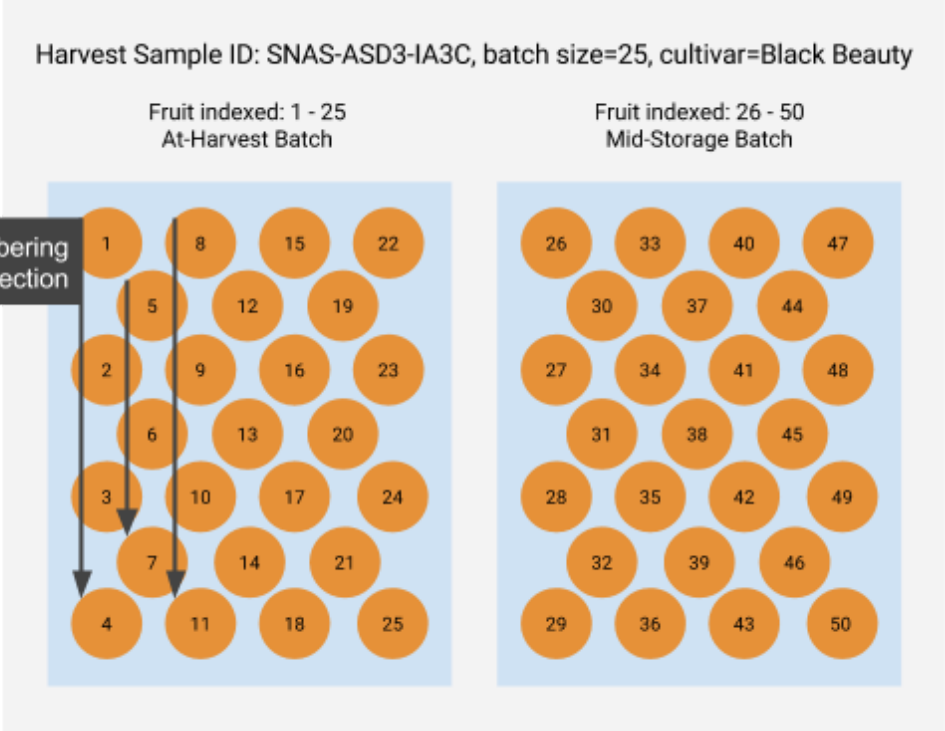
Section 4: Harvest Sample Evaluation

A Harvest Sample represents fruit harvested at optimal picking stage from designated trees planted in an Evaluation Block to be evaluated according to standard protocol as described in the next section. Fruit should be picked from trees that were managed under best orchard practices as agreed between Provar and the Evaluation Block manager. Any fruit that do not meet the required standards may not be included in the Harvest Sample evaluation procedure.

Harvest Sample Evaluation Procedure

Harvest Samples are extracted from Plant Samples or may be acquired directly from a Client for evaluation. Samples collected from Plant Samples must be representative of the Cultivar and Site and climatic conditions and the environment under test. To be representative the following rules apply to a Harvest Sample:

- All fruit in a sample is **harvested** on the **same day**. Taking multiple Harvest Samples at different dates, requires that each sample be evaluated separately.
- Collected from **same origin Plant Sample** (Three or more trees)
- Collected sample using **standard harvest protocols** (see Maturity Targets)
- Harvest adequate **sample size** for the given evaluation strategy (see Section 5.)
- Harvest Samples are kept under identical environmental conditions following the required **storage regime** (see Storage Regimes)



Harvest Samples are evaluated at predetermined intervals (four evaluation stages - see Storage Regimes) after the sample was harvested. Recordings on Harvest Samples can be divided into 2 main types:

- **Harvest Sample Characteristics** are recorded during visual inspection and sensory evaluation of the fruit sample. These characteristics are divided into the following groups:
    - Ripening
    - Colour and Pattern
    - Stone and Flesh Type
    - Shapes and Symmetry
    - Abrasions and Blemishes
    - Eating Quality
    - Storage Diseases and Disorders
    - Overall Score and Indexing
- **Harvest Sample Measurements** are recorded on **individual** fruit in the sample, organized by fruit number in the sample.

Determining Ripeness and Maturity Targets of Harvest Samples

A **maturity target** represents a specific fruit ripeness level when fruit should be harvested in commercial production to allow good eating quality after storage. To estimate maturity targets for new selections and cultivars, ideal ripeness tests for the specific crop should be applied. Clients may also request specific maturity target(s). [8]

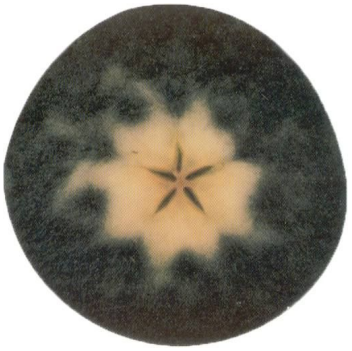
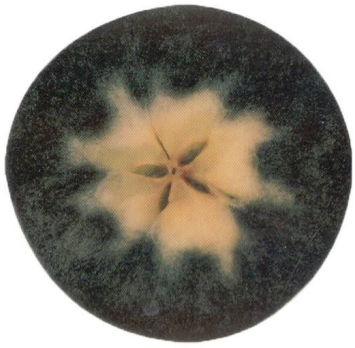
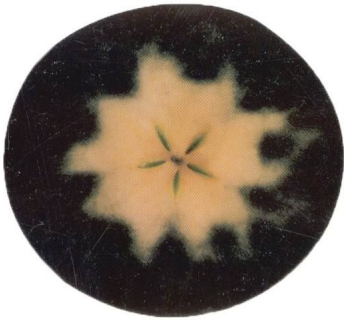
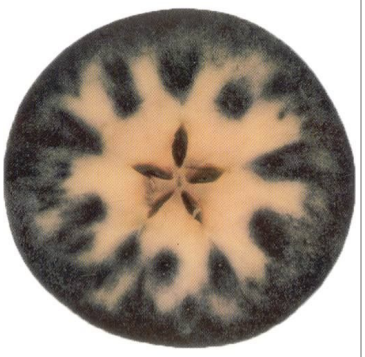
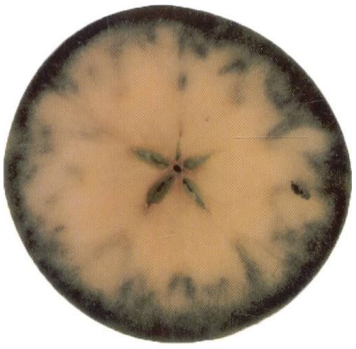
Fruit Type	Test	Ideal Picking Ripeness
Apple	Starch-Iodine Conversion test. Background colour development	30% Starch breakdown. 30 % is the target unless specified by client (Fourteen to seven days before eat ripeness)
Pear	Size and firmness measurement (8mm plunger)	6.0 - 8.0 kg, 7.0 kg target, unless specified by client
Peach & Nectarine	Size and firmness measurement (11mm plunger)	8.0 - 9.0 kg (for firm melting types) 9.0 - 11 kg (for melting types)
Plum	Size and firmness measurement (11 mm plunger) Background colour development Stem-end color development	6.0 - 8.5 kg Not green
Apricot	100% 'wring test' Colour development	Loose stone Not green

Ripeness of Pears

Applying a general rule of thumb, pears at ideal harvest time, will usually detach when "tilted" to a horizontal position from their usual vertical hanging position on the bearing unit. Pear fruit will be unripe or immature during first evaluation, as pears normally requires a cold period before ripening.

Ripeness of Apples - Starch-Iodine Conversion

During ripening, long chained starch molecules break down into smaller units, producing a fruit with a less starchy and sweeter taste. The starch conversion assay uses an iodine and potassium iodide solution that reacts with the long-chain starch molecules to produce a deep blue color (see starch conversion table).

5%	10%	20%
		
25%	30%	40%
		
60%	70%	80%
		

Storage Regimes

Harvest Samples are kept in normal atmosphere storage and evaluated at predetermined intervals to determine the storage potential and shelf life of the selection or cultivar under evaluation. Storage regimes specify a cold storage period, simulating real-world cold storage practices for exported fruit, and also specify a shelf life period, simulating the period fruit is kept in a supermarket. The specific storage regime followed during evaluation is determined by:

1. The **crop type** of the tested selection or cultivar
2. The **harvest window** of the tested cultivar (early, mid, late season - see Harvest windows)
3. The **requirements** of the Client

For any storage regime, evaluation takes place at 4 predetermined intervals.

For Stonefruit the four intervals are:

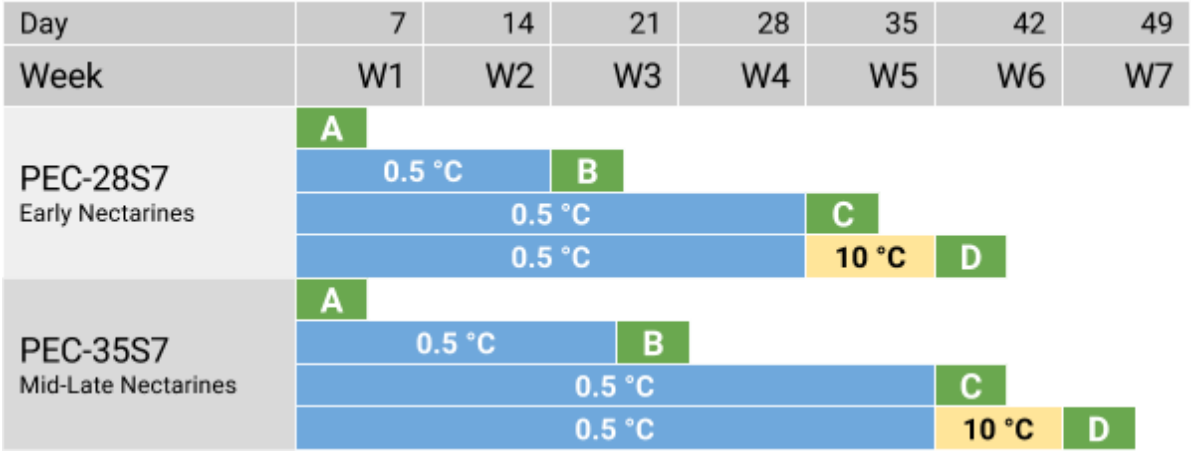
A. **After-Harvest** (Pre-Storage) - Before the sample is relocated to cold storage
B. **Mid-Storage** - Halfway through cold storage period
C. **Post-Storage** - End of the cold storage period, before shelf life period starts
D. **Post-Shelf** - End of the shelf period

For Pome fruit the four intervals are:

A. **After-Harvest** (Pre-Storage) - Before the sample is relocated to cold storage
B. **1st Post-Storage**
C. **2nd Post-Storage**
D. **3rd Post-Storage**

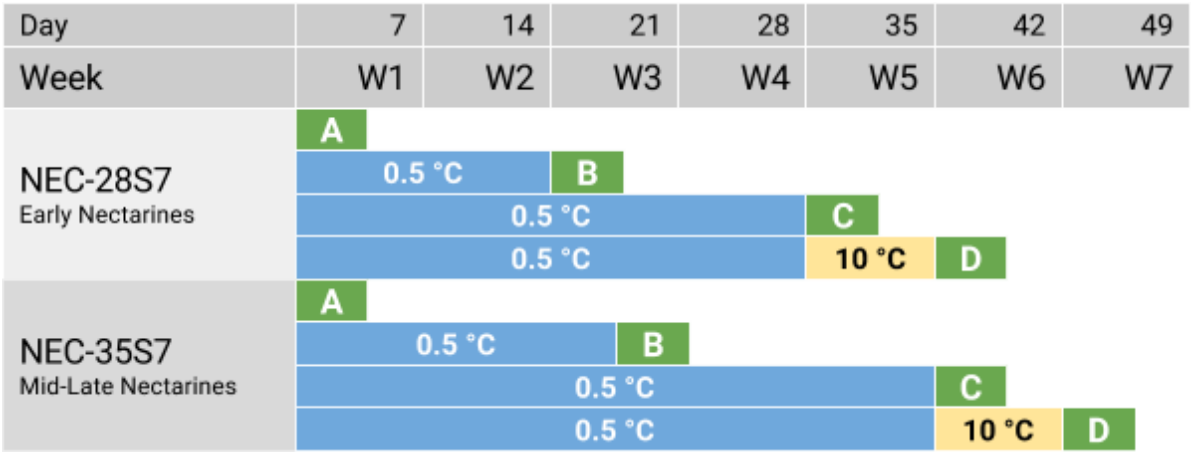
Peaches

- ❏ **PEC-28S7: 28 days @ -0.5˚C** followed by shelf life of **7 days @ 10˚C** for **early** cultivars
- ❏ **PEC-35S7: 35 days @ -0.5˚C** followed by shelf life of **7 days @ 10˚C** for **mid to late** cultivars



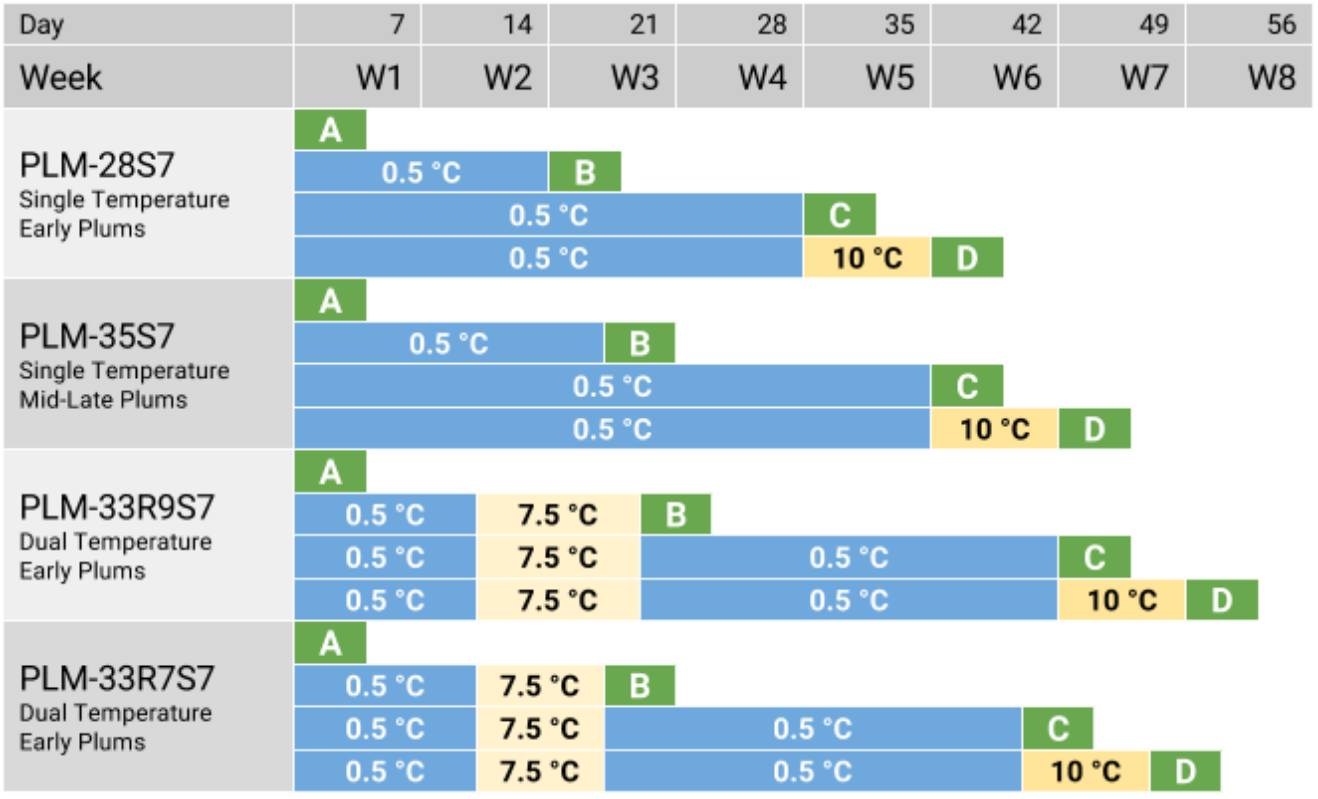
Nectarines

- ❏ **NEC-28S7: 28 days @ -0.5˚C** followed by shelf life of **7 days @ 10˚C** for **early** cultivars
- ❏ **NEC-35S7: 35 days @ -0.5˚C** followed by shelf life of **7 days @ 10˚C** for **mid to late** cultivars



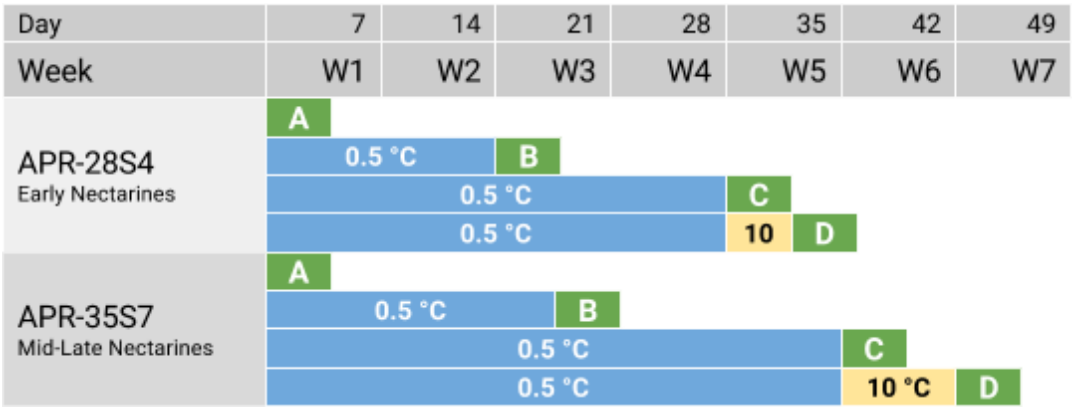
Plums

- ❏ **PLM-28S7: 28 days @ -0.5˚C** followed by shelf life of **7 days @ 10˚C** for **early** cultivars
- ❏ **PLM-35S7: 35 days @ -0.5˚C** followed by shelf life of **7 days @ 10˚C** for **mid to late** cultivars
- ❏ **PLM-33R9S7 (PD9): 10 days @ - 0,5°C**, then **9 days @ 7,5°C**, then **23 days @ - 0,5°C** followed by a shelf life period of **7 days @ 10°C**.
- ❏ **PLM-33R7S7 (PD7): 10 days @ - 0,5°C**, **7 days @ 7,5°C**, **23 days @ - 0,5°C** followed by a shelf life period of **7 days @ 10°C**.



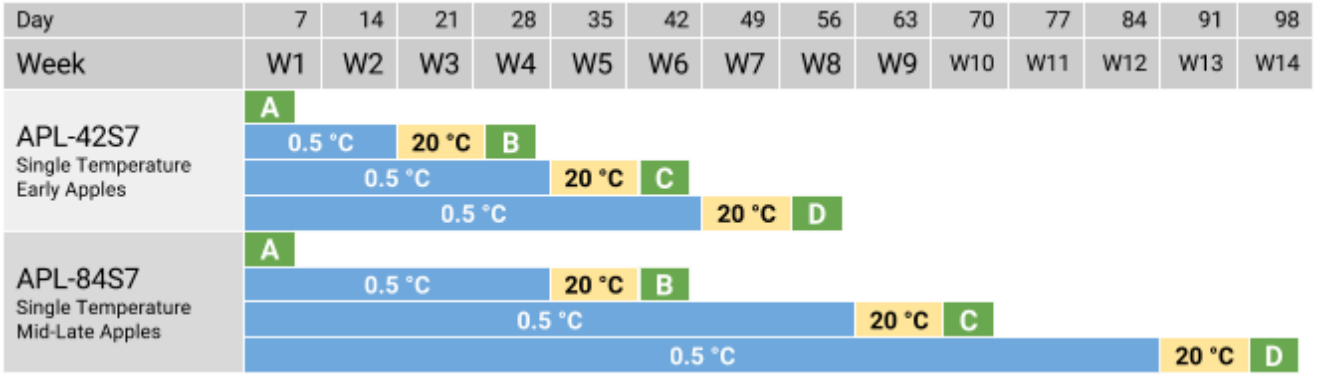
Apricots

- ❏ **APR-28S7: 28 days @ -0.5˚C** followed by shelf life of **4 days @ 10˚C** for **early** cultivars
- ❏ **APR-35S7: 35 days @ -0.5˚C** followed by shelf life of **7 days @ 10˚C** for **mid to late** cultivars



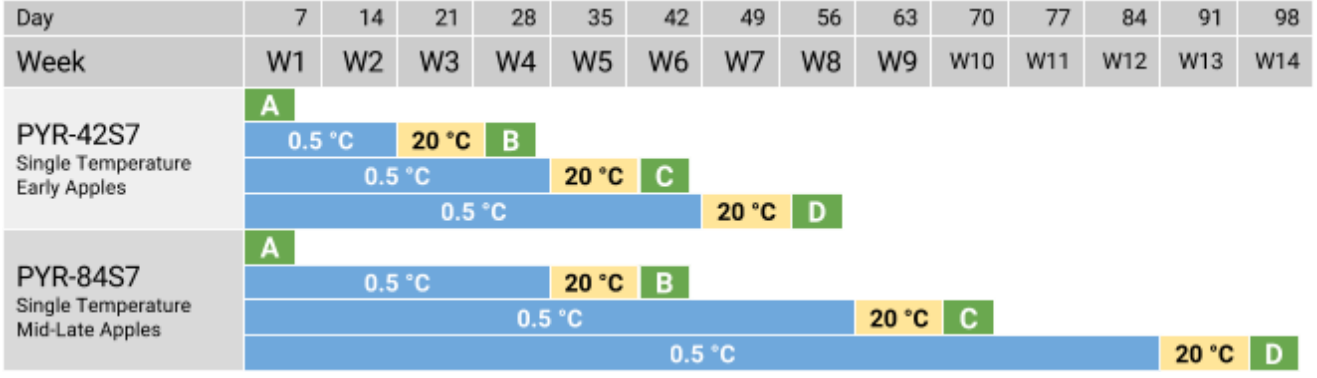
Apples

- ❏ **APL-42S7: 42 days @ -0.5˚C**, extracted at 14 day intervals where each stage is followed by shelf life of **7 days @ 20˚ C** respectively, for early cultivars.
- ❏ **APL-84S7: 84 days @ -0.5˚C**, extracted at 28 day intervals where each stage is followed by shelf life of **7 days @ 20˚ C** respectively, for mid to late cultivars.



Pears

- ❏ **PYR-42S7: 42 days @ -0.5˚C**, extracted at 14 day intervals where each stage is followed by shelf life of **7 days @ 20˚ C** respectively, for early cultivars.
- ❏ **PYR-84S7: 84 days @ -0.5˚C**, extracted at 28 day intervals where each stage is followed by shelf life of **7 days @ 20˚ C** respectively, for mid to late cultivars



Harvest Sample Characteristics

Characteristics: Ripening

Ripening Stage

ID `frut_ripe_stage` ** Applies to all fruit harvest.*

Record a value within the range.

Unripe	Immature	Ideal Ripeness	Mature	Post Optimum / Over ripeness
[0 - 20)	[20 -40)	[40 - 60)	[60 - 80)	[80 - 100]

Ripening is a process in fruit that causes a palatable product. In general, fruit undergoes a number of changes during the fruit ripening process, i.e., it can become sweeter, softer, decrease in sourness and bitterness and change in colour. Colour change is the result of pigments becoming more visible when chlorophyll is degraded.

During sensory fruit evaluation, the stage of fruit ripeness that will change from evaluation stage to evaluation stage needs to be documented. Ideally, sensory evaluation should be performed during ideal eat ripeness, but stages of ripeness from unripe to post optimum (overripe) give valuable information on the progression of characteristics in the course of the different evaluation stages and is therefore of importance.

For each fruit, an ideal eat ripeness represents the best time to perform sensory evaluation. Since optimal harvest dates are not known for most new cultivars and selections, the stage of ripeness needs to be determined during each evaluation.

Pears that are allowed to become too mature or to ripen on the tree develop a coarse, mealy texture and often have core breakdown. Pears picked when slightly immature will ripen as fruit with better quality compared to fruit that were over mature when picked. Pears and plums therefore normally need a ripening period after picking for optimal eating after storage.

Unripe: Green unripe fruit and not palatable. Ripening process has not started or cannot be detected.
Immature: Ripening process has started and first signs of physiological ripening is evident. Fruit can be tasted but not ready for full sensory evaluation. Some preliminary notes can be taken.
Ideal eat ripeness: Fruit are at physiological eat ripeness and ready for sensory evaluation.
Mature: Fruit becomes past the optimal time for sensory evaluation, can be soggy and or heavily laden with juice, textures can become mealy and or mushy. Not ideal for sensory evaluation.
Post optimum/ Over ripeness : Fruit are overripe and sensory evaluation becomes difficult to conduct.- Fruit has matured past the point of ideal eating ripeness and starts to decay. Fruit abnormally soft to the touch, with excessive amount of free juice, and/or the mesocarp tissue in the subepidermal area exhibiting a translucent breakdown.

Firmness Homogeneity (Stone Fruit)

ID `frut_firmness_homog` ** Applies to Stone Fruit*

Record a value within the range.

Large Variation	Variable	Intermediate	Little variation	Homogenous
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Fruit firmness homogeneity (between the fruits in the same evaluation sample) during each evaluation stage will give an indication of the consistency of the ripening process. This attribute indicates whether fruit are variable or homogenous with regards to their progression in ripening.

Maturation Rate (Stone Fruit)

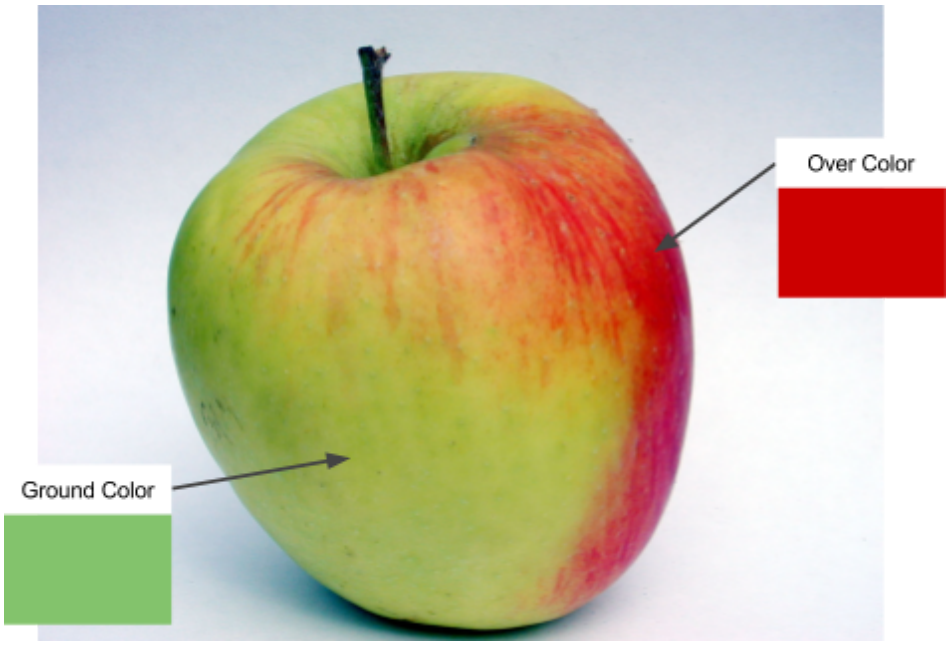
ID `frut_mature_rate` ** Applies to all fruit harvests*

Record a value within the range.

Very slow	Slow	Average	Rapid	Very Rapid
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

The ripening process can be rapid or prolonged depending on the intrinsic chemical, morphological and / or physiological properties of the fruit. The rate of ripening needs to be quantified for each harvest sample in relation to other samples harvested in the same week. This characteristic are determined by measuring the rate / tempo of change in fruit firmness and also more subjectively by monitoring the degradation of fruit firmness by sensing the firmness by hand and by sensory mouthfeel.

Characteristics: Colour and Pattern



Over Colour

ID `frut_over_color` ** Applies to all fruit harvests*

Select a base hue, chroma and lightness.

Red	Pink	Yellow	Green	Orange	Purple	Black	Brown

Fruit over colour is determined by the presence of pigmented cells (cells containing anthocyanins) in the top layer(s) of the fruit skin. Normally these pigments are shades of red, orange, pink and or purple, but may become intense dark red to dark purple and even black in some fruit types.

Ground Colour

ID `frut_ground_color` ** Applies to all fruit harvests*

Select a base hue, chroma and lightness.

Red	Pink	Yellow	Green	Orange	Purple	Black	Brown

Ground colour is the background skin colour of the fruit. Fruit ground colour is distinguishable by the absence of pigmented cells (cells containing anthocyanins). Normally these cells are filled with green chlorophyll that breaks down to shades of yellow or light green or even white. Ground color is a good indicator of fruit maturity for many varieties of apple, pear, peach, apricot and yellow plums. Areas of the skin with no red or purple coloration display the ground color. When the fruit becomes overripe, the skin can change to orange in the case of peaches and apricots. In some cases these cells stay green, e.g. in green apple cultivars.

Bloom of Skin

ID `frut_skin_bloom` ** Applies to all fruit harvests*

Record one or more class labels.

Absent	Moderate	Strong

Describes the presence of a powdery white coating on the surface of the fruit skin. This is caused by the presence of wax-like substance and minute scales that normally can be easily rubbed off from the skin surface. [35]

Flesh Colour

ID `frut_flesh_color` ** Applies to all fruit harvests*

Select a base hue, chroma and lightness.

Red	Pink	Yellow	Green	Orange	Purple	Black	Brown

Describe the Hue property of light used to classify the flesh colour by referring to the colour spectrum.

Stone Cavity Colour (Stone Fruit)

ID `frut_cavity_color` ** Applies to Stone Fruit harvests.*

Select a base hue, chroma and lightness.

Red	Pink	Yellow	Green	Orange	Purple	Black	Brown

Describe the Hue property of light used to classify the stone cavity colour by referring to the colour spectrum.

Bleeding Flesh (Stone Fruit)

ID `frut_flesh_bleed` ** Applies to Stone Fruit harvests.*

Record one or more class labels.

From Skin	From Stone	Throughout

Describe the initiation area for internal flesh colouration. Normally this can apply from skin to stone or from stone to skin or throughout (from both directions).

Over Colour Area

ID `frut_over_area` ** Applies to all fruit harvests*

Record a value within the range.

No Coverage	Little Coverage	Half Covered	Mostly Covered	Completely Covered
0	(0 - 33)	[33 - 66)	[66 - 100)	100

The over coloured area covered with pigments differs from cultivar to cultivar and even from fruit to fruit on the tree and may be fully covered (100%) to no coverage (0%). The coloured area is estimated by allocating a percentage coverage by inspecting all fruit in the sample and allocating a number from the least covered to the largest area covered as percentage over color. The coloured area includes all pattern types, i.e., full colour, blush or striped.

Over Colour Pattern

ID `frut_over_pattern` ** Applies to all fruit harvests.*

Record one or more class labels.

Uncoloured	Striped	Blushed	Bi-Coloured	Mottled	Full Coloured

Pattern Type relates to the specific pattern or design of pigmented areas on the fruit. When most of the fruit area is covered (more than 80%) and no stripes visible the fruit is classified as **full coloured**. **Bi-coloured** relates to more than 50% over coloured area covered with pigmentation and **Blushed** less than 50% coloured area covered with pigmentation. In some cases, fruit can be fully coloured with visible stripes then Full covered and Striped are both applicable patterns, and this case may apply to bi-coloured and blushed fruit. **Striped** fruit are applicable when the ground colour is visible between stripes. **Mottled** is when the skin colour is thin and broken and the underlying ground colour shows through. **Uncoloured** fruit have no visible over colour pigmentation.

Stripe Intensity (Apples)

ID `frut_stripe_intense` ** Applies to Apple harvests*

Record a value within the range. * Also known as `Width of stripes`

No Stripes	Thin Stripes	Medium Stripes	Broad Stripes
0	(0 - 33)	[33 - 66)	[66 - 100)

Due to latest developments in brightly coloured full and blushed apple selections and cultivars, the presence of stripes on fruit may be regarded as a negative quality and therefore need to be fully quantified. Stripe intensity can be scored according to the over colour stripe coverage in relation to the visibility of the background colour.

Characteristics: Stone and Flesh Type

Stone Adhesion (Stone Fruit)

ID `frut_stone_adhesion` ** Applies to Stone Fruit harvests*

Record a value within the range.

Freestone	Semi-Adhesive	Clingstone
[0 - 33)	[33 - 66)	[66 - 100]

In clingstone peaches the stone (also called pip, pit or endocarp) will cling stubbornly to the flesh (mesocarp) of the peach. In freestone peaches, pits are easy to remove, i.e., when a freestone peach is cut in half, the pit will fall freely from the fruit. Semi-adhesive endocarps will be attached to a degree, but not as tight as a clingstone. Semi-freestone is a combination between clingstone and freestone. By the time the fruit of a semi-freestone has ripened, it has become primarily freestone, and the pit should be fairly easy to remove with minimal effort.

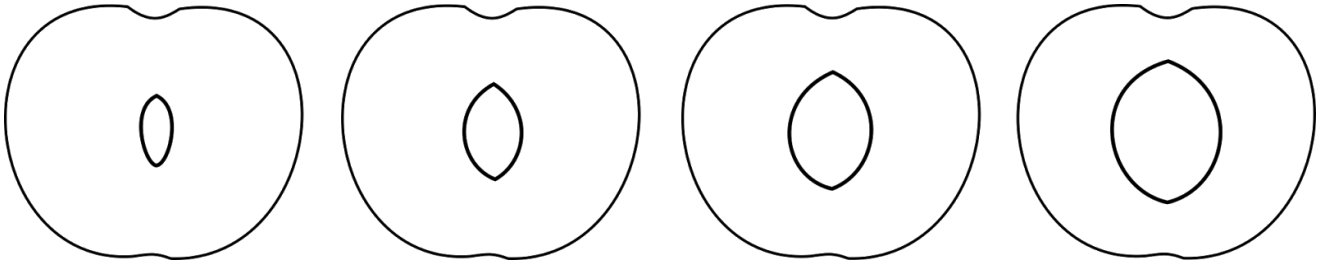
Stone Size (Stone Fruit)

ID `frut_stone_size` ** Applies to Stone Fruit harvests*

Record a value within the range.

Very Small	Small	Medium	Large	Very Large
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

The classification of stone size is done by calculating stone size in relation to the fruit size and thickness of the mesocarp. The stone size may be small, medium or large; based on both the length and width of the stone.



Flesh Type (Stone Fruit)

ID `frut_flesh_type_stone` ** Applies to Stone Fruit harvests.*

Record one or more class labels.

Non-Melting	Firm Melting	Melting

“Melting flesh” types soften more rapidly to a smooth buttery texture, “Non-melting flesh” types soften gradually to a more rubbery texture, and are normally used for canning. Slow melting stays firm longer than melting types and keeps firmer after picking, ultimately becomes melting. [31]

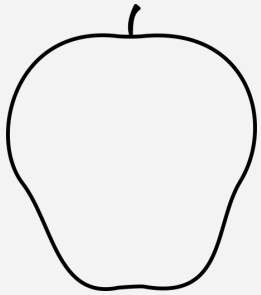
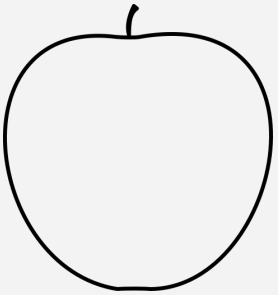
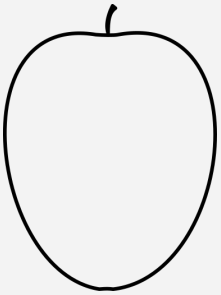
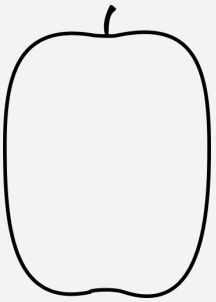
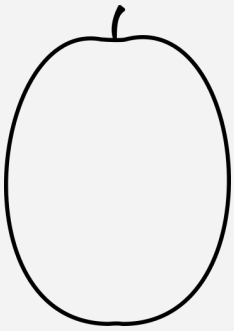
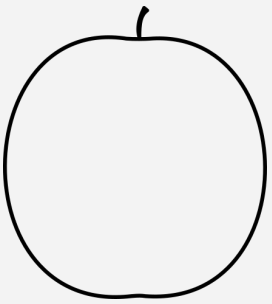
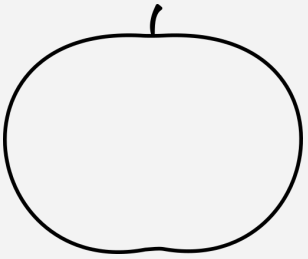
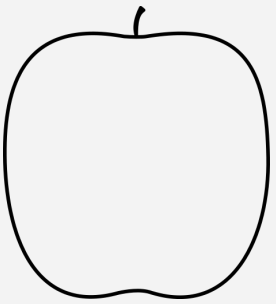
Characteristics: Shapes and Symmetry

Shape Type (Apple)

ID `frut_shape_type_apple`

** Applies to Apple harvests.*

Record one or more class labels.

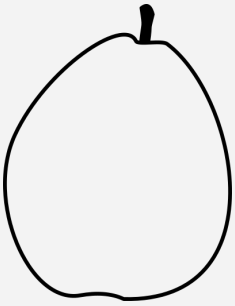
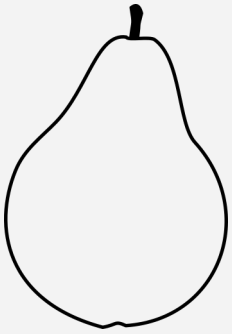
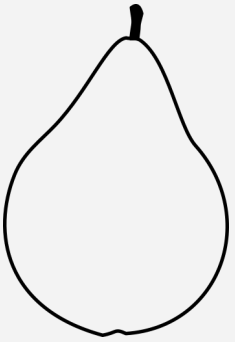
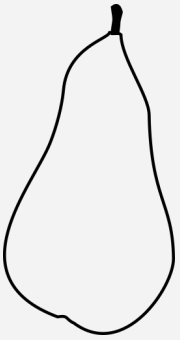
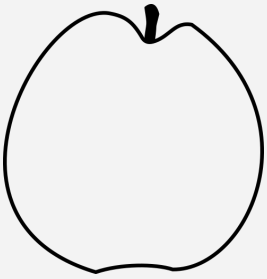
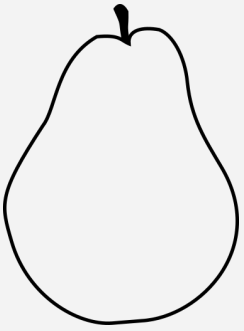
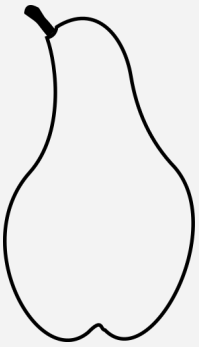
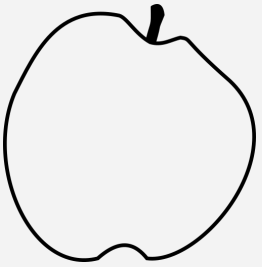
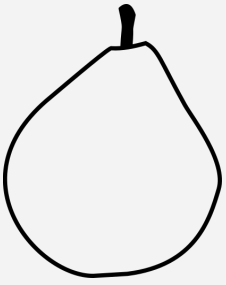
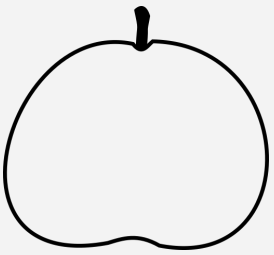
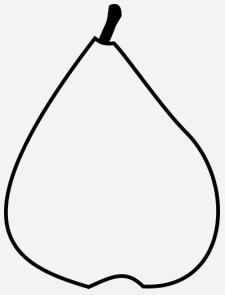
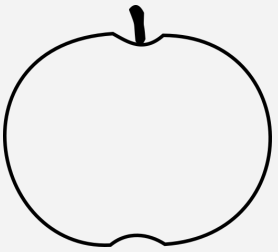
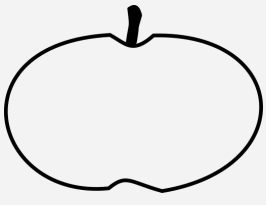
Cylindrical Waisted	Conic	Ovoid	Cylindrical
			
Ellipsoid	**Globose**	**Obloid**	**Apple**
			

Shape Type (Pear)

ID `frut_shape_type_pear`

** Applies to Pear harvests.*

Record one or more class labels.

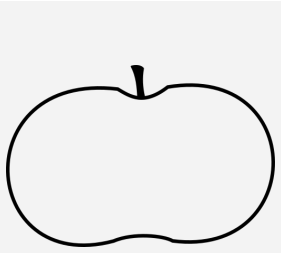
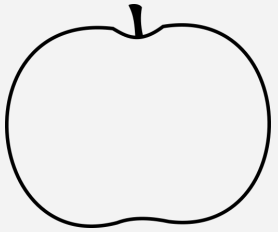
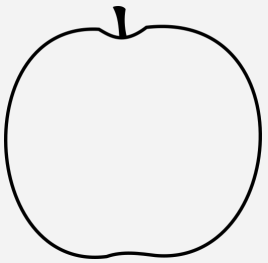
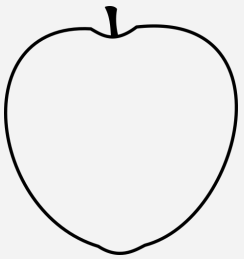
1 - Turbinate	2 - Oblong / Ovate / Pyriform	3 - Obovate / Acute / Pyriform	4 - Oblong / Pyriform
			
5 - Globular / Obtuse / Pyriform	**6 - Ovate / Pyriform**	**7 - Oblong / Ovate / Pyriform**	**8 - Ovate**
			
9 - Obovate / Pyriform	**10 - Globular**	**11 - Globular / Acute / Pyriform**	**12 - Oriental Pear**
			
13. Obloid (Flat)			
			

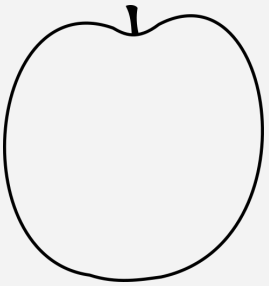
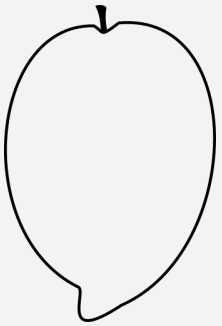
Shape Type (Stone Fruit)

ID `frut_shape_type_stone`

** Applies to Stone Fruit harvests.*

Record one or more class labels.

Very Flat (Doughnut)	Slightly Flat	Rounded	Ovate
			

Oblong	Elongated
	

Normally stone fruit shapes are rounded spherical forms. Flat fruit is shorter i.e. the fruit height are small relative to its width e.g. “doughnut” / flat peaches. Ovate forms have a shape like the longitudinal section of an egg. Oblong fruit are slightly elongated with identical sides. Elongated fruit are exceptionally long i.e. the fruit height are large relative to its width.

Shape Symmetry

ID `frut_shape_symmetry`

** Applies to all fruit harvests*

Record a value within the range.

Asymmetrical	Intermediate	Symmetrical
[0 - 33)	[33 - 66)	[66 - 100]

When observing individual fruit within the sample, Complete shape symmetry for each fruit means complete identical sides of the fruit, even when flipped or turned. Unbalanced or Asymmetrical fruit shape means the fruit shape is irregular and crooked and sides are not identical when turning the fruit.

Shape Consistency

ID `frut_shape_consistent` ** Applies to all fruit harvests*

Record a value within the range.

Very Variable	Not Uniform	Intermediate	Uniform	Very Uniform
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

When the total sample and fruit within the sample all have a similar fruit shape and form, the shape is described as consistent or Uniform. When fruit within the sample have variable shapes, the sample shape and form are inconsistent or Variable.

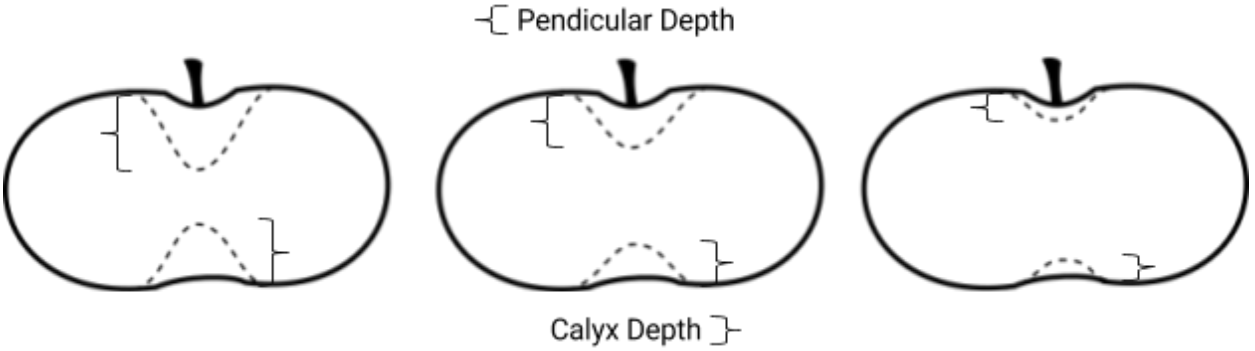
Pendicular Opening Depth (Stone Fruit)

ID `frut_pendicul_depth` ** Applies to Stone Fruit harvests*

Record a value within the range.

Very Shallow	Shallow	Intermediate	Deep	Very Deep
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

The pendicular opening of the fruit is the open space at the stalk end of the fruit. The degree of openness of this area is described by looking at the depth with a deeper opening being less attractive.



Calyx Opening Depth

ID `frut_calyx_depth` ** Applies to all fruit harvests*

Record a value within the range.

Very Shallow	Shallow	Intermediate	Deep	Very Deep
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

The calyx opening is the open space at the calyx end of the fruit. During development, the set of sepals at the bottom of flower stays on the fruit and forms a small star-shaped opening called the calyx. The calyx opening depth is determined by measuring the depth of this opening. A deeper opening is regarded as less attractive. Flat peaches are prone to russeting and cracking in this area.

Calyx Opening Width

ID `frut_calyx_width` ** Applies to all fruit harvests*

Record a value within the range.

Very Narrow	Narrow	Intermediate	Wide	Very Wide
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

The calyx opening width is determined by measuring the width of the calyx opening. A wider opening is regarded as less attractive.

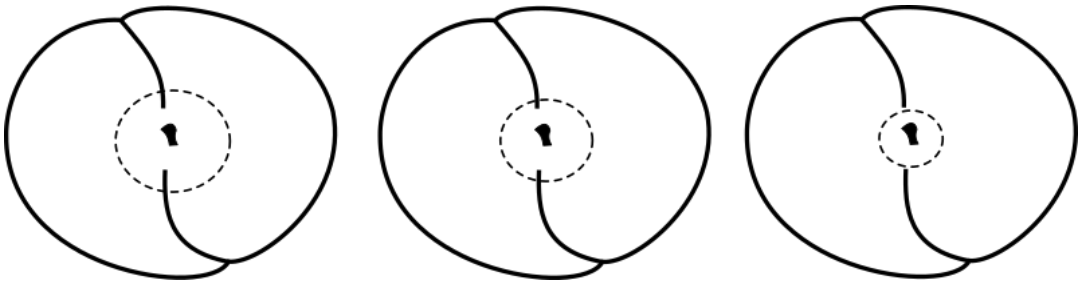
Pendicular Opening Width (Stone Fruit)

ID `frut_pendicul_width` ** Applies to Stone Fruit harvests*

Record a value within the range.

Very Narrow	Narrow	Intermediate	Wide	Very Wide
[0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

The pendicular opening of the fruit is the open space at the stalk end of the fruit. The openness of this area is described by measuring its width. A wider opening is regarded as less attractive.



Pistilar Cavity Split (Stone Fruit)

ID `frut_pestilar_split` ** Applies to Stone Fruit harvests*

Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Cavity split can be described as cracking at the calyx end of the fruit. Genetically different flat peach cultivars have different susceptibility levels to cavity split under the same cultivating and environmental circumstances. This may be more pronounced under certain production practices, such as practices to support rapid growth, i.e., irregular water or excessive thinning during the hardening stage of the pit. Too early or too late thinning can also have an influence on the occurrence of cavity split.

Fruit Tip

ID `frut_calyx_tip` ** Applies to Stone fruit harvests*

Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Older cultivars of especially Peaches and Nectarines are known to have a prominent fruit tip towards the fruit calyx end. The absence of this tip can be expressed in two ways, i.e., this area can be sunken or rounded.

Fruit Tip Softening

ID `frut_calyx_soft` ** Applies to Stone fruit harvests*

Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Older cultivars of Peaches and Nectarines are known to have a prominent fruit tip towards the fruit calyx end. The protruding fruit tip may become soft when the fruit matures and it is regarded as a negative trait, especially if fruit are exported to international markets.

Fruit Suture

ID `frut_suture` ** Applies to Stone fruit harvests*

Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Stone fruit are prone to have a sunken fruit suture. The fruit suture is the sunken line running from the stem-end to the blossom (calyx) end of the fruit. The suture can be prominent when the shoulders of the fruit bulges /protrude to form a prominent and deep line.

Stem Length (Pome Fruit)

ID `frut_stem_length` ** Applies to Pome Fruit harvests*

Record a value within the range. * Also known as 'Stalk or Pedicel Length'

Very Short ~10mm	Short ~20mm	Intermediate ~30mm	Long ~40mm	Very Long >50mm
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Stems may be long, short or medium in length. The stem length is based on a projection from the cavity bottom to the upper stem tip of the stem.

Stem Thickness (Pome Fruit)

ID `frut_stem_thick`

** Applies to Pome Fruit harvests*

Record a value within the range.

* Also known as 'Stalk or Pedicel Thickness'

Very Thin	Thin	Intermediate	Thick	Very Thick
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Stem thickness can be either slender, medium or thick and is determined by the circumference of the stem. The relative stem thickness can be classified according to any of the above 5 classes.

Pubescence

ID `frut_pubescent`

** Applies to Stone fruit harvests*

Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

The surface of peaches is covered by a dense indumentum (hairs) which may serve various protective purposes. The length and the quantity of the hairs on peaches can vary considerably and may be influenced by prevailing environmental and soil conditions.

Characteristics: Abrasions and Blemishes

Abrasions

ID `frut_abrasion` ** Applies to all fruit harvests*

Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

The presence of any abrasions or markings that detracts from the fruit's appearance and associated with a **physical deformity**, e.g. scraping, wearing or injury, is regarded as abrasions. It can include scrapes, scratches, scuffs, grazes, cuts or any other markings observed.

Blemishes

ID `frut_blemish` ** Applies to all fruit harvests*

Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Any blemishes on the fruit sample that detracts from the fruit's appearance and associated with **colour changes** due to deformity or injury is noted and can include any stains, blotches, flecks and other discolourations observed.

Russeting

ID `frut_russet` ** Applies to all fruit harvests*

Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Russeting is a disorder of the fruit skin that results from microscopic cracks in the cuticle and the subsequent formation of a periderm. The russeted areas are reddish brown in colour, with a cork-like and slightly rough texture. Russeting may appear on only a small portion of each fruit, or may cover its surface. Severe russeting may be accompanied by fruit cracking which usually renders the fruit useless.

Russeting Position (Apples)

ID `frut_russet_position` ** Applies to Apple harvests.*

Record one or more class labels.

Stem-area	Calyx-area	Entire Fruit

Russeting is a brown, corky netlike skin disorder on fruit. It may appear on only a small portion of each fruit, or cover its surface. Severe russeting may be accompanied by fruit cracking which usually renders the fruit useless.

Russeting Position (Pears)

ID `frut_russet_position` ** Applies to Pear Fruit harvests.*

Record one or more class labels.

Stem-area	Calyx-area	Tip	Top	Neck	Entire Fruit

Russeting is a disorder of the fruit skin that results from microscopic cracks in the cuticle and the subsequent formation of a periderm. The russeted areas are reddish brown in colour, with a cork-like and slightly rough texture. Russeting may appear on a small portion of each fruit, or cover its surface totally. Severe russeting may be accompanied by fruit cracking which usually renders the fruit useless.

Russeting Type

ID `frut_russet_position` ** Applies to All Fruit harvests.*

Record one or more class labels.

Fine	Net-Like	Rough	Cracked

Russeting is a brown, corky netlike condition on the skin of fruit. It may appear on only a small portion of each fruit, or may cover its surface totally. Severe russeting may be accompanied by fruit cracking which usually renders the fruit useless.

Pistilar Cavity Russeting (Stone Fruit)

ID `frut_pestilar_russet` ** Applies to Stone Fruit harvests*

Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Flat peach cultivars genetically differ in their susceptibility to cavity russeting under the same environmental conditions. The occurrence and severity of russeting may be enhanced by certain production practices such as practices to support rapid growth, i.e., irregular water or excessive thinning during the hardening stage of the pit. Too early or too late thinning can also have an influence on the occurrence of cavity russeting.

Lenticels (Pome Fruit)

ID `frut_lenticel` ** Applies to Pome fruit harvests*

Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Lenticels are pore-like structures consisting of cells with large intercellular spaces on the surface of the skin. Lenticels are more apparent on some cultivars than on others. The size of the individual lenticels may vary from small, almost invisible to large. The lenticels may also vary in appearance from visually attractive (white) spots to russeted, unattractive spots.

Spots

ID `frut_spot` ** Applies to all fruit harvests*

Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

On stone fruit like nectarines, spots are prone to develop. These spots can be large or small, numerous or few, singular or confound. Spots can also be associated with blemished and russeted areas.

Sugar Spots (Stone Fruit)

ID `frut_sugarspot` ** Applies to Stone Fruit harvests*

Record a value within the range.

None	Negligible	Inconspicuous	Intermediate	Conspicuous	Severe
0	(0 - 20)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

On stone fruit like nectarines, “sugar spots” are prone to develop. These spots can be large or small, numerous or few, singular or confound. The spots are associated with high sugar contents and an indication that the fruit is very sweet.

Characteristics: Eating Quality

Taste refers to the senses experienced inside the mouth associated with the tongue. Taste primarily refers to sweet, salt, bitter, astringent and sourness / acid contents. A “balanced” taste would refer to a desired and well-balanced ratio between sugar (sweet) and acid (sour) content of the fruit.

Aroma is detected inside the nose and include aspects related to the sense of smell. The words “aroma” and “bouquet” are used to describe favourable odours. Odours are tiny volatilized compounds that floats in the air and get stuck in the nose, ultimately giving a favourable or unfavourable smelling experience.

Texture is one of the “**Mouthfeel”** experiences and focuses primarily on crunchiness, crispness, mealiness etc. of the product. Viscosity, firmness, thickness, hardness, fineness are other mouthfeel descriptors used in the food industry.

Flavour is the combination of aroma, taste and mouthfeel converged into one to create a complete profile, experienced as a singular sensory experience when eating or drinking.

Sugar

ID `frut_taste_sugar` ** Applies to all fruit harvests*

Record a value within the range.

Very Low Sweetness	Low Sweetness	Intermediate	Sweet	Very Sweet
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Sweetness is a primary taste sensation associated with the sugar content in the fruit.

Acid

ID `frut_taste_acid` ** Applies to all fruit harvests*

Record a value within the range.

Very Low Acid	Low Acid / “Sprightly”	Intermediate	Tart	Very Tart
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Sourness is a primary taste sensation associated with the acid content in the fruit. “Sprightly” refers to a slight acidic taste.

Sugar Acid Balance

ID `frut_taste_balance` ** Applies to all fruit harvests*

Record a value within the range.

Very Tarty	Tarty	Balanced	Sweet	Very Sweet
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Sugar-Acid balance is a primary taste sensation that distinguish the complexity between sweet and acid taste associated with the presence of sugars and acids in the fruit. “Sprightly” refers to a slight acidic taste. Low acid and low sugar taste are negatively experienced in terms of a taste profile and can be described as a **“Neutral”** taste.

Aroma

ID `frut_taste_aroma` ** Applies to all fruit harvests*

Record a value within the range.

Flat / Insipid	Bland	Intermediate	Flavoursome	Intense
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

The presence of a strong aroma described by the presence of favourable odours is classified as an intense aroma component present. The absence of aroma is described as flat or insipid and normally associated with a **“watery”** flavour experience.

Juiciness

ID `frut_taste_juice` ** Applies to all fruit harvests*

Record a value within the range.

Very Dry	Dry	Intermediate	Juicy	Very Juicy
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Juiciness is one of the textural attributes that is associated with “**freshness**” and good keeping ability. The presence of a substantial amount of juice in the flesh of the fruit is classified as very juicy. The absence of juice is described as very dry.

Skin Thickness

ID `frut_skin_thick` ** Applies to all fruit harvests*

Record a value within the range.

Very Thin	Thin	Intermediate	Thick / Crisp	Very Thick
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Depending on the thickness and taste, the fruit peel is sometimes eaten as part of the fruit, as with pome and stone fruit. Crisp skins can compliment soft textures or firm textures can conceal thick skins. In some cases the peel is hard, firm or crisp, it can be too firm and become unpleasant or inedible.

Firmness

ID `frut_text_firm` ** Applies to all fruit harvests*

Record a value within the range.

Very Soft	Soft	Intermediate	Firm	Compact / Hard
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Fruit firmness describes the pressure needed to change or retain the form of the flesh unaltered in spite of pressure or force applied during biting or chewing.

Texture Crispness (Apples)

ID `frut_text_crisp_apple` ** Applies to Apple harvests*

Record a value within the range.

Very Mealy	Mealy	Intermediate	Crisp	Very Crisp
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Crispness of a fruit is a mouthfeel characteristic and associated with the flesh texture that quickly breaks down in smaller particles during chewing, while mealiness is associated with a soft dry mouthfeel. The **difference between crispy and crunchy** is that **crispy** means the fruit has a **crisp** texture that is brittle yet tender, while **crunchy** means the fruit is likely to crunch and shatter / break and make a sound when bitten. Soft and mealy fruit will also have a low chewing resistance and crisp textures. Crispness is difficult to maintain in some fruit cultivars and selections become **mealy** due to inferior keeping quality.

Texture Crispness (Pears and Stone Fruit)

ID `frut_text_crisp` ** Applies to Pear and Stone Fruit harvests*

Record a value within the range.

Very Buttery	Buttery	Intermediate	Crisp	Very Crisp
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Pear and Stone fruit flesh texture can be crispy (normally when unripe) and may develop into a fruit with a light buttery texture and smooth resistance when chewing.

Texture Crunchiness

ID `frut_text_crunch` ** Applies to all fruit harvests*

Record a value within the range.

Very Low Resistance	Low Resistance	Intermediate	Crunchy	Very Crunchy
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

The **difference between crispy and crunchy** is that **crispy** means the fruit has a **crisp** texture that is brittle yet tender, while **crunchy** means the fruit is likely to crunch and shatter / break and make a sound when bitten. Crunchy texture offers **sustained, granular resistance** to the chewing jaw action and is difficult to overcome with hard and firm fruit textures.

Grain

ID `frut_text_grain` ** Applies to all fruit harvests*

Record a value within the range.

Melting/Very Fine	Fine	Intermediate	Grainy	Coarse
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Pear flesh texture can be grainy or fine, depending on the morphological structure and interrelationship between the cells of the flesh. Grainy texture feels rough to touch (mouthfeel) and easy to experience many tiny pieces the mouth, also described as gritty or grainy.

Stone Cells (Pears)

ID `frut_stonecell` ** Applies to Pear harvests*

Record a value within the range.

None	Very Few	Few	Intermediate	Many	Prominent
0	[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Pear flesh may sometimes be infused with grit around the pear ovary. The grit consists of clusters of stone cells and can be very fine or coarse. Stone cells, a subtype of sclereid cells, are made of some other very hard tissue like peach pits and nut shells. [32]

Characteristics: Storage Diseases & Disorders

Occurrence of storage diseases and / or physiological disorders rely on the ability of the evaluator to identify these abnormalities in the laboratory after harvest and / or during the different evaluation stages. Fruit needs to be cut to observe and identify internal disorders. [33]
To enable visual determination of the internal quality, the fruit is cut into two halves along the equator. With stone fruit the two halves are simply twisted to opposite directions.

Diseases Detected (Stone Fruit)

ID `frut_disease_stone` ** Applies to Stone Fruit harvests.*
Record one or more class labels.

Botrytis	*Monilinia Laxa*	Other	None

Occurrence of stone fruit diseases may be recorded at any stage of the evaluation.

Diseases Detected (Pome Fruit)

ID `frut_disease_pome` ** Applies to Pome Fruit harvests.*
Record one or more class labels.

Brown rot	Core rot	Varied rot	*Gloeosporium* rot	Grey mold
Blue mold	*Alternaria* rot	Other	None	

Occurrence of diseases may be recorded at any stage of the evaluation.

External Disorders Detected (Stone Fruit)

ID `frut_extdisorder_stone` ** Applies to Stone Fruit harvests.*
Record one or more class labels.

Shrivel	Poor Skin Colouration	Bruising	Rain marks	Skin Cracking
Visible Split Stone	Other	None		

Shrivel - Visible lines or wrinkling of the surface due to moisture loss.
Poor post harvest coloration of skin - large portions of the fruit surface retain the immature or ground colour.
Bruising - Visible bruise marks are evident on the fruit surface and usually visible as a water saturated discoloured area just below the skin surface due to perished cells.
Rain marks (“tear drops”) - Markings on the fruit surface due to rain or chemical spray damage
Skin Cracking - Means any crack that exposes the flesh of the fruit
Visible Split Stone - Where the stone of the fruit is split to such an extent that an aperture on the stem end of the fruit is visible.

Internal Disorders Detected (Stone Fruit)

ID `frut_intdisorder_stone` ** Applies to Stone Fruit harvests.*

Record one or more class labels.

Internal Sunburn	Heat damage	Aerated tissue	Gel breakdown
Internal Breakdown	Flesh Breakdown	Woolliness	Pulpiness
Rubbery texture	Internal Browning	Split Pit	Other
None			

Disorders may be recorded at any stage of the evaluation.

Internal sunburn damage - The texture and colour of the tissue beneath the surface (usually accompanied by visible external sunburn damage) is notably different from the deeper or surrounding tissue and is usually depressed and tough.
Heat Damage - Can manifest in different forms. External heat damage can be observed as discoloured areas on the fruit surface, which may also form depressions (similar to sunburn damage) and usually forms on fruit that was exposed to light. Internal heat damage to the mesocarp may be caused by exposure to temperatures exceeding 35°C for three consecutive days. The fruit internally "cooks" which compromises the textural integrity, fastens ripening and may lead to a higher incidence gel breakdown and shrivelling.
Aerated tissue - Aerated tissue in flesh of stone fruit differs from normal flesh by exhibiting white coloured areas with a dry and fibrous appearance.
Gel Breakdown - Fruit with gel breakdown has a normal external appearance (outer mesocarp), while gelatinous breakdown occurs in the inner mesocarp tissue that surrounds the stone. The disorder spreads outwards if the severity increase. The flesh discolor from translucent to brown. This tendency is associated with a loss in juiciness.
Internal Breakdown - Fruit with internal breakdown has a normal external appearance, but the mesocarp tissue discolored to brown. If the severity increase the color changes from a light to dark brown. This tendency is associated with a loss in juiciness.
Flesh Breakdown - Tissue breakdown occurs in the middle zone of the mesocarp, which may be translucent or pulpy and accompanied by loss of free juice. The area around the stone has a normal appearance. The disorder spreads outwards towards the epidermis.
Woolliness - The fruit has a normal external appearance, but the mesocarp has a dry mealy texture. When the fruit are cut along the equatorial axis and the two halves are squeezed by hand, no juice emanates from the flesh.
Pulpiness - Similar to woolliness, except that the fruit flesh contains a small amount of juice.
Rubbery texture - A rubbery texture can be experienced with stone fruit. It is characterised by a dry and tough chewy mouthfeel. Rubbery textures are normally associated with too early harvest dates when fruit cannot ripen to an optimal eating quality.
Internal Browning - Manifests as browning of the flesh throughout the mesocarp to varying degrees. Visibility of internal browning depends on the native flesh colour.

Split Stone or Pit - Split stones are genetically determined and depends on the cultivar. Certain production practices can enhance the occurrence of split stone, such as practices that promote rapid growth for instance irregular irrigation or excessive thinning during the hardening stage of the pit. Too early or too late thinning can also influence the occurrence of split pit.

External Disorders Detected (Pome Fruit)

ID `frut_extdisorder_pome` ** Applies to Pome Fruit harvests.*
Record one or more class labels.

Bruising	CO_2 Injury	Chemical Injury	Friction Marking/Rub Marks
Heat Injury	Jonathan Spot	Lenticel Breakdown	Low Oxygen Injury
Bitter pit	Blemishes	Shrivel	Soft Scald
Sun Scald	Superficial Scald	Skin cracking	Senescent Scald
	Other	None	

The occurrence of disorders in the plant sample may be recorded at any stage of the evaluation.

Bruising damage - Caused either by dropping the fruit onto a surface or by dropping an object onto the fruit (impact bruising), by rubbing the fruit against other fruit or other surface (vibration or abrasion bruising), or by pressing fruit against each other or a hard surface (compression bruising). This physical damage can occur during harvesting, hauling and packing operations, and as a result of fruit movement in the package during transit to the market.
Carbon dioxide (CO_2) injury - Similar to superficial scald, but likely to be more rough, depressed and well defined. This disorder is associated with exposure to CO_2 concentrations that are significantly higher than atmospheric levels.
Chemical Injury - Small, dark areas on the surface, and sub-surface lenticel tissue. Depressions usually form around these lesions due to desiccation. Usually associated with exposure to phytotoxic chemicals in a volatile or soluble form. Prolonged exposure, or higher concentrations of phytotoxic chemicals may result in larger patches of dark skin on the fruit. Circular injury patches may form due to liquid retention between adjacent fruit in containers.
Friction Marking / Rub Marks - Poorly defines areas of brown surface discolouration that often occurs on protruding points of the fruit as a result of handling and transport.
Heat Injury - Related to a hot-water wash during packing. May be similar to surface scald, but develops earlier in storage, usually within 2 to 3 weeks of exposure.
Jonathan Spot - Circular, brown spots of 2 to 4 mm in diameter that only affects the skin and often the lenticels. On red coloured apples the spots may appear black and concentrated on the highly developed coloured areas.
Lenticels Breakdown - A global skin disorder of apples in which lenticels develop dark 1–8 mm diameter pits shortly after processing and packing
Low Oxygen (Alcohol) Injury - Dark brown, water soaked surface lesions that is sometimes associated with sub-surface tissue damage. It occasionally resembles soft scald.
Bitter Pit - Bitter pit is a common disorder found on apples that causes dark spots on the fruit surface and occurs late in the season or in storage. Bitter Pit is related to a lack of calcium in fruit and may be enhanced by dry soil conditions during production.
Shrivel - Visible lines or wrinkling of the surface due to moisture loss.

Soft Scald - Smooth, and brown coloured, irregular shaped, but well defined areas on the fruit surface. The disorder is slightly related to colour development, but rarely occurring at the stem or calix end of the fruit.
Sun Scald - Either bleached, or brown areas on the side of the fruit that was exposed to the sun, sometimes accompanied with water-soaked subsurface tissue. The area darkens after storage, with the cortex tissue below the lesions tasting bitter and discoloured to brown.
Superficial Scald - Brown discolouration of the skin (rough to the touch in severe cases), that tend to develop after extended periods in cold storage. Symptoms become more prominent after removal from cold storage and exposure to higher temperatures. Lesions are usually confined to poorly coloured areas of red, or bi-colour apples, but occur randomly on green or yellow apples.
Skin Cracking - Any crack that exposes the flesh of the fruit.
Chemical Injury - Pears - Dark spots at the lenticels as a result of injury to the skin and subsurface tissue. It is caused by exposure to volatile or soluble chemicals. Small depression caused by dehydration may occur following injury. Circular injury patterns may occur where liquid was retained between adjacent fruit in a container.
Friction Marking - Pears - Common to most cultivars. Brown skin discolouration, evident on protruding surface elements.
Senescent Scald - Pears - Dark brown skin discolouration starting as small isolated areas. Usually occurs towards the calyx end of the fruit and turns yellow in cold storage. Large areas of the surface may turn brown either during storage or after extraction to warmer temperatures. The fruit fails to ripen, normally softens, and the skin may slough off.
Superficial Scald - Pears - Brown surface discolouration that occurs after prolonged cold storage, or during ripening after storage. Symptoms usually appear around the neck of the pear at first.
[34]

Internal Disorders Detected (Pome Fruit)

ID `frut_intdisorder_pome` ** Applies to Pome Fruit harvests.*
Record one or more class labels.

Brown Core	Internal Browning	Internal CO_2 Injury	Low temperature breakdown
Senescent breakdown	Vascular breakdown	Water Core	Internal breakdown
Core flush	Other	None	

Brown Core - Diffuse browning of tissues in the core area near to the carpel. Occurs after extended cold storage periods, but becomes more prominent when fruit are exposed to warmer temperature after storage.
Internal Browning - Dispersed, brown coloured flesh affecting only the cortex, or also the core tissues. Most evident in a transverse section at the juncture of the stem and the core. Vascular tissue are usually unaffected and the texture of the fruit appears normal.
Internal Carbon dioxide (CO_2) Injury - Well defined areas of brown, moist tissues in the cortex or core. Sometimes associated with main vascular tissues. The lesions may become light brown and dry with time, and may form cavities in affected areas. External CO_2 damage may also be present.
Low Temperature Breakdown - Well-defined diffused browning of outer cortex tissues where the affected tissue are moist and separated from the fruit surface by unaffected tissue. The core tissue is usually unaffected. Intact fruit may have a spongy feel when compressed. Soft scald may be present on the same fruit.

Senescent Breakdown - Softening and browning of affected cortex tissue. Affected tissue are usually dry and poorly defined. Vascular tissue are likely to be prominently brown, resembling freezing injury. Red skin turns darker and green or yellow skin turn brown in areas of breakdown. A symptom referred to as “mealy breakdown” is characterised by the entire fruit turning dry and mealy. In some cases the surface split and the flesh breaks open.
Vascular Breakdown - Browning of the main vascular bundles and some adjacent tissues. The remaining cortex may appear normal, but affected areas may extend into cortex tissues.
Water Core - Translucent, liquid-infused areas of tissue around vascular bundles, or affecting additional tissues inside, and outside the core area. Characterised by water soaked areas of flesh. The affected areas, mostly associated with the vascular bundles, are firm and translucent.
Internal Breakdown - Discolouration or browning of the internal tissue. Develops due to the collapse of cell membranes and walls that results in leakage and oxidation of the cell material.
Core flush - The affected tissue radiates in wedges from the core and varies from pink to light brown in colour. In severe cases the discolouration turns dark brown.
[34]

Internal & External Disorders Detected (Pome Fruit)

ID `frut_disorder_pome` ** Applies to Pome Fruit harvests.*
Record one or more class labels.

Bitter Pit	Freezing injury	Stem cavity browning	Premature ripening
CO2 injury	Core Breakdown	Other	None

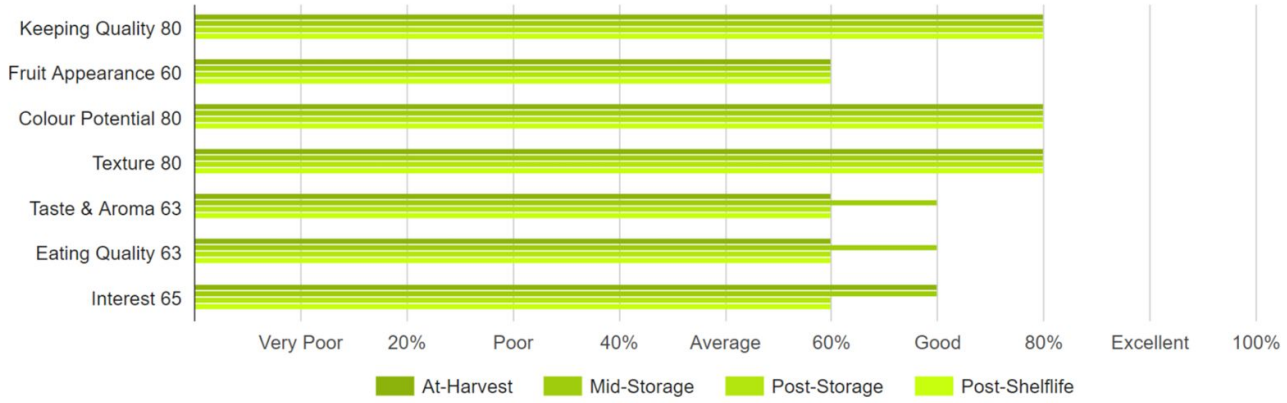
Bitter Pit - Small, brown, necrotic in the flesh 3 to 5 mm in diameter, more common to the calyx portion of the fruit, sometimes visible through the skin as dark coloured depressions.
Freezing - Brown discolouration of the skin often with water soaked areas. Brown cortex tissue, with darker brown vascular tissue. Cavities may occur due to the dehydration of moderately frozen tissue.
Stem Cavity Browning - Brown skin and subsurface tissue in the stem bowel. Core browning usually accompanied by stem cavity browning.
Bitter Pit (Anjou Pit) - Pears - Brown, corky lesions in the flesh, mainly towards the calyx end. Symptoms include an uneven surface, often with dark coloured depressions, or uneven yellowing of the skin towards the calyx end of the fruit.
Premature Ripening - Pears - Associated with cool, late season growing conditions. Presents as early ripening, mixed maturity, yellowing of the calyx end in some fruit, pink calyx lobes. Unlike normal breakdown premature ripening begins at the calyx end immediately beneath the skin.
Carbon dioxide (CO_2) Injury - Pears - Browning of internal walls of the carpel, and in some cases adjacent core tissue. With more extensive exposure the cortex tissue may turn light brown. Cavities may form in the damaged tissue. External symptoms of carbon dioxide injury have not been observed.
Core Breakdown - Pears - Soft, brown, watery collapse of tissues around the core during or after ripening.
Freezing - Pears - Translucent, water soaked appearance of tissue while frozen. Tissue turn light brown after some time in cold storage, often in a pattern conforming to the shape of the pear. A green coloured water injected zone may be present in the outer cortex. Cavities may form in the fruit. There may be no evidence of freezing on the surface, or the surface of the pear may turn brown, accompanied by brown subsurface tissue.
[34]

Characteristics: Overall Score and Indexing

An overall rating is given to indicate how well cultivars or selections have performed during the evaluation process. This calculation is based on the mean scores of the **Overall impression** of each of **seven characteristics** and is used to rate the cultivar / selection under evaluation. The **broad based criteria** are defined by the Overall characteristics and is used to position the selection in terms of general acceptability. During each evaluation, a table containing the broad based criteria is then used to score and position the cultivar / selection in terms of the following traits:

1. Overall keeping quality
2. Overall fruit appearance
3. Overall colour potential
4. Overall texture
5. Overall taste and flavour
6. Overall eating quality
7. Overall interest

Example of Score report for “Overall” ratings.



Overall Keeping Quality

ID `frut_overall_keepqual` ** Applies to all fruit harvests*

Record a value within the range.

Very Poor	Poor	Average	Good	Excellent
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

An overall rating is performed to determine how well the cultivar or selection is likely to keep in storage, based on a subjective but informative view during observations over the period of four evaluation stages.

Overall Appearance

ID `frut_overall_appear` ** Applies to all fruit harvests*

Record a value within the range.

Very Poor	Poor	Average	Good	Excellent
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

An overall rating is performed during four stages of evaluation to position the cultivar and / or selection for visible qualities related to SIZE, FORM, UNIFORMITY, PRESENCE OF DISORDERS and COLOUR, i.e., intensity, brightness and hue.

Overall Colour Potential

ID `frut_overall_color` ** Applies to all fruit harvests*

Record a value within the range.

Very Poor	Poor	Average	Good	Excellent
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

An overall rating is performed to position the cultivar for overall external colour potential by taking in account the covered / coloured area, stripe coverage and how “ease of colouring” the fruit colour-up. Colour variability within and between fruit should be considered. This rating should be more or less static during the four stages of evaluation.

Overall Texture

ID `frut_overall_texture` ** Applies to all fruit harvests*

Record a value within the range.

Very Poor	Poor	Average	Good	Excellent
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

An overall rating is performed during four stages of evaluation to position the cultivar in terms of its inherent textural attributes, taking in account characteristics associated with TEXTURE, i.e., MEALINESS , CRISPNESS, CRUNCHINESS, HARDNESS, SOFTNESS, FIRMNESS, and any other mouthfeel characteristics that may affect the overall perception of texture.

Overall Taste & Aroma

ID `frut_overall_taste` ** Applies to all fruit harvests*

Record a value within the range.

Very Poor	Poor	Average	Good	Excellent
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Based on four stages of evaluation an overall rating is performed to position the cultivar in terms of overall performance of taste and aroma in combination with each other. The SUGAR and ACID taste, SUGAR : ACID BALANCE, AROMA and presence of off-tastes are taken into account.

Eating Eating Quality

ID `frut_overall_eatqual` ** Applies to all fruit harvests*

Record a value within the range.

Very Poor	Poor	Average	Good	Excellent
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

Based on the four stages of evaluation an overall rating is performed to position the cultivar in terms of overall eating quality. FLAVOUR is qualified as the combination and convergence of aroma, taste and mouthfeel to create a complete profile. SKIN THICKNESS, SUGAR : ACID BALANCE, AROMA, JUICINESS, and TEXTURE attributes are taken into account.

Overall Interest

ID `frut_overall_interest` ** Applies to all fruit harvests*

Record a value within the range.

Very Poor	Poor	Average	Good	Excellent
[0 - 10)	[20 - 40)	[40 - 60)	[60 - 80)	[80 - 100]

An overall rating is performed to position the cultivar in terms of Overall interest. PERCEIVED KEEPING QUALITY, APPEARANCE, COLOUR POTENTIAL, OVERALL TASTE AND AROMA and OVERALL EATING QUALITY are taken into account, but **NOT the commercial potential** of the selection or cultivar in terms of harvest time, time on the market shelf and / or in relation to any other commercial cultivars.

Harvest Sample Measurements

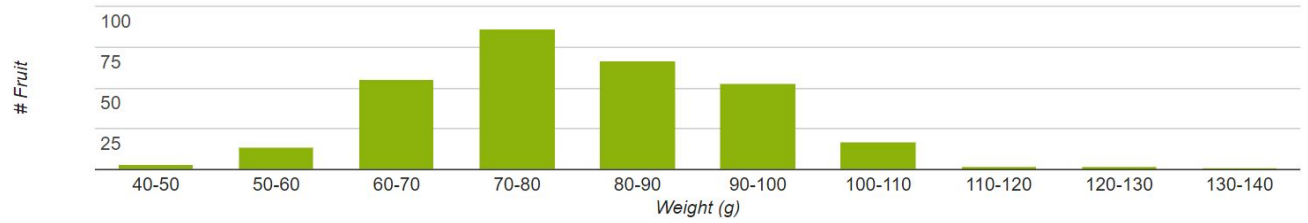
To rank, order and differentiate between samples, laboratory based apparatus are used to determine the fruit weight, fruit diameter, firmness, total soluble solids and acid content of each sample.

The following measurements are recorded for each individual fruit in the Harvest Sample:

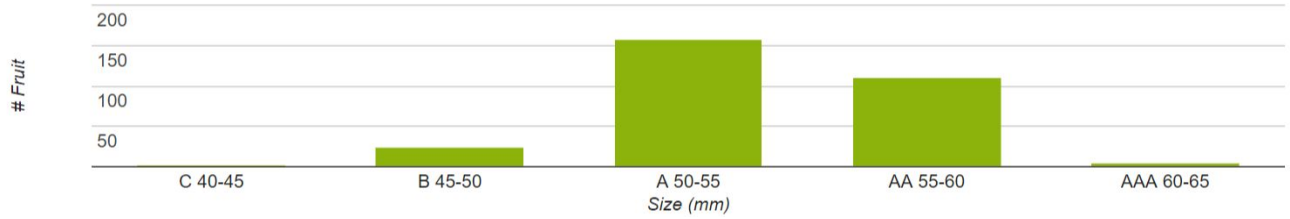
Measurement	Unit	Description
Length	mm	Values in mm, measured with a handheld electronic caliper
Weight	g	By GUSS scale attachment (SK-03)
Diameter	mm	GUSS EFM size measure attachment for FTA (SZ-03)
Firmness	kg	Firmness values in kg, measured with a GUS FTA GS-25 penetrometer using an 11mm plunger for stone fruit and apples and a 6mm plunger for pears
Total soluble solids (TSS)	%	All sugar content values in % TSS, measured with an Atago DBX-3 refractometer
Acidity	%	All acidity values in % titratable malic acid, measured with a Metrohm potentiometric titrator
Over Colour	(L*, a*, b*)	Measurement of over colour within the CIELAB colour space
Ground Colour	(L*, a*, b*)	Measurement of ground colour within the CIELAB colour space

See below examples of Measurements presented as charts in Provar Evaluation Reports.

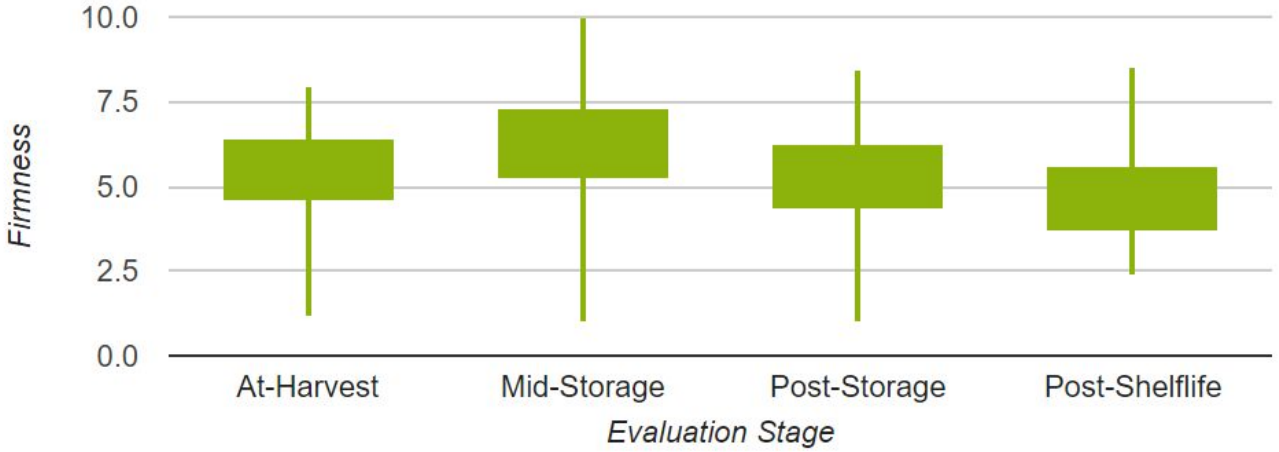
Weight Distribution



Circumference (Size class) Distribution



Firmness Distribution



TSS Distribution

Maturity Indexing

Measurements (including TSS, acid, TSS / acid, firmness, diameter, weight, colour and starch breakdown) are used to characterise the **Harvest Sample Maturity** at a specified harvest date for the harvested cultivar or selection from a specific Evaluation Block in a specific year.

Harvest Indexing

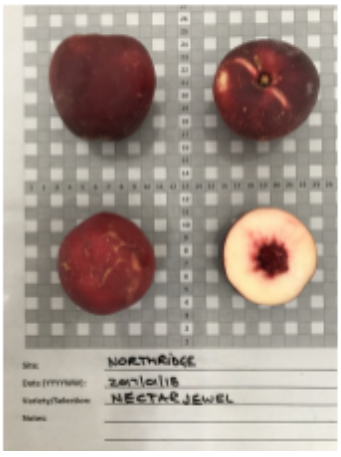
- To determine the **optimal harvest date** for the selection or cultivar under evaluation, the Harvest Sample should be harvested at a specific picking date at once to quantify the variability of fruit maturity within this harvest window, i.e, picking a Harvest Sample that is **representative of the maturity distribution** at the given date.
- Distribution of measurements (including TSS, acid, TSS / acid, firmness, diameter, weight, color and starch breakdown) are used to qualify the **Harvest window** for the harvested cultivar or selection from a specific Evaluation Block in a specific year.
- Harvest indexing is subjected to environmental factors and cultivation practices applied within the Evaluation Block. Therefore, the recommended harvest window and optimal harvest date are determined according to the specific evaluation Block and for the specific year of harvest and should be interpreted as such.

Fruit Photographs

Images of each selection or cultivar under evaluation collected as photographs during the whole evaluation process include the following:

1. Tree form (when tree is in dormant stage)
2. Fruit in tree (overall picture showing production potential)
3. One cut fruit hanging in tree during harvest clearly displaying flesh colour and skin colour (stone fruit)
4. Iodine Test for Apples 3-5 harvested fruit, cut and stained to illustrate starch conversion
5. Other interesting or abnormal tree and phenological characteristics
6. Any diseases or disorders present on the tree or fruit
7. Fruit in box after harvest (photographed in shade)
8. Fruit in laboratory on grid (4 fruit in different positions, displaying all angles and one cut fruit for stone fruit)
9. Fruit in laboratory on white background displaying all angles (using daylight lamps)



Section 5: Evaluation Strategies

Evaluation strategies describe the procedures involved in evaluating a Plant Sample and Harvest Sample to formulate the required report.

Harvest strategies differ based on the following parameters:

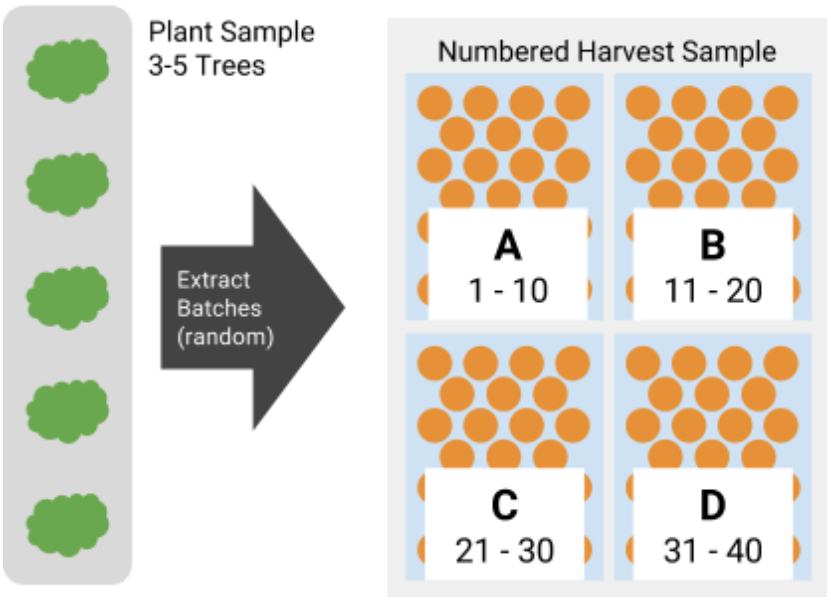
- Size of the **Plant Sample** (number of trees) - should be adequate for Plant Sample evaluation recording to be **representative** of the selection or cultivar under evaluation. An adequate tree sample size is required to provide the required amount of **fruit to be harvested**.
- Size of the **Harvest Sample** (number of fruit picked) should be adequate for Harvest Sample recordings and measurements to be representative of the maturity target under test. The Harvest Sample may also be harvested at multiple dates on the Client's request.

Screening Evaluation

- **Screening Evaluations** are performed to evaluate **specific characteristics** of a cultivar or selection compared to other cultivars or selections. A **small harvest** sample can be picked at **random** for this evaluation protocol. This picking strategy is not recommended for statistical analysis of true production potential.
- Screening Evaluations are performed on a variable number of cultivars or selections **to identify the best / superior** selection or cultivar under evaluation, i.e., to select superior cultivars or selections. Screening Evaluations include tree evaluation on 3 to 5 trees per Evaluation Block. All relevant tree characteristics and phenological stages are recorded. A total of 40 fruit are harvested at random from these trees. A four stage visual and sensory fruit evaluation is applied at different intervals (See Storage Regimes) to characterise fruit quality, storage and shelf life potential.
- Ideally Harvest Samples are harvested from two or three evaluation Sites (localities) over a two to three year period..

Sample Parameters

- **Number of trees in Plant Sample:** 3-5 trees
- **Number of fruit in Harvest Sample:** 40 fruit
- **Picking Strategy:** Picked at random at optimal harvest date



Evaluation Procedure

1. Determine the optimal harvest date (see section on Ripeness and Maturity Targets) during weekly visits and / or according to Client specifications.
2. Take photos in Evaluation Block
    a. Tree form (when tree is in dormant stage)
    b. Fruit distribution in tree (indication of production potential)
    c. One cut fruit hanging on tree during harvest clearly displaying the flesh and skin colour (stone fruit)
    d. Iodine Test for Apples where 5 harvested fruit are cut and stained to determine the level of starch conversion
    e. Other interesting or abnormal tree and phenological characteristics
    f. Diseases present
    g. Fruit in box after harvest (photographed in shade)
3. Harvest 40 fruits per Harvest Sample **Randomly selected** and representative of the 3-5 trees in the Plant Sample
4. Pack fruit in boxes in orchard and take photo of fruit in box (in shade).
5. Label each harvested box with corresponding bar codes.
6. Transport fruit to evaluation laboratory and re-pack in boxes according to standard packing procedures.
7. Store fruit according to storage regime (See Storage Regimes section).
8. Evaluation Stage A takes place directly after harvest. Take fruit 1-10 and follow the following evaluation procedure:
    a. Take photos of fruit in laboratory
        i. Fruit on grid (4 fruit in different positions, displaying all angles, for stone fruit one cut fruit)
        ii. Fruit on white background displaying all angles using daylight lamps
    b. Record visual characteristics
    c. Record individual fruit measurements (See Individual Fruit Measurements) of all fruit in the following order: height, diameter, weight, firmness, °brix.
    d. Perform sensory evaluation according to the evaluation sheet.

e. Cut the fruit in two half sections along the equator, twist the two halves in opposite directions with stone fruit, to enable visual determination of the internal quality and to identify any physiological disorders**.**
f. Collect 150 g of fruit with peel by cutting 15 g per fruit and extract juice for titration.

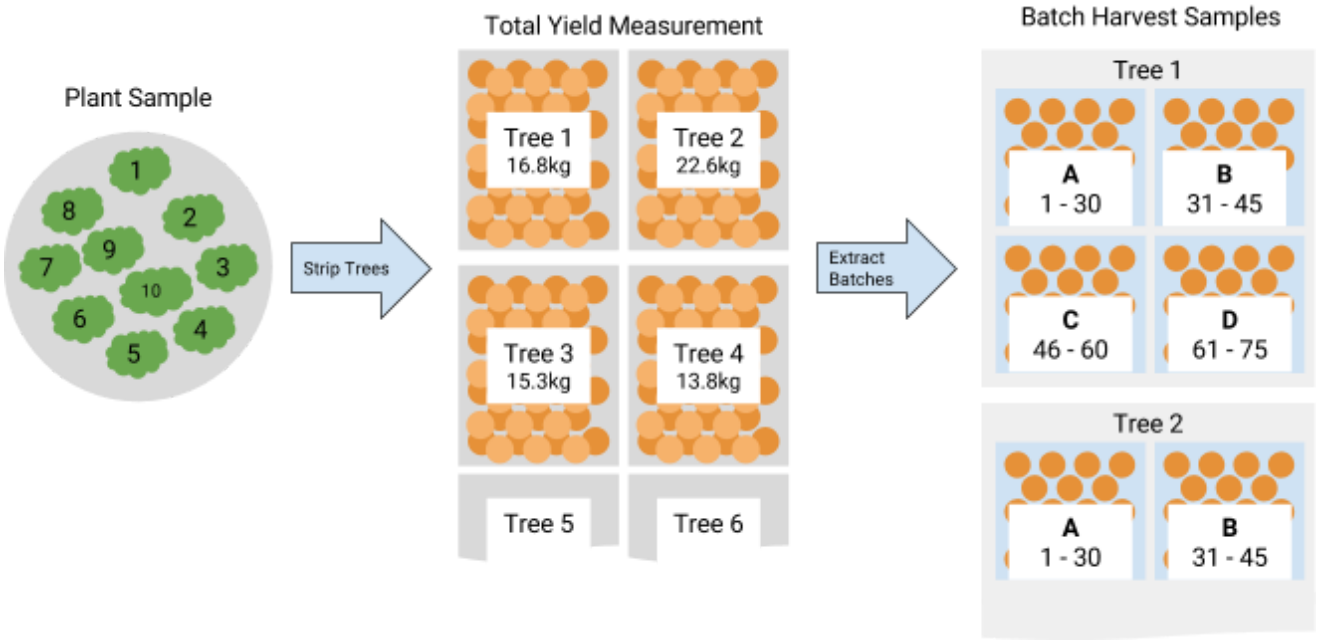
9. Evaluation stage B takes place mid storage. Take fruit 11-20 and follow the evaluation procedure as described in 8. (Photographs not needed, unless abnormalities or disorders need to be documented).
10. Evaluation stage C takes place after storage. Take fruit 21-30 and repeat the evaluation procedure in step 8.
11. Move fruit 31-40 into post-storage shelf life treatment.
12. Evaluation stage D takes place after shelf storage. Take fruit 31-40 and repeat the evaluation procedure in step 8.
13. Destroy/Discard Harvest Sample.
14. For apples and pears only the first After harvest evaluation takes place on untreated fruit directly from the orchard, whereas the following three evaluations are performed after 7 days at 20°C post storage treatment at -0.5°C.

Full Trial Evaluation

- **Advanced** (Full trial) evaluation is performed to characterise the adaptability and commercial potential of fruit selections or cultivars on at least 10 trees per Harvest Sample, recording all relevant tree characteristics and phenological stages, picking all fruit from the trees to estimate production potential and quantify visual and sensory characteristics on 750 fruit in total at four stages during and after storage, including shelf life evaluation.
- To determine the actual **production potential,** a Harvest Sample needs to be picked at optimal ripeness at a specific maturity target**.** All the fruit on the trees under evaluation is harvested at once.
- Total yield per tree (kg) is determined by weighing the fruit.
- A full **Maturity Indexing** is included in this evaluation protokol and a **Harvest index** can be derived from the data generated during the maturity indexing.

Sample Parameters

- **Number of trees in Plant Sample:** 10 Full bearing trees
- **Number of fruit in Harvest Sample:** Strip all fruit at predetermined optimal harvest date to determine total kilograms harvested per tree and fruit size distribution per tree.
- **At random collect** 75 fruit per tree from the harvested fruit and repack in individual boxes for evaluation in laboratory.



Evaluation Procedure

1. Determine optimal harvest date (see section on Ripeness and Maturity Targets) during weekly visits and / or according to Client specifications.
2. Harvest all fruit from each of 10 trees (10 tree Harvest Sample = Tree 1 to 10) in separate crates / boxes.
3. Weight the total fruit harvested per tree (kg).
4. Measure diameter of each tree trunk at 5 cm above soil level tree (Tree 1 to 10).
5. Take photos in evaluation Block
    a. Of tree form (ideally when tree is in dormant stage)
    b. Fruit distribution in tree (indication of production potential)
    c. One cut fruit hanging in tree during harvest displaying flesh and skin colour (stone fruit)
    d. Iodine Test for Apples using 3-5 harvested fruit, cutted and stained to determine level of starch conversion
    e. Other interesting or abnormal tree and phenological characteristics
    f. Diseases present
    g. Fruit in box after harvest (in shade)
6. Re-pack 75 fruit in 10 boxes from each harvested tree. Number Boxes according to tree number.
7. Label each harvested box according to Bar-code allocated to the Harvest Sample - use same labels on all boxes.
8. Transport fruit to evaluation laboratory.
9. Extract (30 fruit per Tree x 10 tree Harvest Sample) for Maturity Indexing and Harvest Indexing.
10. Store remaining fruit (45 fruit x 10 Trees) according to storage regime for the following three evaluation stages.
11. Evaluation Stage A takes place directly after harvest. Take fruit 1-30 and follow the following evaluation procedure:
    a. Take photos of fruit in laboratory (see Fruit Photographs)
        i. Fruit on grid (4 fruit in different positions, displaying all angles, for stone fruit one cut fruit)

ii. Fruit on white background displaying all angles using daylight lamps

b. Record Individual fruit measurements (See Individual Fruit Measurements) of all fruit (30 x 10 trees) in the following order: height, diameter, weight, firmness, °brix.
c. Collect 150 g of fruit with peel by cutting 15 g of 10 fruit per fruit per tree Harvest Sample and extract juice for titration for each tree Harvest Sample.
d. At random collect a sample of 20 fruit and record visual characteristics.
e. Perform sensory evaluation according to the evaluation sheet.
f. Cut the fruit in two half sections through the equator or twist the two halves in opposite directions with stone to visually determine the internal quality and to identify any physiological disorders.

12. Evaluation stage B takes place mid storage. Take fruit 31-45 from cold storage from each harvested tree (15 fruit x 10 trees) and follow the evaluation procedure:
    a. Record Individual fruit measurements (See Individual Fruit Measurements) of all fruit in the following order: height, diameter, weight, firmness, brix
    b. Perform visual and sensory evaluation on random sample of 20 fruit according to evaluation sheets.
    c. Collect 150 g of fruit with peel by cutting 15 g per fruit and extract juice for titration.
13. Evaluation stage C takes place after storage. Take fruit 46-60 from cold storage and repeat the evaluation procedure in step 12.
14. Move fruit 61-75 into shelf storage treatment.
15. Evaluation stage D takes place after shelf storage. Take fruit 61-75 from cold storage and repeat the evaluation procedure in step 12.
16. Destroy / Discard Harvest Sample
17. For apples and pears only the first After harvest evaluation takes place on untreated fruit directly from the orchard, whereas the following three evaluations are performed after 7 days at 20°C post storage at -0.5°C (Refer to storage regimes).

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Glossary

Characteristic	Definition
Abrasions	Any markings that detracts from the fruit's appearance and associated with a physical deformity, scraping, wearing or injury and can include scrapes, scratches, scuffs, grazes, cuts or any other markings observed.
Acid	Sourness is a primary taste sensation associated with the presence of acids in the fruit.
Adaptability	Aptability describes the phenotypic response of the cultivar or selection to the environmental conditions. Poor adaptability will normally be associated with abnormal growth and production characteristics, including stunted or limited growth, poor morphological development of leaves and of shoots, occurrence of small and blemished fruit and may also include all aspects related to prolonged dormancy.
Alternate Bearing	Alternate or biennial bearing occurs when a cultivar or selection produces a very heavy crop of fruit in one season followed by a light or no crop in the following season.
Aroma	Aroma experience occurs inside our noses and includes aspects related to our sense of smell. The words "aroma" and "bouquet" are words used to describe favourable odours. Odours are tiny volatilized compounds, floating in the air and get stuck in our noses giving us a good or bad smelling experience.
Bearing Habit	Bearing habit relates to the bearing unit on which fruit develop and can be on various shoot lengths from very short (spur-type) to long shoots.
Bearing Position	Fruit buds can form on various positions on the shoot, i.e., at the base nearest to attachment to the older shoot or branch preceding development of the bearing shoot, middle, tip of shoot or evenly spaced across the whole shoot.
Bleeding Flesh	Describe the initiation area for internal flesh colouration. Normally this can apply from skin or from the stone (pit).
Blemishes	The presence of any blemishes on the fruit sample that detracts from the fruit's appearance and associated with colour changes due to deformity or injury is noted and can include any stains, blotches, flecks and other discolourations observed.
Bloom of Skin	Describes the presence of a powdery white coating on the surface of the fruit skin. This is caused by the presence of wax like substance and minute scales that normally can be easily rubbed off from the skin surface.
Branching Density	In relation to trees planted in the same year and in the same evaluation block, it is possible to visually distinguish differences in branching density of trees. A Weak branching density indicates a low number of side branches developing from the main stem/trunk while Strong branching density is distinguishable if the tree develops numerous side branches form the main stem.
Branching	Branching Habit relates to the natural characteristic shape, appearance, or growth form

Habit	of the side shoots and crotch angles of the branches and shoots. It develops from specific genetic patterns of growth in combination with environmental factors and is part of the structural organization of every Plant Sample.
Calyx Openness - Depth	The calyx opening is the open space at the calyx end of the fruit (i.e., the green structures that stays behind on fruit that develop at the bottom of the flower are called sepals, and together all the sepals are called the calyx). The openness of this area is described in its depth with a deeper opening being less attractive.
Calyx Openness - Width	The calyx opening is the open space at the calyx end of the fruit (i.e., the green structures that stays behind on fruit that develop at bottom of flower are called sepals, and together the sepals are called the calyx). The openness of this area is described in its width with a wider opening being less attractive.
Colour Potential Inside Tree	Red color development on fruit inside the tree canopy varies with environmental conditions, where light and temperature are the key factors. Anthocyanin production in apples is light dependent; not only the intensity but also the quality of light influences anthocyanin formation. Low temperatures increase and high temperatures reduce anthocyanin concentration in apple peels.
Crispness	Crispness, a mouth-feel characteristic is associated with the fruit flesh texture that quickly brakes down in smaller particles during chewing, while mealiness is associated with a soft dry mouthfeel and butter-like textures relate to lite and smooth resistance when chewing.
Crunchiness	The difference between crispy and crunchy is that crispy is having a crisp texture; brittle yet tender while crunchy is likely to crunch and shatters / break and makes a sound when biting. Crunchy texture offers sustained, granular resistance to jaw action and is difficult to overcome when associated with hard and firm fruit textures.
Feather Density	When new shoots grow in spring, some of the buds are not inhibited by apical meristem and buds produces side shoots during summer called feathers in stone fruit.
Firmness	Fruit firmness describes the pressure needed to change or retain the form unaltered in spite of pressure or force.
Firmness Homogeneity	Fruit firmness homogeneity between the fruits during each evaluation stage will give an indication of the consistency of the ripening process.
Flavour	Flavour is the combination of aroma, taste and mouthfeel to create a complete profile that we are experiencing when eating or drinking. Flavour is when taste, aroma and mouth-feel converge into one sensory experience.
Flesh Colour	Describe the property of light by which the flesh colour is classified in reference to the colour spectrum.
Flesh Type	Flesh type in stone fruit relates to the intrinsic flesh developmental properties. “Melting flesh” types, which soften rapidly to a smooth buttery texture, “Non-melting flesh” types soften gradually to a rubbery texture, and are the mainstay of peaches used for canning. Slow melting stays on tree longer, holds firmer after picking, ultimately becomes melting.

Flower Burst Span	Period from first to last flower stage within a season. The flower burst span is important in view of adaptability of the cultivar or selection to the specific growing area and also relates to the inherent chilling requirement of the Plant sample. Normally when flowering is brief (short period), the fruit will be of equal size and maturity. When the flowering period is extended, fruit size and maturity will be variable and not acceptable.
Flower Density	Flower density relates to the number of flowers on the tree during full flowering period and can be very low or even no flowers developing or high number of flowers.
Flower Distribution	Flowers can be distributed on the whole tree in an Even distribution pattern or flowers can be concentrated in certain areas of the tree or even certain positions on the shoot (Uneven).
Flower Position	Fruit buds can form on various positions on the shoot, i.e., at the base nearest to attachment to the older shoot or branch preceding development of the bearing shoot, middle, tip of shoot or evenly spaced across the whole shoot.
Flower Thinning	Depending on the flower density, flower thinning can be necessary to reduce the amount of fruit on the tree.
Flower Type	Stone fruit flowers can be identified as either showy, or non-showy, where showy flowers are well formed, attractive and larger fruit compared to non-showy flowers.
Fruit Set Potential	Fruit set relates to the number of fruit that develops on the tree before thinning and can be low or even no fruit developing or high number of fruit in relation to trees planted in the same year and in the same evaluation block.
Fruit Suture	Stone fruit are prone to have a fruit suture that is the sunken line running from the stem-end to the blossom (calyx) end of the fruit. The suture can be prominent when the shoulders of the fruit bulges /protrude forming a prominent and deep line.
Fruit Thinning	For high and very high fruit set, fruit thinning needs to be applied to reduce the amount of fruit on the tree.
Fruit Tip	Some older cultivars of especially Peaches and Nectarines are known to have a prominent fruit tip towards the fruit calyx end. This tip can be absent in two ways, i.e., this area can be sunken or rounded.
Fruit Tip Development	Some older cultivars of Peaches and Nectarines are known to have a prominent fruit tip towards the fruit calyx end and may become soft when the fruit matures. This is a negative trait as especially if fruit are exported to international markets.
Grain	Flesh texture can be grainy or fine, depending on the morphological structure and inter-relationship between the cells of the flesh. Grainy texture feels rough to the touch and it is easy to experience many tiny pieces in the mouth, also described as gritty or grainy.
Ground Colour	Fruit ground colour is distinguishable by the absence of pigmented cells (cells containing anthocyanins) in the top layer(s) of the fruit skin or deeper tissue within the fruit.

Growth Form	Inherent character of the tree as well as environmental stimuli affect the phenotypic tree growth form. Acrotony or basitony are frequently considered as two fundamental phenomena underlying, respectively, the *bushy* growth habit. Mesotony is the term used to name preferred development of shoots and branches from the median (nearest to the middle) part of a tree or annual shoots.
Growth Potential	In relation to trees planted in the same year and in the same evaluation block, it is possible to visually distinguish differences in height and circumference of the tree canopy. The way the tree is filling its “space” in the row also shows how vigorous the trees are growing.
Growth Type	For Apple trees the *Lespinasse* growth types are used to descibe the iherent growth charactersitics and can be described as Type I, II, III or IV.
Juiciness	Fruit juiciness is one of the textural attributes that is associated with apple freshness and good keeping ability. The presence of a substantial amount of juice in the flesh of the fruit is classified as very juicy. The absence of juice is described as very dry.
Leaf Color	Leaf colour refer to the pigments visible on the leaf lamina and described in hue format, i.e., normally observed as green or red.
Lenticels	A lenticel is a porous tissue consisting of cells with large intercellular spaces in the periderm of the secondarily thickened organs like fruit. Lenticels may be small, almost non-visible or large. They may be vary between attractive white spots to russeted unattractive spots.
Maturation Rate	The ripening process can be rapid or prolonged as a results of the intrinsic chemical, morphological and / or physiological properties of the fruit. This characteristic can be deducted from the rate / tempo of change in firmness measurements and also more subjectively by monitoring the degradation of fruit firmness by sensing the firmness by hand and by sensory mouth-feel.
Number of Picks	The number of harvests per season for a selection or cultivar that may be required to achieve a full commercial harvest. With some cultivars a prolonged ripening period requires more than one harvest (normally associated with adaptation to the specific planting area).
Over Colour	Fruit over colour is distinguishable by the presence of pigmented cells (cells containing anthocyanins) in the top layer(s) of the fruit skin. Normally these pigments are shades of red, orange, pink and or purple, but may become intense dark red to dark purple and even black in certain plum cultivars.
Over Colour Area	The over coloured area covered with pigments differs from cultivar to cultivar and fruit to fruit on the tree and may be fully covered (100%) to no coverage (0%). The coloured area is estimated by allocating a percentage of coverage by inspecting all fruit in the sample and allocating a number from the least covered to the largest area covered as percentage over color.
Over Colour Pattern	Over colour pattern type relates to the specific pattern or design of pigmented areas on the fruit. When most of the fruit area is covered (more than 80%) and no stripes visible the fruit is classified as full coloured. Bi-coloured relates to more than 50% over coloured area covered with pigmentation and Blushed less than 50% coloured area

	covered with pigmentation. In some cases, fruit can be fully coloured with visible stripes then Full covered and Striped are both applicable patterns, and this case may apply to bi-coloured and blushed fruit. Striped fruit are applicable when the ground colour is visible between stripes. Mottled is when the skin colour is thin and broken and the underlying ground colour shows through. Uncoloured fruit have no visible surface pigmentation.
Pendicular Openness - Depth	The pendicular opening of the fruit is the open space at the stem end of the fruit. The openness of this area is here described in its depth with a deeper opening being less attractive.
Pendicular Openness - Width	The pendicular opening of the fruit is the open space at the stem end of the fruit. The openness of this area is described in its width with a wider opening being less attractive.
Pistilar Cavity Russeting	Under the same environmental conditions, fruits from different flat peaches show differences in russeting susceptibility. This may be more severe due to cultural practices such as practices supporting rapid growth, i.e., irregular water or excessive thinning during the hardening stage of the pit.
Pistilar Cavity Split	Under the same environmental conditions, fruits from different flat peach cultivars show differences in cracking susceptibility at the calyx end of the fruit. This may be more severe due to cultural practices such as methods supporting rapid growth, i.e., irregular water or excessive thinning during the hardening stage of the pit.
Precocity	Precocious cultivars and selections have an inherent tendency to produce a crop of fruit early in the life of the tree after planting.
Pre-Harvest Drop	Early dropping of fruit from the tree due to ineffective stem attachment mechanism to the shoot may be inherent to the cultivar or selection.
Productivity	General observation re. inherent ease of fruit set and ability of tree to fully develop all fruit to optimal harvest stage without loss of size and fruit quality. For productive fruit trees, pruning and training is almost as important as fertilizer and water in association with the cultivar.
Prolonged Dormancy Symptom	Prolonged dormancy symptoms are an indication of poor adaptation to mild winter climates or non-optimal growth conditions during budbreak. Symptoms include reduced break of vegetative and reproductive buds, prolonged flowering duration, lower fruit set, uneven fruit size and fruit ripeness at harvest. The most prominent symptom is the absence or extended delay of lateral vegetative budbreak.
Pubescence	The surface of peach is covered by a dense indumentum (hairs) which may serve various protective purposes. The length and the quantity of the hairs on peaches can vary considerably and may be influenced by environmental and soil conditions.
Ripening Stage	The stage of ripeness in the fruit sample. Ripening is a process in fruits that causes a palatable product. In general, fruit undergoes a number of changes during fruit ripening, i.e., it can become sweeter, softer, decrease in sourness and bitterness and change in colour. Colour change is the result of pigments becoming more visible when chlorophyll is degraded.

Russeting	Russeting is a brown, corky netlike condition on the skin of fruit. It may appear on only a small portion of each fruit, or may cover its surface. Severe russeting may be accompanied by fruit cracking which usually renders the fruit useless. Retiform russet can be specified as a special form of russet.
Russeting Position	Describes the position where russeting occurs on the fruit surface.
Secondary Flowering	Secondary flowering can occur in most fruit types due to environmental stimuli and some cultivars are more prone to this occurring due to their inherent genetic make-up. The secondary flowers open later than the primary flowers and also tend to produce lesser quality fruit with a shorter storage life.
Shape Consistency	When observing the total fruit sample and all fruit represents a similar shape, the shape is consistent.
Shape Symmetry	Observing individual fruit within the sample, Complete shape symmetry for each fruit represents full symmetry when the one side of the fruit becomes exactly like another if you flip, slide or turn it. Unbalanced or Asymmetrical fruit shape represents irregular and crooked shape, and don't match up perfectly when turning the fruit
Shape Type	Refers to the shape of the fruit whether, rounded, elongated, flat, etc.
Skin Thickness	Skin or peel, also known as rind or skin, is the outer protective layer of a fruit which can be peeled off. Depending on the thickness and taste, fruit peel is sometimes eaten as part of the fruit, such as with pome and stone fruit. In some cases the peel is hard, firm or crisp, it can be too firm and become unpleasant or inedible.
Spots	On stone fruit like nectarines, spots are prone to develop. These spots can be large or small, numerous or few, singular or confound. The spots can be associated with "sugar spots" – an indication the fruit is so loaded with sugar. These spots can be associated with blemished and russeted areas.
Stem Length	The stem or also known as stalk that supports and attaches a fruit on the bearing unit. Stems may be long, short or medium in length; this is based on their projection from the cavity bottom to the upper stem tip.
Stem Thickness	The stem or also known as stalk that supports and attaches a fruit on the bearing unit. Stem thickness can be slender, medium or thick based on their substance.
Stone Adhesion	Stone adhesion refers to the way the pit or stone is attached to the fruit flesh. In clingstone peaches the stone clings to the flesh (mesocarp) of the peach. In freestone peaches, stones are easy to be remove, Semi-adhesive endocarps will be attached to a degree, but not as tight as a clingstone. Semi-freestone is a combination between clingstone and freestone.
Stone Cavity Colour	Describe the property of light by which the stone cavity colour is classified in reference to the colour spectrum.
Stone Cells	Around the pear ovary the pear flesh may sometimes be infused with (very fine or

	coarse) grit, made of clusters of so called stone cells. Stone cells, a subtype of sclereid cells are made up of some other very hard tissues like peach pits and nut shells.
Stone Size	The pit or stone may be small, medium sized or large; based on the length and width and classed in relation to the fruit size and thickness of the mesocarp.
Stripe Intensity	The percentage patterned area normally refers to the intensity of Stripe coverage and can be distinguishable from intermediate - when 40-60% of the area between the striped pigmented (striped area) is visible background colour. Stripe intensity can be scored according to the over colour stripe coverage in relation to the visibility of the background colour.
Sugar	Sweetness is a primary taste sensation associated with the presence of sugars in the fruit.
Sugar Acid Balance	Sugar-Acid balance is a primary taste sensation that distinguish the complexity in terms of the balance between sweet and acid taste.
Sugarspots	On stone fruit like nectarines, “sugar spots” are prone to develop. These spots can be large or small, numerous or few, singular or confound. The spots can be associated with high sugar contents and an indication the fruit is very sweet.
Taste	Taste refers to the senses experienced inside our mouth and associate with our tongue. Taste primarily refers to sweet, salt, bitter, astringent and sourness / acid contents. A “balanced” taste applies to a good ratio between sugar (sweet) and acid (sour) contents of the fruit.
Texture	Texture is one of the “Mouth-feel” experiences and focuses primarily on crunchiness, crispness, mealiness etc. of the product. Viscosity, firmness, thickness, hardness, fineness are other mouth-feel descriptors used in the food industry.
Training System	Training fruit trees starts when trees are planted, as setting the structure early helps young trees to become productive early. Various systems were developed over the years including Tatura, Palmette, Spindle, Slender Spindle, Solex, Bi-axis, etc.
Trellis System	Espalier training on structures by using different trellising systems when the main trunk of the tree and branches are tied to wires and setting the structure to become productive early. Trellising systems are used to support trees against wind and for maximum sunlight interception and higher fruit yields and quality.
Uniform Ripening	Uniform ripening of fruit within a tree is directly linked with the flowering period and the adaptability of the cultivar or selection to the specific environmental conditions. Chilling requirements that are not met will result in prolonged dormancy symptoms and extended flowering periods as well as variability in ripening between fruit.