

## Correct harvest date

There is general agreement that apples destined for medium or long-term storage should be in an unripe condition at the point of harvest but close to the onset of ripening (sustained increase in ethylene production and in respiration rate).

Picking too early is to be avoided since fruits are likely to have a tough texture, high acidity, low sugar and poor flavour development. Early picked fruit may also have insufficient red coloration (important for dessert cultivars) and may have increased susceptibility to storage disorders such as superficial scald, bitter pit and core flush.

Late picked fruit are likely to be too soft for the market and to develop disorders such as senescent breakdown during storage or marketing. The general appearance of the fruit may be adversely affected and the background colour may be too yellow for market requirements.

During the period leading up to harvest, changes are taking place in many of the characteristics of the fruit. By picking fruit at frequent intervals and storing these under [recommended conditions](#) for varying periods relationships have been established between harvest parameters and ex-store quality.

Harvest maturity parameters commonly used include total soluble solids (usually measured with a refractometer), titratable acid, total soluble solids to acid ratio, starch content, background colour and firmness.

In some cases several parameters are combined to provide a single harvest maturity index. Perhaps the most publicised index is that produced by Streif (1996) which is calculated as follows:

Firmness (kg) measured with an 11 mm probe  $\times$  9.81

Soluble solids concentration (%)  $\times$  starch score (1-10)

In the UK it is usual to [measure starch](#) by cutting fruit at the equator and applying a solution of iodine to the cut surface. The area of blue-black stain is assessed as a percentage of the surface area often with the aid of transparent gauges. These gauges should be available from advisers or marketing groups.

The information presented in [Table 6](#) will enable growers to convert % starch to the 1-10 scale used in the calculation of the Streif index. In practice the percentage starch coverage can only be estimated with an accuracy of about plus or minus 2.5% even with the help of the transparent gauges referred to earlier. Therefore it is essential to include at least 10 apples in the sample for maturity testing.

## Details on the Starch-iodine staining test

A solution comprising 1% iodine and 4% potassium iodide is required. Local chemists no longer provide this solution as it is classified as hazardous under the COSHH regulations. These require precautions in the preparation of the mixture and its subsequent handling and use.

Iodine is harmful by inhalation and in contact with skin and potassium iodide may cause sensitization by inhalation and skin contact and is irritating to eyes and skin and may cause harm to an unborn child. It is advisable to wear suitable protective clothing, gloves and eye/face protection.

In the case of an accident or if you feel unwell, seek medical advice immediately. In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

The solution should be applied to a freshly cut fruit surface. Although the pattern of staining may be apparent soon after application it is preferable to leave the stained sections for up to an hour in order to obtain a more reliable assessment.

## Picking date recommendations for Cox's Orange Pippin and clones - medium to long-term storage

In the UK greatest attention has been made in determining the harvest maturity parameters for the storage of Cox apples. Comprehensive studies of the relationship between harvest maturity parameters and the storage quality of Cox apples have been carried out since 1994, under the auspices of the UK Quality Fruit Group (QFG).

The QFG was formed in response to the poor performance of Cox apples on the UK market in 1992 and 1993. The UK national maturity indexing programme began in 1994 with funding provided by English Apples and Pears Ltd.

Picking dates of Cox for storage should be guided mainly by firmness of the fruit at the point of harvest using the threshold levels given in [Table 7](#).

[Table 7](#). Relationship between harvest and ex-store firmness (penetrometer fitted with an 11 mm probe) for Cox apples. Fruit stored under recommended conditions of 1.2% O<sub>2</sub> (<1% CO<sub>2</sub>) at 3.5°C (see [Section 9](#))

| Ex-store firmness | Harvest firmness (kg) |        |
|-------------------|-----------------------|--------|
|                   | January               | April* |
| 6.5               | 9.4                   | 10.2   |
| 6.0               | 8.2                   | 8.7    |

\* Storage of Cox in 1.2% O<sub>2</sub> (<1% CO<sub>2</sub>) should be completed by the end of March

Recognising the need to achieve acceptable levels of sensory attributes in addition to texture, the harvest firmness levels associated with 6 kg firmness ex-store were adopted by the QFG. Picking for adequate ex-store firmness almost always ensures adequate ex-store greenness of the background colour and provided that [fruit mineral composition](#) complies with recommended standards then physiological disorders related to senescence should be avoided.

Changes in starch pattern should also be taken into account, as, in some years, the change in firmness is too gradual to provide a clear indication of when to pick.

Ideally Cox for long-term storage should be picked when the percentage of the cut surface stained blue/black is between 80-90% and no lower than 70%.

Provided that starch levels comply with the recommendation then firmness can be used as the deciding factor on when to harvest. However, where firmness remains high but starch degradation reaches 90-80% then picking for mid- to long-term should commence and be completed by the time that starch declines to 70%.

At the present time the use of firmness and starch pattern are considered more informative than the 'Streif' maturity index that combines both attributes together with soluble solids concentration.

(However, the 'Streif' index is preferred to individual harvest parameters for determining the correct harvest date for Conference pears. Conference pears for long-term storage should be picked before the 'Streif' index falls below 0.7.)

In the 'Bodensee' region of Germany a 'Streif' index of 0.21 (equivalent to 2.1 when using the formula presented above) was associated with the optimum harvest date for Cox apples. However, the evaluation of quality ex-store was on the basis of sensory tests, objective measures of quality such as firmness, acidity, soluble solids and background colour, and incidence of diseases and disorders.

This assumes that the interests of consumers and growers can be represented in an overall quality score for the product. In reality there is probably zero tolerance by consumers to diseases and disorders and improved scores for some sensory attributes that result from later harvesting do not compensate for other deficiencies in the fruit.

### Picking date recommendations for Cox's Orange Pippin and clones - immediate sale or short-term storage

No national harvest maturity standards can be provided for Cox apples destined for immediate marketing or for short-term storage. In many cases particular producer or marketing groups have developed their own 'standards' in order to supply their retail customers with fruit of a higher sensory quality for a limited period. Such fruit is often referred to as 'mature' or 'tree-ripe' in order to distinguish this from the different character of Cox harvested earlier and stored for longer periods.

Taste panel studies on Cox were carried out at East Malling in 1980 which showed a decline in firmness, crispness and acidity with later picking, whilst sweetness and aroma increased. Cox apples with an average starch iodine staining pattern of less than 70% (black) or with more than 60% of the sample population containing in excess of 0.1 ppm ethylene, were considered to have developed acceptable eating quality on the tree and were therefore suitable for immediate sale and remained acceptable after 3 months of CA storage.

It is recognised that the [storage conditions](#) recommended for apples picked at a stage to provide long storing capability may not be the most appropriate for 'mature' or 'tree-ripe' fruit. Storage conditions need to be sufficiently stringent to prevent loss of firmness and background colour but should not induce abnormal metabolism.

Late-picked Cox apples are more likely to develop low temperature breakdown and alcoholic off-flavours in CA storage than those harvested earlier. Particular care should be taken over the [monitoring of fruit quality](#) in store.

There is a need to develop standards for harvest maturity parameters for Cox and other dessert apples intended for immediate sale. This would prevent fruit of unacceptable eating quality being supplied to the markets. Additionally harvest maturity standards are required for 'tree-ripe' fruit that provide acceptable eating quality for storage period of 2-3 months. Research is required to identify optimum conditions for the storage of fruit picked at advanced stages of maturity.

### Picking date recommendations for Bramley's Seedling

Although it is important to harvest Bramley apples at the correct stage of maturity to achieve the required quality ex-store, there are no harvest maturity standards available. This is due partly to the gradual rate of change in parameters such as firmness, starch pattern and soluble solids (sugar) concentration that are normally used for judging when to harvest. However, there has been no systematic study of these and other parameters as potential maturity indicators for Bramley.

Generally picking date advice is based on fruit size and background colour and the rate of maturation of other varieties such as Cox. Since there are fewer constraints as regards sensory quality than with dessert apples, there is a tendency to pick Bramleys early to obtain green, firm fruit from store.

There is a tendency for increasingly earlier harvesting of Bramley prompted by concerns that fruit may be too large if left on the tree. Larger fruit have lower calcium levels and are less likely to store well. Picking dates for Bramley need to be considered in conjunction with [mineral composition](#) and [storage conditions](#).

Early harvesting of Bramley apples that are critically low in calcium is likely to aggravate [bitter pit](#) development. However, delaying the harvesting of low calcium fruit will increase susceptibility to [low temperature and senescent breakdown](#). From general experience fruit picked after the middle of September are less likely to provide premium quality after prolonged CA storage. However, out-turn quality is likely to be enhanced by adopting more stringent CA conditions and by categorising the storage potential of fruit on the basis of their mineral composition.

Where these requirements are met there is likely to be no adverse response to harvesting early. Increasingly Bramley apples for long-term storage are harvested from late August onwards. The fact that early harvesting dramatically accentuates the development of superficial scald is of little consequence as long as fruit are treated after harvest with a chemical antioxidant such as [diphenylamine \(DPA\)](#) or with [SmartFresh™](#). [hyperlink] If, in the future, DPA was unavailable to treat Bramley apples, alternative strategies are in place to minimise scald development.

The success of strategies such as scrubbed low oxygen storage, [low ethylene storage](#) and [SmartFresh™](#) application would depend critically on harvesting at the correct stage of maturity. Greatest benefits of [SmartFresh™](#) application are achieved on fruit picked at the correct stage of maturity for long-term storage.

There is a need to develop harvest maturity indices for DPA-treated Bramley apples stored under various conditions currently recommended and to develop picking date criteria for minimising scald development in Bramley apples not treated with DPA and stored in scrubbed low oxygen and/or low ethylene storage. The impact of harvest maturity on the processing quality of Bramley apples stored under a range of conditions also needs to be assessed.

### Picking date recommendations for air and CA storage of Gala

Early picking of Gala apples may compromise fruit size, red colour and flavour potential. Picking too late may compromise fruit firmness and accentuate the development of a greasy skin.

Selection of the correct clone, appropriate pruning and thinning practices will help to ensure that the decisions on harvest date are based solely on the rate of maturation of the fruit on the tree.

Waiting for size and colour can seriously compromise eating quality and storage potential. There is also evidence that late harvesting causes a severe skin disorder in apples held in air storage (see Section 13). [hyperlink]

The results of a 3-year project (2000-02) funded by HDC (TF122) showed clearly the influence of harvest date on storage quality of Gala apples. Fruit harvested over a 2-week period in 2001 (24 September - 8 October) and 2002 (17 September - 1 October) were virtually free of storage disorders when stored in CA conditions ( $CO_2 / O_2$ ) of 8/13, <1/2 and <1/1 for the recommended periods (see Section 9) [hyperlink] and subjected to a simulated marketing period.

This indicates that fruit picked at an advanced stage of maturity as indicated by the starch-iodine test (Ctifi score of 6-8.6 in 2001 and 7.3-7.5 in 2002) are acceptable for storage in CA (except 5/1) for the prescribed periods. This accords with the results of early work which suggested that fruit should be picked when the starch coverage is 50-90 (% black) and firmness is in excess of 7 kg.

However, while it is important that fruits remain in a firm condition and free of physiological disorders it is also important that the skins of the fruit should not become greasy. **To avoid the development of greasiness after storage it was necessary to harvest at a much earlier stage of maturity i.e. when starch had declined to a Ctifi score of about 3-5.7 in 2001 and 2.6-2.8 in 2002.**

The average Ctifi score for minimising greasiness in fruit from the same Kent orchards in 2001 and 2002 was 3.5, which is equivalent to a starch coverage of about 85%. This figure is close to that (starch above 80%) suggested by the Quality Fruit Group (QFG) to achieve the best eating quality after long-term storage (QFG Newsletter No. 3 - 5 September 2002).

The evidence from the Quality Fruit Group that early picking may provide better flavour in stored Gala apples is also backed by the views of Australian research workers (personal communication) who claim that maximum flavour from store is associated with harvesting at the onset of the climacteric rise in respiration that is coincident with a rapid rise ethylene production.

Fruit for storage in 5/1 until early April must be picked before ripening on the tree is too advanced. In 2001 and 2002 only the first pick of fruit was suitable for long-term storage in 5/1.

Based on the data obtained in the two Kent orchards in both years the picking date criteria for successful 5/1 storage were 3-4.4 on the Ctifi starch chart (78-88% black), 90-93 N (9.2-9.5 kg) firmness, 10-10.9 (%) soluble solids and 25-55% of fruits with internal ethylene concentrations above the ripening threshold of 100 ppb.

Benefits of SmartFresh™ application have been achieved on fruit picked at a later stage of maturity. It appears that, for Gala, time of harvest may not be such a critical factor in deriving a benefit from SmartFresh™ application when compared with other cultivars.

### Picking date recommendations for air and CA storage of Braeburn

The picking date recommendations provided below were developed from a 3-year project (2003-6) funded by the HDC (project TF152). It is clear from data obtained in all years of the study that the picking 'window' is quite narrow for Braeburn. The following criteria were used to identify the optimum harvest date:

- Avoidance of scald
- Background colour maximum score of 2 (light green) on WWF colour chart
- Firmness minimum of 6.8 kg at despatch
- Greasiness maximum score of 1 on 0-5 scale

It was reassuring that over the 3 years the starch iodine test could be used to indicate optimum time of harvest. Firmness was too variable between the years to be of use as a guide to harvest date and there was little change in soluble solids concentrations over the harvesting period. Starch levels suggested for optimum storage quality are as follows:

|                             | Starch          |                         |
|-----------------------------|-----------------|-------------------------|
|                             | % surface black | Ctifi 1-black, 10-white |
| <b>Air storage December</b> | 85-75           | 3-5                     |
| <b>CA storage January</b>   | 85-75           | 3-5                     |
| <b>CA storage March</b>     | 80*-75          | 4*-5                    |

\* Lower starch coverage required to reduce risk of superficial scald

Picking according to these starch criteria generally provided the best eating quality in each of the years.

Picking earlier than indicated by starch levels is likely to lead to poor appearance, loss of eating quality and wastage due to scald development. Later harvesting will lead to greasiness, loss of appearance and eating quality and is only appropriate for shorter term storage.

### Picking date recommendations for CA storage of Meridian

There are only preliminary results relating maturity of Meridian apples at harvest to ex-store quality. Indications are that starch levels decline too late to be of use as an indicator of harvest date for storage. A significant change in starch levels was associated with the development of greasiness of the skin.

Ethylene concentrations in the fruit were low in fruit sampled at all picking dates and, therefore, ethylene evolution is unlikely to be of use as indicator of optimum harvest date.

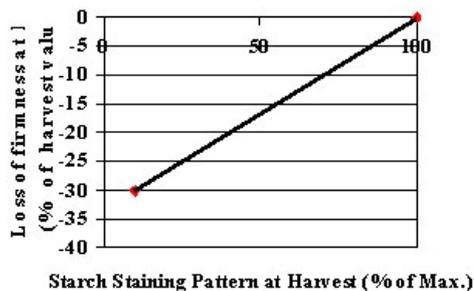
### Picking date recommendations for Discovery

Discovery has an inherently short shelf-life and needs to be marketed quickly under conditions that slow the rate of softening. It is particularly important to keep the fruit temperature below 10°C during distribution.

The starch staining pattern determined on consignments of fruit at harvest can be used to predict the loss in firmness of fruits kept at 10°C (Fig. 2). This method can help to regulate the supply of Discovery to the fresh market by offering a method to identify over-mature fruit at harvest. However, this test cannot be used to estimate the actual

shelf-life of Discovery apples, as the temperature experienced during distribution is likely to be variable.

**Fig. 2. Firmness loss v starch test in Discovery**



There is a need to pick over Discovery trees several times rather than delay until the majority of fruits are of acceptable quality. In the latter situation a proportion of the apples will be too ripe to provide acceptable quality after distribution.

**Table 6. Relationship between % starch coverage and starch score**

| % Starch (blue-black) | Starch score (Streif chart) |
|-----------------------|-----------------------------|
| 100                   | 1                           |
| 78-99                 | 2                           |
| 70-77                 | 3                           |
| 58-69                 | 4                           |
| 40-57                 | 5                           |
| 28-39                 | 6                           |
| 18-27                 | 7                           |
| 8-17                  | 8                           |
| 3-7                   | 9                           |
| 0-2                   | 10                          |

The [Cifl chart](#) is particularly useful for estimating starch patterns. The chart shown here is for cultivars that show a progressive clearance of starch from the centre of the apple.

A second chart is available (not shown) for cultivars that lose starch progressively from all regions of the flesh (radial type). An approximate conversion of score to % black is as follows: 1-100%, 2-94%, 3-88%, 4-82%, 5-73%, 6-69%, 7-63%, 8-47%, 9-33%, 10-13%.

## Predicting and choosing optimal harvesting dates for fresh consumption, short and long term storage of commercial apple cultivars and their clones

### Correct harvest date

Picking on the [correct harvest date](#) is crucial in ensuring that the quality of apples reaching the consumers is optimal and that consignments meet the quality criteria that are set by multiple retailers and the wholesale market.

For each cultivar the time of fruit maturation on the tree varies from orchard to orchard and from season to season. Consequently decisions on harvesting cannot be made based on an arbitrary calendar date.

Growers need to equip themselves with a penetrometer to test the firmness of the fruit and a quantity of a solution containing 1% iodine and 4% potassium iodide in order to perform [starch iodine tests](#).

Testing for firmness and presence of starch in the weeks prior to the expected harvest date is essential in allowing the grower to draw up a harvesting schedule and make full use of a harvesting 'window'. This will help to ensure that the fruit from each orchard is at the correct stage of maturity to enable the grower to implement his or her marketing plans.

Growers will need to be aware of information received from the Quality Fruit Group maturity programme and of long-range predictions issued earlier in the growing season. But the final decision on when to harvest must be based on maturity measurements made on fruit from each orchard prior to picking.

It is important that all quality characteristics of the fruit in each orchard are considered in order to achieve maximum profitability. The fruit must be sufficiently large and well coloured to satisfy market demands.

However, the consequences of delayed harvest to achieve higher grade-out of Class 1 fruit must be realised fully and the fruit stored for an appropriate period under suitable [storage conditions](#).

### Picking date criteria

Cox's Orange Pippin and clones for [medium \(December/January\) to long-term storage \(February/March\)](#)

Picking dates of Cox for storage should be guided mainly by firmness of the fruit at the point of harvest. To achieve 6 kg firmness in fruit stored in CA (1.2% O<sub>2</sub> <1% CO<sub>2</sub>) at 3.5°C until January or March, the minimum firmness at harvest should be 8.2 and 8.7 kg respectively.

Growers should not rely entirely on fruit firmness especially in years when the change in firmness is too gradual to provide a clear indication of when to pick. In this situation the change in starch pattern should also be used. Cox for long-term storage should be picked when the percentage of the cut surface stained blue/black is between 80-90% and no lower than 70%.

When starch levels remain high then firmness can be used to decide when to harvest. However, where firmness remains high but starch declines to 90-80% then picking should commence and be completed by the time that starch declines to 70%.

Growers should start testing for starch and firmness about 2-3 weeks before the expected/predicted date for the commencement of harvest for long-term storage. Experience has shown that mid-August is an appropriate time to begin monitoring Cox maturity in order that a reliable 'trend' can be established.

'Trend' lines are normally too variable to accurately predict when fruit will achieve critical levels of starch or firmness. However, approximate predictions can be made using an average figure for starch loss of 2% per day and firmness loss of 0.1 kg per day ('Effigi' penetrometer fitted with an 11 mm probe).

-Greatest benefits from [SmartFresh™](#) application are achieved on fruit picked at the correct stage of maturity for storage. However, starch coverage should be less than 70% in order to reduce susceptibility to stem end russet browning.

Cox's Orange Pippin and clones for immediate sale or [short-term \(October/November\) storage](#).

Cox apples with an average starch iodine staining pattern of less than 70% (black) have a higher potential eating quality but are only suitable for short to medium term CA storage (Table 5). They should remain in an acceptable condition for up to 3 months in CA (1.2% O<sub>2</sub> <1% CO<sub>2</sub>) storage at 3.5°C.

-In many cases particular producer or marketing groups have developed their own maturity 'standards' in order to supply their retail customers with fruit of a higher sensory quality for a limited period.

Table 5. Harvest maturity parameters issued by the Quality Fruit Group for Cox apples intended for immediate sale and for CA storage for different periods. (NB. Air storage of Cox apples should be terminated by mid-October unless [SmartFresh™](#) is applied after harvest

| Marketing periods | Minimum values at harvest                                  |   |
|-------------------|--|---|
|                   | Firmness (kg)<br>(Penetrometer fitted with an 11 mm probe) | Starch<br>(% cut surface stained black) |
| Feb/March         | 8.6  | 75                                      |
| Jan/Feb           | 8.2  | 70                                      |
| December          | 8.0  | 60                                      |
| Mid November      | 7.7  | 60                                      |
| Mid October       | 7.5  | 50                                      |

|           |     |     |
|-----------|-----|-----|
| Immediate | 6.5 | <50 |
|-----------|-----|-----|

### Bramley's Seedling for long-term storage

-No harvest maturity standards are available for [long term stored Bramley](#).

Earlier harvesting of Bramley is encouraged to avoid fruit becoming too large if left on the tree. However, there is an increased risk of scald and the development of bitter pit will be increased in low-calcium fruit. Late picking increases fruit softening and yellowing and the development of greasiness and flesh breakdown in stored fruit. Bruise susceptibility increases as picking is delayed.

From general experience fruits picked after the middle of September are less likely to provide premium quality after prolonged CA storage.

Greatest benefits of SmartFresh™ application and other strategies to control ethylene production are achieved on fruit picked at the correct stage of maturity for long-term storage.

-Picking Bramley too early and immature for immediate sale can result in consumer dissatisfaction. English Apples & Pears Ltd. have developed a maturity release index (MRI) for Bramley using firmness, acidity and sugar (soluble solids) measurements of the fruit:

$$\text{Firmness (kg) x acidity (g/l)} = \text{MRI}$$

Sugar (%)

Growers should not market Bramley with an MRI above 17.

### Gala and clones for air and CA storage

[Gala fruit for long-term storage](#) should be picked when the starch coverage has declined to 80-85 (% black)

-[Termination dates for storage](#) in air and different CA conditions should be adhered to strictly

### Braeburn and clones for air and CA storage

Growers need to be aware of advice being provided on the best time to [harvest Braeburn](#). This will be available through the Quality Fruit Group (QFG) and other sources.

Maturity criteria for picking for storage are: starch cover of 85-75 (% black) for air storage until December and CA storage until January. Contrary to common practice fruit intended for long-term (March) CA storage should be harvested slightly more mature, starch cover of 80-75%, in order to reduce the risk of superficial scald. Picking at the higher end of these ranges for starch is likely to provide the longest storage potential.

Picking Braeburn at too immature a stage will result in an inferior appearance and eating quality and a heightened susceptibility to superficial scald.

-Picking too late can result in a greasy skin and poor texture of the flesh.

### Meridian for CA storage

-Preliminary advice is to [harvest Meridian](#) fruit for storage when the firmness of the fruit is 7.1-7.6 kg.

### Discovery

[Discovery](#) has an inherently short shelf-life and needs to be marketed quickly under conditions that slow the rate of softening.

It is particularly important to keep the fruit temperature below 10°C during [distribution](#).

## Optimising the harvesting and handling of fruits in the orchard

The information provided in this section should be read in conjunction with other important sources of information namely two DVDs produced by HDC entitled 'Harvesting Quality Apples and Pears' issued in 2006 and 'Creating Champion employees' issued in 2008. The 'Keeping it Clean' DVD issued by HDC in 2007 is relevant to the harvest operation.

**Only select and place in the bin Class 1 fruits, picked in such a way as to avoid damage. "Apples bruise more easily than eggs break".**

### Specification requirement

In order to maximise the financial return it is important that pickers pick fruit that has the potential to meet the final pack specification. Even if 100% of the fruit selected by the picker meets this specification, the handling of the fruit from tree to final packed unit can reduce that percentage dramatically. Therefore it is vital that selection by the picker equals as near as possible the customer specification requirement.

To meet this objective it is important to:

- Identify the potential customer, be it multiple retailer, wholesaler or processor.
- Identify the criteria within each customer specification.
- Assess the potential grade-out of the crop within an orchard against planned customer specification.
- Evaluate the potential financial return, taking into consideration the handling, storage, packing and marketing costs.
- Decide which customer the fruit is targeted at.

Fruit that has no chance of achieving a positive financial return should be removed in advance of harvest. To achieve the optimum quality and volume performance from each picker, the picker should only have two decisions to make:

1. Is it the correct size?
2. Has it got the right colour?

Progressive growers in other countries achieve this by the systematic removal of sub-standard fruits during the thinning operations at various stages of the season, starting at the fruitlet stage and continuing during the summer.

## Planning

Identify factors that will enable efficient harvesting and handling to take place

- Estimate the yield within the orchard.
- Calculate the number of bins required.
- Ensure all bins have been checked and are fit for purpose.
- Ensure there is as near as possible a smooth surface, free of potholes and ruts for pickers, bulk bins and tractors.
- Ensure all equipment such as tractors, pallet loaders, picking trains, trailers/transporters have been serviced prior to harvest.
- Check picking buckets are in good order and free of dust, dirt and rough surfaces.
- Estimate the potential of each picker and ensure enough resources have been allocated for the job.

## Training of pickers and supervisors

Ensure pickers and supervisors have been trained. Where possible this should be done in advance of the first day of picking.

- Organise training courses for supervisors with a qualified instructor. The greatest influence on reduction of bruising will be gained by effective supervision.
- Organise training courses for pickers. Where possible this should be done in advance of the day of picking. Ideally gather the pickers together for a 2-hour training session. It is important that pickers understand where the apples they are picking will end up and a simple process flow example of the passage of fruit from the orchard to the supermarket shelf will help to indicate the importance of their actions.
- Where picking trains are used, ensure that pickers and supervisors are adequately trained and understand the system to be used

Key factors in the training course are:

- Health and safety.
- Hygiene.
- Proper use of the picking bucket.
- What to pick.
- Simple instruction on size evaluation.
- Correct methods of picking - how to handle fruit without bruising it.
- Correct approach to picking branches and trees.
- Correct procedure for emptying the bucket into the bin without causing damage to the fruit.
- Correct use of ladders or steps (where necessary).
- Teamwork if using picking trains.

## Bin placement for picking without trains

During harvesting bins should be placed in a way that ensures that their subsequent movement is minimised and allows them to be picked up by the tractor/pallet loader without damage to the bin or fruit, while allowing the pickers easy access, without unnecessary walking with a full picking bucket. Surveys carried out by FAST Ltd have linked the extent of bruising to the number of bin movements. The following points should be considered:

- Use the knowledge gained from crop estimates to ensure the correct number of bins is available.
- When placing the bins in the orchard ensure the position of each bin is optimised, in particular that the runners do not drop into any ruts making removal by pallet transporters difficult.
- Where growers have large enough orchards with intensive single row systems, it can be more cost and quality efficient to use bins mounted on low specially designed trailers, drawn between the rows by mini tractors and with small groups of pickers picking directly into the bins.
- Very large orchards with bed systems can be more efficiently picked using a self-propelled picking truck with transfer belts positioned within close reach of each picker.

## Picking trains

When using picking trains, all staff must receive full training prior to picking. It is important to cover health and safety considerations of working close to moving machinery.

The following points should be considered:

- The number of pickers to allocate to each gang. From experience most growers feel that 6-8 is the ideal number and it should always be an even number so they pick up the row evenly. Also, if possible, it is good practice to keep the gang members the same from one day to the next
- The number of bins to have on each train. If there are not enough bins the train fills up before the end of the row, but if the train is too long it can cause problems when turning at the end.
- The number of trains to have per orchard. This depends on the size of the orchard and whether all fruit has to be picked as quickly as possible e.g. all fruit is destined for one CA store.
- The length of the orchard rows. Growers need to plan where the next train will need to be to ensure even picking of the orchard
- The support system the trees are on (post & wire/ individual stakes). This affects how many rows can be picked at one time
- The quantity of fruit that will be picked per row (selective picking or strip picking). This affects how many trains, pickers, bins and supervisors will be needed.
- The supervision of the gang. Some growers use one supervisor per gang and others have a mobile supervisor across all gangs in the orchard as well as a supervisor checking quality back in the yard.
- The payment of the gang. Will it be piece work per bin, hourly with a bin bonus? This also affects how to control quality.
- The transport of the bins back to the main yard. Will the train take them back, or will the bins be removed at the side of the orchard and taken back on a separate trailer? This will affect how many trains are required. If fruit is being unloaded in the yard it is necessary to ensure that the gangs always have additional trains to pick into.

## Equipment

Choose suitable equipment that matches the scale of the operation

- Picking buckets should be selected and adjusted to meet the capability of pickers.
- Tractors should be able to access the rows without causing damage to the trees or fruit.
- Pallet forks should be of the type that allows easy access and removal from beneath the bulk bins.

## Supervision of pickers

Supervision of pickers is critical if damage to fruit during picking is to be minimised.

- If using trains, pickers should be organised into groups according to ability to ensure pickers are not being 'carried' by others and causing bad feeling amongst the group. This will then make supervision easier and it is important that pickers should not be left without supervision for long periods.
- If trains are not used, then the supervisor should be given a gang to oversee and ideally this should consist of about 10 pickers. If the gang is too big then the supervisor struggles to keep a close eye on each picker, as they ideally need to view a bin twice before it is full.
- Supervisors should be capable of controlling the pickers with authority, but should be accessible and able to give advice while maintaining respect from the pickers.
- Supervisors should brief their group at the start of each day, or as soon as practicable, to remind them of any key points found during the previous day's picking.
- To control pickers efficiently supervisors should have access to quality control (QC) assessments carried out at the packhouse/storage centre on each picker's fruit.
- The practice of combining the roles of supervisor and tractor driver should be avoided.
- The picking supervisor is able to observe faults in the pickers working methods in the orchard and must be trained to do so. Early detection and correction of poor picking practices will eliminate this particular cause of fruit damage.
- Communication is crucial between all parties during picking. Pickers can become frustrated if there is too much 'down time' during the day and supervisors can become de-motivated if they are not kept up-to-date with information e.g. which orchard will be picked next and feedback of quality assessments.

## Safety, health and hygiene

Before starting work all pickers should, as part of their induction, be made fully aware of safety, health and hygiene requirements necessary to meet HSE and Food Safety Regulations.

- Any features of the site operation that could affect the picker or any other person present should be made known to the picker as part of the induction.
- The location of toilets and hand washing facilities must be clearly indicated to the picker.
- The location and name of the first aid person must be clearly available to the picker.
- A hygiene notice embodying all the key legal health, hygiene and safety requirements must be handed to each picker, this should be read, understood (translation provided where required) and signed by the picker and returned to the management and filed against a register of pickers' names.
- Signs indicating the site safety, health and hygiene requirements should be clearly displayed where pickers will be aware of the requirements.
- Extra safety considerations need to be made if a picking train is being used, and it is a good idea to devise a set of 'rules' e.g. no picker to approach the train when the tractor horn has been sounded.

## Quality control in the orchard

A systematic approach to quality control (QC) in the orchard should be exercised, monitoring the performance of each picker against the required standard.

- Periodic assessment of fruit picked by each picker should take place during the working day. Samples should be taken directly from the bins for this purpose.
- An independent QC check on each picker's fruit should be made the following morning when any bruising not evident on the day of picking will be identifiable. Some bruises may not appear until 12 hours after picking.
- If fruit (as is likely) leaves the site for a central storage site, supervisors should sample and label a minimum of 50 apples from each picker's bins and carry out an assessment the following morning.
- Where trains are used, no one picker can be singled out, unless it is very clear that there is one picker who is picking below standard, so each gang must be treated as a whole, regardless of individual protests.
- Where an independent QC carries out a QC check the next day the results should be recorded and passed back to the orchard supervisor, who should take action accordingly.

## Bin labelling for traceability

Traceability is crucial, and it starts in the orchard. Clear identification of critical information must be secured to the bin before it leaves the orchard.

- Critical identification information, which must be traceable from when the bin leaves the orchard, is grower, orchard, cultivar, pick date and picker or gang.
- It is important to remember that whatever system is used, it must be robust enough to ensure that even after handling the bin many times, the fruit is still traceable to the particular orchard in case of any residue/contamination issues.
- There are various systems used by growers to identify bins.
  1. A label containing the above information. This is ideally a 3-part system, allowing one part to be affixed to the bin, one part to be handed to the picker (which acts as a receipt to guarantee payment) and the third part to be handed to the office for accounting and payment purposes.
  2. An identity label with a unique lot reference number that is supported by a reference document containing the essential information.
  3. An electronic system such as 'Crop-Picker' or 'Pickwise' is a good way to record bins picked out in the orchard and then can be downloaded on a computer at the end of the day.
  4. Crop-Picker is supplied by Crop-Ware Ltd ([www.cropware.co.uk](http://www.cropware.co.uk))
  5. Pickwise is supplied by Supply Chains Systems Ltd ([www.pickwise.co.uk](http://www.pickwise.co.uk))

## Transport of fruit from the orchard to the packhouse/storage complex

Once harvested, fruit must be placed in the shade as soon as possible before transporting to the storage complex in a manner that avoids deterioration or damage to the fruit and is cost effective. The hotter the fruit the greater the cooling requirement, using electricity, which not only increases costs but also the carbon footprint - both key considerations in the current market.

## Planning

Identify the key factors that will influence the efficient movement of bins from orchard to the storage complex.

- Assess the potential number of bins that will be picked in each working day.

- Will picking trains be used?
- Identify the distance from orchard to storage complex.
- It is important that fruit is moved from the orchard without delay to avoid detrimental effect on storage/shelf life.
- Identify equipment that is available to make this process more efficient.

## Distances and location

Identify the distances from each orchard to the storage complex.

- Categorise the orchards into distance groups.
- Up to ¼ mile (400 metres).
- Between ¼ mile and ½ mile (400-800 metres).
- Greater than ½ mile (800 metres).

## Roads and access

Assess the suitability of roads and access to orchards.

- Can hard roadways, either concrete or tarmac be utilised?
- What is the surface of internal pathways around orchards on which fruit will be transported?
- Will picking trains be used, if so will a full train go back to the main storage complex or be unloaded on the side of the orchard?
- Is there suitable access for forklifts, bin transporters or lorries?
- Is there hard standing for a collection point for loading lorries?
- Lorries need an area of at least 48 feet x 60 feet (16m x 20m).

## Equipment

Identify the right equipment for your situation. It will differ from farm to farm

- If all the orchards (or over 80%) on the farm are within ¼ mile of the pack-house/ storage complex, then picking trains can take a full load back to the storage complex and be unloaded and re-loaded with empty bins. If a train has 6 bins this is equivalent to 3 trips of a tractor-mounted rear end forklift and is less damaging during movement.
- Where at least half the orchards are between ¼ and ½ mile (400-800 metres) from the pack-house/storage complex it may not be feasible for a picking train to be unloaded and to return to the orchard without loss of picking time. It may be easier to unload at the orchard and then transport the bins to the storage complex separately. A good system is to use a tractor-mounted forklift and a trailer capable of carrying up to eight bins.
- Where the system described above is used, the fruit will be carried to the headland by the train and unloaded into stacks of bins ready for loading onto a trailer.
- If picking trains are not used, then a tractor with a rear-mounted forklift is the best way to get the bins out of the alleys and placed in rows on the outside of the orchards for transport back to the storage complex.
- If all the orchards are greater than ½ mile (800 metres) from the packhouse/storage complex transport systems become more complex. In such situations, it is more convenient to transport the fruit on purpose-built bin/pallet transporters or lorries.
- Self-loading bin transporters are quick and efficient. Their delivery rate over short and medium distances may make bin stacking in the orchard unnecessary.

## Increase in fruit temperature once picked

It is important to avoid the build-up of temperature in the bins once fruit has been picked.

- Ensure fruit does not stay in the orchard for longer than absolutely necessary.
- Covering bins with insulated and/or reflective white bin covers will give measurable benefits on early varieties, particularly Discovery.

## Shaded area for holding fruit once picked

Placing bins in a shaded area will alleviate temperature build up.

- Placing bins in the shade will help to reduce temperature build-up in the bins.
- Temperatures can rise by several degrees in the centre of the bin.
- The adverse effects of the temperature increase on storage life can be significant.

## Fruit transferred to store within two hours of picking

The effect on storage life is dramatic if field heat is not removed quickly.

- Temperature build-up will effect storage duration.
- The [effects of temperature on the marketable quality](#) of apples are considerable.

## Loading tractor/lorry

Safety measures must be observed during loading to avoid risks to operators.

- When transporting fruit by tractor-mounted carriers, forklifts, trailers or transporters, safe working rules and practices must be observed.
- Ignoring these rules could lead to injury or death to the operator or other people working nearby.
- Always make sure that tractors and other equipment is in safe working order before use (forks, chains, hydraulic hoses and couplings etc.).
- Operators should fully understand what each control is for.
- Controls should be clearly marked to avoid misunderstanding or misuse.
- All safety equipment required for legal compliance should be in place and fit for purpose e.g. guards etc.
- Maximum carrying capacity should not be exceeded.
- Always drive carefully, bearing in mind the load being carried, ground conditions and the state of any roads.

- Do not stop or start suddenly or corner at speed.
- When carrying bins or pallets of boxes ensure vision is not impaired.
- When reversing with loaded trailers or transporters, ensure there are no obstacles or people in the way before moving off.
- Take extra care in orchards where fruit is being picked.
- Slow down when leaving orchards or when joining roadways, your vision may be restricted.
- Look out for overhead obstructions.
- When the tractor is travelling unloaded ensure that the forks are in the safe 'transport' position or kept at 8 inches (20 cm) above the ground.
- Carry bins/pallets as near to the ground as possible on tractor carriers. Forks should be tilted slightly so that bins or boxes are carried against the lift frame. Do not move a load that is higher than the backrest of the forklift.
- Do not carry extra people on tractors or trailers.
- Use flashing lights when travelling on public roads.

### **Shared transport to storage facility**

Considerable benefits, in quality and cost efficiency can be gained from co-operation with others in transportation to a central storage facility.

- Sharing transport with a neighbour may enable fruit to be moved quickly, reducing unnecessary delays in the transfer from orchard to store.
- Savings in cost as well as quality benefits can be gained.

### **Use lorries with air cushion suspension**

To avoid unnecessary bruising in transit lorries with air cushion suspension should be used wherever possible.

- When fruit is transferred by any system, it is at risk from bruise/damage.
- Transferring fruit on a lorry can contribute towards unnecessary bruising if best practice is not observed.
- Whenever possible use lorries with air cushion suspension, particularly for longer distances. Generally today most haulage firms will operate lorries with air cushion suspension.
- However, some smaller operators may still have lorries with conventional spring suspension. This may be perfectly satisfactory for short distances, if driven carefully, but should not be used for longer journeys.

### **Production areas and dedicated storage facilities**

The location of storage facilities in relation to the production area can have a significant influence on long-term storage potential.

- The optimum location for a store would be close enough to the orchards to allow all fruit to be loaded in a store within 2 hours of being harvested.
- In most cases this may not be practical, and, in order to utilise high specification storage, longer distances may be required.
- In order to ensure fruit has sufficient shelf life when the store is opened, it will be necessary to balance the factors involved.
- If high specification storage is available, with rapid temperature pull-down capabilities and the facility to achieve CA conditions with flushing, but 4 hours distant, it will still be better than storage close at hand with poor pull-down and slow establishment of CA conditions.

### **Transport to central storage facility**

A co-ordinated approach to transport arrangements to central storage facilities is vital if the benefits in fruit quality from the correct growing and harvesting of fruits are to be maintained.

- Where fruit is destined for a central storage complex, co-ordination of transport is vital.
- Transport arrangements should be part of central site planning, ensuring pickups are planned and at regular intervals to avoid unnecessary bottle-necks occurring.
- The optimum should be to remove fruit from the orchard and deliver to the storage complex within 2 hours i.e. three pick-ups a day.