# Evaluation of high quality Australian bred sweet cherries for export and domestic markets

Darren Graetz
South Australian Research and Development Institute (SARDI)

Project Number: CY11016

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Level 7
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Telephone: (02) 8295 2300
Fax: (02) 8295 2399




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# Final Report

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**Project Number:** **CY11016**

Research Organisation: South Australian Research and Development Institute
GPO Box 397
Adelaide SA 5001

Project Leader: Darren Graetz
Leader, Fruit Tree Breeding
Phone: (08) 8303 9362
Facsimile: (08) 8303 9424.
Email: Darren.graetz@sa.gov.au

**Purpose of the Report:**
To provide a final report for activities of the SARDI Australian sweet cherry breeding program relating to HAL Project number: CY11016 "Evaluation of high quality Australian bred sweet cherries for export and domestic markets" for the period 26/9/11 to 30/6/14.

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30 June 2014

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## Media Summary

The SARDI National Cherry Breeding program at Lenswood in South Australia is a traditional breeding program that has used sexual hybridisation to develop seedling populations from which to select individuals with the best combination of commercial traits. The program aims to breed sweet cherries with the following attributes to support the Australian cherry industry.

- Large fruit size
- Rain crack resistant fruit
- Self-fertility
- Precociousness
- Wider adaptation to Australian growing conditions

The Australian National Cherry Breeding project will conclude in June 2014 after nearly 30 years of breeding. The program has discovered approximately 130 promising new large sized, well-adapted cherry lines with improved rain cracking resistance for the Australian cherry industry in that time. The majority of these were selected in the final 5 years of the program and still require evaluation on rootstock to determine their commercial potential.
SARDI will graft and store all the promising lines and potentially useful breeding material identified by the breeding program at its secure Nuriootpa Research Centre site in the Barossa region of South Australia.
Cherry Growers of South Australia (CGSA) are undertaking a project (HAL CY12024) that will largely complete the evaluation and rationalisation of the remaining national breeding program lines against seven comparators on three rootstocks at a site in the Adelaide Hills. The rootstocks to be used are: the industry standard Mazzard F12/1 and the precocious rootstocks Krymsk 5 (ANFIC) and Giesela 6 (Graham's FacTRee). It is envisaged that this approach will efficiently unlock the value from the national breeding program's three decades of investment delivering new varieties and supporting recommendations about suitable rootstock combinations.

An "Australian Cherry Breeding and Evaluation" business plan was completed by Julie Haslett of 1DAY Pty Ltd consultants in August 2012. It was presented to the Cherry Growers of Australia (CGA) at the August 2012 AGM.

Australian cherry growers can fast-track and evaluate small scale semi-commercial plantings of the breeding program's most advanced material; six lines are suggested as candidates. Limited commercial trialling of one line is already being conducted.

The released variety, Sir Douglas has completed favourable local evaluation on Mazzard rootstock with its major characteristics being similar to the popular new variety Blackstar. Further evaluation on the precocious rootstock, Gisela 6 may further enhance its performance. Six varieties have been released commercially from this breeding program to date.

Significant economic advantage should arise to growers and exporters from the adoption of new sweet cherry varieties having improved fruit quality and cultural characteristics under Australian conditions.

## Technical Summary

Problem

The Australian cherry industry currently grows varieties with four major characteristics that significantly constrain the ability of the industry to consistently deliver large quantities of high quality fruit to overseas and domestic markets.

- Fruit is susceptible to cracking after rainfall
- Fruit is often small
- Fruit is often soft, difficult to handle and store
- Many varieties are self-incompatible and require other specific cross pollination varieties for acceptable fruit set

These characteristics, combined with the cultural issues of poor precocity and a lack of adaptation to Australian growing conditions, limit the productiveness of many existing and new imported cultivars. An Australian breeding and evaluation facility is a good industry risk mitigation strategy. This is particularly so, given the recent focus on climate change which is predicted to see many production areas become generally warmer and drier overall, reducing winter chill whilst increasing the frequency of summer rainfall events.

Scientific methods

The objective of any breeder is to accumulate as many favourable genes in breeding populations as quickly as possible. Mass selection or the selection of parents based on their phenotype followed by random mating of superior individuals expressing the traits of interest is used in the Australian cherry breeding program.

Controlled hybridisations were achieved by enclosing the flowers of self-incompatible mother trees prior to bloom inside insect proof nets. Flowers were then individually pollinated by hand at full bloom with pollen collected and stored from selected male self-fertile parents. Ripe fruit was harvested, seeds removed, cold treated and geminated. Seedlings were then raised in the glasshouse before being grown on in a field nursery for a single growing season. Dormant trees were then trimmed and bare rooted before bundling and inoculation with "No Gall". Trees were planted in the field in single rows, 4 metres apart at 0.5 metre spacing between trees. Trees were then trained to a single leader without heading to allow early fruit production, which occurred from year 3 onwards.

All cropping trees were observed on an interval of no more than 3 days each harvest season to assign a harvest date. When harvest dates were assigned, a base level of assessment including crop level, average fruit weight, firmness and colour was also recorded in the field. Trees with excessively small or unsound fruit due to softness or rain cracking were recorded as field rejects of no commercial value. Field reject data while of no commercial interest is valuable to the breeder in determining breeding value of parental combinations enabling efficiency gains in further breeding work. Individual trees judged to have met basic minimum standards of fruit size and soundness had a subsample of their fruit crop harvested and were subjected to an extended assessment in the laboratory. Laboratory assessment measured the quality parameters of fruit diameter, average weight, fruit shape, the amount and type of any damage present (physical bruising, check and ring rain cracking, nose cracking and under colour fruit), total soluble solids (°Brix), flavour profile, eating quality and stem characters, along with a comment on the examiner's overall perception of the sample. A grade for the

particular sample was also determined. These were: (1) reject-no commercial value; (2) some value- retain for further evaluation, and; (3) Commercial value- top ranking.

At the completion of the season all seasonal records were digitised into a single spreadsheet and this annual set of results was appended to previous seasons' data. A combination of data handling packages, Microsoft Access and Microsoft Excel were used to view, manipulate and analyse data. Data were reviewed on an individual tree basis enabling rating and decisions to be made on multiple seasons' results. The weighing of an individual line's prospects and subjective categorisation was as far as possible based on all available data and accumulated experience. Decisions made on the basis of single season's results were avoided where practical. Categorisation was reassessed each season and downstream action was determined by the category attributed. At the time of this report all lines had been categorised from the 2013/14 season.

After each harvest season a grafting program of identified promising lines onto Mazzard F12.1 rootstocks for internal secondary evaluation requirements and the National Cherry Variety Evaluation Program (NVCEP) was carried out. Bare rooted grafted trees were then made available to be planted the next winter.

Removal of trees representing genetically inferior germplasm determined to have no further value was conducted in winter each year, allowing adjacent trees extra space and resources in which to flourish.

Evaluation trees planted in previous years were mainly trained during summer, resulting in only a small amount of detail pruning required late in winter. Remnant seedling trees were then further encouraged to develop a vase shape for greater fruiting area and minimally pruned except for reducing their overall height to minimize damage to protective nets.

Major research findings and industry outcomes

There have been a number of major outputs during the last three years-:

- An "Australian Cherry Breeding and Evaluation" business plan was completed by Julie Haslett of 1DAY Pty Ltd consultants in August 2012. It was presented to the Cherry Growers of Australia (CGA) at the August 2012 AGM.
- 131 lines have been identified, categorised and progressed for evaluation on rootstock.
- A 671 tree evaluation resource has been planted and developed at Lenswood Research Centre. The aim of evaluation is to identify lines that have commercial and breeding value on commercial rootstocks and allow further rationalisation of the overall resource.
- The variety collection associated with the breeding program has been rationalised to 41 varieties. This includes material with breeding value, and comparator varieties for both trialling and description under the UPOV guidelines.
- All breeding and variety collection lines are being grafted and warehoused at SARDI's secure Nuriootpa Research Centre as a national resource.
- A limited commercial trial release of 1H.RE has been established and trials are progressing but yet to crop. Interested growers in Tasmania (1), New South Wales (2) and South Australia (2) accessed 50-100 tree batches for trial plantings.
- A further 6 lines (3C.B, 3I.R, 7BE.BBR, 4O.CK, 7C.BSK and 3U.HU) have been suggested as candidates for Australian cherry industry growers interested in fast-

tracking and evaluating small scale semi-commercial plantings of the breeding program's most advanced material.

- All Category 1 selections are planted in the National Variety Evaluation Network. However, the National Variety Evaluation Network has failed to deliver its expected outcomes and appropriately financed and/or formal project coordinated schemes with mandated deliverable outcomes seem the best way forward in future.
- Improved identification systems in the form of individual tree labelling for all program germplasm has improved data accuracy, tracking and in-field efficiencies.
- The breeding program release "Sir Douglas" has performed favourably compared to Stella in local evaluation trials on Mazzard rootstock with the advantage of being a week earlier in maturity and more crack resistant. Its characteristics are analogous to the popular new variety Blackstar and it may further benefit from a pairing with a precocious rootstock such as Gisela 6.

Recommendation and future work

The SARDI national breeding program has developed a large amount of germplasm since its inception through its breeding activities. Funding constraints and low levels of industry support for local breeding are described in the "Australian Cherry Breeding and Evaluation" business plan completed by Julie Haslett of 1DAY Pty Ltd consultants, presented to the Cherry Growers of Australia (CGA) at the August 2012 AGM. Under these circumstances it is recommended that an increased focus on evaluation of this material occurs before further breeding is considered.

The cherry breeding program contains a significant amount of material of commercial interest. In an effort to realize the commercial potential of the SARDI bred material, Cherry Growers of South Australia (CGSA) are now undertaking a project (CY12024) that will evaluate the remaining national breeding program lines against seven comparators on three rootstocks at a single site in the Adelaide Hills of South Australia. The rootstocks used are, the industry standard Mazzard F12/1 and the precocious rootstocks Krymsk 5 (ANFIC) and Giesela 6 (Graham's FacTree). Every effort should be made to help facilitate this work.

This approach will efficiently unlock the value from the national breeding program's three decades of investment delivering new varieties and supporting recommendations about suitable rootstock combinations. The CGSA and collaborating nursery groups are to be commended for their proactive support of this initiative. Ideally, an expanded version also incorporating all available international varieties being contemplated for commercial plantings in Australia in two other major cherry growing states to enable open and direct comparison is required. Implementing such a national system would provide clear information on the relative value of the new varieties but to also reduce the risk exposure of grower members to poorly informed planting decisions.

A dedicated Australian sweet cherry breeding program supported by industry remains the best method of obtaining locally adapted varieties in the face of climate change. It is also the only means by which the Australian industry can guarantee open access to high quality new varieties into the future given the current prevalence of poorly adapted imported varieties in the Australian market place and increasingly restricted access to "club" varieties from international breeding programs.

Should future breeding be attempted it is recommended that this occur on a targeted basis utilising the superior germplasm and parental information accumulated in this breeding program. The processes and systems should incorporate the efficiencies of field nursery and bare-rooted tree production systems utilised in the later years of this breeding program. Critically, grafting programs for promotion of identified material into evaluation should begin as early as practical and should incorporate the use of precocious rootstocks.

Australian cherry growers can fast-track and evaluate small scale semi-commercial plantings of the breeding program's most advanced material. If this is undertaken the following lines are suggested as candidates (3C.B, 3I.R, 7BE.BBR, 4O.CK, 7C.BSK and 3U.HU).

There is a significant amount of time, effort and capital embedded in evaluation plantings at Lenswood which are well advanced towards cropping. Industry should investigate ways to maintain access to these plantings as it would eliminate the need to replicate them in another place at some time in the future, saving significant resources.

It is also strongly recommended that CGA take steps to realise the investment it has made in National evaluation plantings by gathering and analysing evaluation results by whatever means practical. A third party provider to visit and physically evaluate these plantings may be required.

It is also strongly recommended the breeding program genetics and variety collection is warehoused at a secure site. This is already occurring as SARDI is now grafting and storing duplicate trees of all lines and potentially useful breeding material identified by the breeding program at its secure Nuriootpa Research Centre in South Australia. Mazzard F12-1 is the rootstock chosen for the storage of this collection. Ongoing care and maintenance will be required to ensure none of its valuable contents is lost. Ultimately this task will be made easier by future rationalisation of the resource which can only occur through further evaluation to determine the relative worth of each line. There is little doubt that this resource has the embedded ability to benefit the Australian cherry industry long term if handled and exploited correctly.

## Introduction

Australia has a reputation as a producer of high quality horticultural products. Major export markets for Australian cherries have been Hong Kong, Singapore and Taiwan with smaller quantities going to UK, Europe, South Korea and the Middle East. Demand for quality cherries in these markets is still strong although competition has reduced the opportunity for price premiums. In recent years the cherry industry has relied heavily on the domestic market for the majority of its sales. This has been in part due to a series of market access issues blocking or restricting access to some international markets and competition from other lower priced exporters. To maintain viability Australian producers must become more price competitive whilst increasing overall quality and increase export sales into markets not currently being accessed.

Australia's main competitor in South East Asia and UK/Europe is Chile. Labour accounts for 70-90% of production costs for cherries making it a labour intensive industry. The cost of labour in Chile is far cheaper than in Australia. The problem for Australian growers is that the higher cost of production associated with higher labour costs directly translate to a higher

priced product. Overseas buyers then expect a higher quality product. Large, well presented fruit usually commands a higher price on most markets, especially where supply is limiting.

Most markets define large fruit as those having a diameter of 25mm or larger. This equates to a fruit weight of approximately 10 grams. As fruit supply has improved, quality expectations have risen with market expectations dynamically increasing to favour sizes in the 26-28mm range. Traditional varieties grown in Australia usually achieve weights in the range of 7-9 grams per fruit. The commercial reality is that a premium is usually paid for the larger fruit sizes and this is the criteria most commonly used to delineate quality in terms of value. The general trend is now towards producing progressively larger and firmer fruit to differentiate a producer's product and obtain market share and price premiums. With this in mind there is a need to access varieties with a greater genetic size and firmness potential capable of producing more fruit in these larger size ranges and with greater firmness. The best method of evolving with these industry trends is genetic improvement.

Rain crack damage renders fruit unsaleable. Larger fruit is more susceptible to rain cracking in general. Solutions such as protecting orchards with plastic rain covers are expensive and often generate an environment more conducive to fungal infection. Research by Knoche et al., (2006) has demonstrated that much of the cracking of cherry fruits is caused by osmotic uptake of water through the skin of the fruit following rainfall events via stomata and microcracks. Microcracks develop over the life of the fruit as a consequence of thinning and stress on cuticular membrane. Cuticular membrane is deposited in Stage I of fruit growth and there has been shown to be little change in cutin and wax amounts during subsequent stages II and III. As the fruit rapidly increases in surface area during Stage III an essentially constant amount of cuticular membrane is stretched over an enlarging fruit surface resulting in a thinning of the cuticular membrane. This thinning also results in elastic and plastic strain (Knoche et al., 2004). Microcracks develop as a result, these are restricted to the cuticular membrane and do not extend into the epidermal and hypodermal cell layers or the mesocarp. Microcracking is exacerbated by free water causing changes in the mechanical properties of the cuticular membrane, high concentrations of water vapour (ie RH>90%) (Knoche & Peschel, 2006) and early onset of fruit softening which begins at Stage III of fruit maturation (Kondo & Danjo, 2001). Fruit with microcracks are also easily infected by fruit rot pathogens such as *Botrytis cinerea* and *Monilinia laxa* (Borve et al., 2000). The best long term solution to this problem is genetic improvement.

Any market developed requires a consistent supply of product. Self-fertile varieties generally produce more consistent crops. Self-fertility is controlled by a single multi-allelic gene and can be inherited through hybridisation with self-fertile varieties. Another important cultural trait that should be selected for in any breeding program is precocity. This decreases the lead time to cropping of new plantings and increases the overall level of cropping, greatly advantaging the producer.

New varieties with fruit displaying the following characteristics are required to achieve the magnitude of change required to positively impact on the future of the Australian industry.

- Large fruit size
- Rain crack resistant fruit
- Self-fertility
- Precociousness
- Wide adaptation to Australian growing conditions

The development of early and later maturing varieties to extend a fairly compressed production period is also desirable. Some growers are turning to the use of specific geographic locations to extend their season using varieties grown in traditional areas.

SARDI began breeding to these objectives at Lenswood in the early 80's using a traditional crossing program between imported germplasm from North America and Europe with a large self-fertile composition and local well adapted Australian selections. An extensive collection of genetic material has been assembled and incorporated into the program through plant introductions from around the world.

- This three year selection and evaluation phase follows on from thirty years of active breeding, initially as a state based program (17 years) and more recently the national cherry breeding program (13 years). Since its inception 6 varieties have been released. Sir Don and Sir Tom (1998), Dame Roma (2001), Dame Nancy, Sir Hans and Sir Douglas (2002). A limited commercial trial release of 1H.RE has been established and trials are progressing but yet to crop. Interested growers in Tasmania (1), New South Wales (2) and South Australia (2) accessed 50-100 tree batches for trial plantings.

Judicious inter-mating of better performing selections over subsequent generations and the strategic incorporation of high quality international germplasm is now showing impressive results. Many lines showing commercial potential have been identified in recent seasons and grafted onto rootstock to begin evaluation.

All superior performing selected lines are grafted onto rootstock for inclusion in replicated evaluation trials under semi-commercial planting conditions to further investigate their potential. Advanced lines determined to have commercial appeal were up until 2012 included when appropriate into the national variety evaluation network formed in conjunction with Cherry Growers of Australia (CGA). The national variety evaluation network initially consisted of 14 grower run trial sites encompassing all major cherry growing districts across Australia. In 2011 a further three young and progressive growers were added to the program. Information from these trial sites and breeding program evaluations was to form the basis of a collaborative decision making process with the CGA in the commercialisation of new varieties. Unfortunately this voluntary system proved very difficult to obtain feedback from and was subsequently abandoned in 2012. Contact continues with several individuals (mainly recently included grower members) but to date results have been limited.

## Materials and Methods

The SARDI national cherry breeding program at Lenswood is a traditional breeding program that uses sexual hybridisation to develop new seedling populations from which to select individuals with the best combination of traits. The program aims to develop improved Australian sweet cherries to meet demand from overseas and domestic markets. To accomplish this, initial hybridisations focused on crossing self-fertile international varieties with locally adapted lines of both local and international origin. Several parental lines exhibited a range of tolerances to rain cracking. As a result, the varieties "Sir Don" and "Sir Tom" were developed and released in 1998. These have been used extensively as parents. Inter-mating has continued over subsequent generations using better performing selections with the strategic incorporation of high quality international and locally adapted germplasm. Targeted traits of interest include harvest maturity (early or late), self-fertility, rain crack resistance, fruit firmness and large fruit size.

The breeding process begins with pollination (August-November) using either freshly collected desiccated pollen or pollen stored at $-20^{o}C$ from the previous season. This is a time consuming and labour intensive procedure due to the need for individual hand pollinations using self-infertile parents within insect proof enclosures.

Fruit from crosses is harvested just prior to full maturity and the seed extracted for treatment and stratification prior to germination. Seed germination involves removing the flesh from the fruit and placing seeds in running water for 7 days before transferring them to moist sand at 1 degree Celsius. Seeds are then transferred to pots when a primary root appears and grown on in the glasshouse before hardening off in a shade house prior to planting into a field nursery on drip irrigation in spring.

The program during its active breeding phase aimed to plant 1000 new seedlings annually. A decision to terminate breeding and concentrate on selection and evaluation of material already produced was made in 2007. Final crosses were made in spring 2007 and the final 2,000 seedlings were planted in spring 2008.

Blocks are fumigated prior to planting because they have now had multiple plantings of cherries. Fumigation is required as non-specific replant disease would reduce plant health and vigour. Methyl-bromide was traditionally the fumigant of choice; however Telone® has now replaced this chemical following its withdrawal from the market. Application and efficacy depends heavily on soil temperature and moisture content, effectiveness is reduced if applied to cold excessively wet soils. If a cold wet spring occurs, fumigation must be delayed and in turn planting. Planting of seedlings occurs preferably in late winter depending on weather conditions. Historically seedlings should not be planted later than the end of September to minimize the risk of temperatures above 30 degrees Celsius occurring. High temperatures post planting can cause severe transplant shock and death of seedlings.

Seedlings are raised in the glasshouse before being grown on in a field nursery for a single growing season. Dormant trees are then trimmed and bare rooted before bundling and inoculation with "No Gall", to protect against crown gall. Trees are then planted in field primary selection seedling blocks in high density format with single rows 4m apart and tree spacing's of 0.5m. Trees are trained to a modified free standing central leader system and maintained in their limited space. Leaders are left unstopped as the tree approaches full reach

to slow extension growth and promote spurring and fruiting. The aim is to quickly break juvenility and promote fruit production which can occur from year 3 onwards.

Breeding strategies

- The main strategy involved hybridisations focused on crossing self-fertile international varieties with locally adapted lines of both local and international origin. Then inter-mating better performing selections over subsequent generations with the strategic incorporation of high quality international and locally adapted germplasm which exhibit multiple traits of interest
- Annually collecting a proportion of "selfed" and open pollinated seeds from lines showing potential as parents. Evaluation of these offers the potential to discover superior lines from favourable chance re-assortments of the genes.
- Collection of targeted progeny evaluation data helps to determine the parental line's value as a parent through proportional analysis of useful traits transmitted to progeny. This is most useful when the original cross is, in genetic terms, wide (eg. local x international germplasm) as there should be a wider range of segregation in the progeny.

HW Fogel (in Janick and Moore, 1975) suggest good progress can be made in recombining characters by hybridising standard cultivars for simply inherited or readily measurable characters. However, as programs progress some of the quantitatively inherited characteristics, such as disease resistance, hardiness, rain crack resistance and quality will require more sophisticated breeding systems. The focus on improving self-fertility in the current breeding strategy also enables inbreeding and the concentrating of homozygous factors to be explored along with backcrossing. These techniques combined with improved selection of parents to transmit specific characters offers increased chance of genetic gain and should reduce time to ultimate success.

Bailey, C.H. & Hough, L.F. in Janick and Moore, (1975) advocate budgeting the resources of a project among several objectives and selecting mainly on two to three phenotypes that seem equally promising for achieving that objective (eg. size, total soluble solids (TSS) and firmness). Employing the budget (the total number of seedlings that can be afforded for the given objective) and raising several intermediate-sized progenies rather than trying to choose a single pair of parents for one large population to fulfil the budget. Although these comments were directed towards apricot breeding they are equally valid in the breeding of sweet cherries. This is the tactic that has been employed by our program.

With little data available on the transmission rates of traits by individual parents it is conceivable that certain combinations of parents will perform well below expectations, whilst others may produce surprising results. It is therefore prudent to adopt several strategies. Given past experience, the overall success rate for producing economically promising new lines is likely to be well below 1%, requiring large total numbers of progeny to be produced.

Other minor breeding strategies also employed involve:

- Modified backcrossing, however its use has been limited by a lack of available data to identify high quality backcross parents in successive generations.
- Interspecific hybridisation has been used in a very minor way to try to develop different tree forms and sources of possible rain crack resistance.

Fresh fruit assessment

Since 2007 the following important changes were made to the way fruit of individual trees was assessed. The result of these changes has been a more systematic and rigorous assessment regime and greater certainty in interpreting results. The major elements and reasons for change are discussed below.

Fruit undergoes preliminary assessment on each tree at an interval of no more than three days during harvest. Harvest dates are assigned at fruit maturity and a quick assessment of fruit quality made. Lines deemed to be not of sufficient standard then receive a base level of assessment where crop level, average fruit weight, firmness and colour is recorded in the field. These trees usually display excessively small or unsound fruit due to softness or rain cracking and are recorded as field rejects of no commercial value. Field reject data, while of no commercial interest, is valuable to the breeder in determining breeding value of parental combinations enabling efficiency gains in future breeding work.

Individual trees judged to have met basic minimum standards of fruit size and soundness have a subsample harvested and are subjected to an extended assessment in the laboratory. Laboratory assessment measures the quality parameters of fruit diameter, average weight, fruit shape, damage type, total soluble solids (Brix), flavour profile, eating quality and stem characters, along with a comment of the examiners overall perception of the sample.

Laboratory assessment results culminate in an "action category" rating for each selection assessed. This is a broad category reflecting an overview of a selection's merit for a given season also taking into account, tree age and previous history. It reflects the breeder's assessment of a line's potential future given all available information. The broad categories used and a brief definition are detailed below.

- Category 1. "**Reject**"- substandard and displaying insufficient characters to be of further use. This results in the tree being removed and destroyed.
- Category 2. "**Retain**"- denotes a line displaying a desirable trait or traits that warrants further investigation of its potential. May be used for breeding.
- Category 3. "**Potential**"- displaying a combination of traits and physical fruit properties that make it a superior performer for that season and more likely to perform to commercial standard in the future. Likely to be used for breeding but not necessarily of commercial standard. Lines in this category are immediately grafted for inclusion in secondary evaluation trials should they perform well again the following season, if they have not been grafted previously.

In cherry breeding most initial assessment weighting is placed on the major traits of "Size" when converted to a "Size Grade" (a matrix function of average fruit weight and crop level), damage (rain and growth cracking, general marking) and firmness. Firmness is initially a subjective measure in the categories soft, intermediate, firm and very firm corresponding with the international cherry descriptors. Firmness is also recorded as a quantitative numerical value for lines of potential using a FirmTech2 machine. General cracking is visually assessed and divided into type (rain and nose cracking) and percentage damage. A holistic view of these and several other traits are considered in the final analysis and especially when selecting possible parents for further breeding.

Traits of interest include-:

- *Precocity* – Crops are produced earlier enabling faster generation times.
- *Crop* – The ability to crop consistently is very important, biennial bearing should be selected against. It is preferable for a tree to fruit on long lived spurs rather than laterals as the tree can be maintained in a more compact form and will likely benefit from a more compact bloom and harvest.
- *Fruit Size* – Best market returns are usually in the larger categories. Can be measured as diameters or more efficiently by weight.
- *Total Soluble Solids* –A major component of taste. Heritability in peaches is moderate ($h^2$=0.01-0.35). References to peach heritability are made as peach is often used as the type species for Prunus and is well documented; cherry heritability's could be expected to be similar.
- *Acidity* – A major component of taste which has two major components, malic acid and citric acid whose amounts vary considerably between cultivars (Wills, *et al*., 1983). Currently overly acidic fruit are rejected. Heritability in peaches is low ($h^2$=0.19). Recent research suggests varieties with increased acidity level's may prove advantageous where long export travel times and extended storage make flavour retention difficult, improving consumer quality.
- *Flavour* – Approach is to reject poor or bland flavoured types and select for those that have character. Paunovic and Plazinic, (1981) indicates it is possible to select better flavoured apricot types than the original parents although heritability in peaches is low ($h^2$=0.06-0.16).
- *Colour* –An important factor in consumer appeal and helpful as a maturity indicator.
- *Firmness* – A difficult trait to measure objectively unless using measuring equipment like the FirmTech or Durofel, when breeding overly soft lines can be discarded. Heritability in peaches is low ($h^2$=0.01-0.13).
- *Ripening Period* – Ripening period in peaches has been shown to be highly heritable ($h^2$=0.74-0.84). Late ripening germplasm has been sourced from Hungary and Canada to help with this ideal.
- *Stem length and quality* – Excessive and very short stem lengths are selected against for reasons including ease of picking, fruit aesthetics and ease of separation during the packing process. Stems should be of moderate thickness to be relatively robust and not easily separate from the fruit and retain a natural green colour for a significant period post-harvest. Stems are seen by consumers as an indicator of freshness and can detract from perceived consumer quality
- *Self-fertility* – Is a preferred but not an essential requirement of new varieties. It is determined late in the evaluation process due to the requirement for extensive cultural work or relatively expensive DNA testing. Its determination can be made by several seasons of flower bagging with fruit counting or by single season observations of pollen tube growth in pistil microscopy or allele determination by molecular testing.

Size as determined in the field for initial fruit assessments is recorded as fruit weight or diameter. Small size is the reason the overwhelming majority of lines discarded in the field are rejected. The decision to reject will be made as an arbitrary function of the fruit diameter and crop load without conversion to a SizeGrade as in laboratory assessments. This reflects the cherry's natural genetic tendency towards having progeny with mean fruit size closer to the small-fruited parent than to a larger fruited one (Fogle, 1961).

Precocity as a trait is not necessary for an excellent sweet cheery but it is very important with respect to progress in their development. To use the example of D. Byrne (1993), assuming we can advance a trait about 20% each generation and a generation time is 5 years, effective advancement is 4% per year. Lower the generation time to 4 years and the effective advancement per year is now 5% per year, a 25% increase in efficiency. Hence it is important to use precocious selections from progenies as much as possible in subsequent crosses. Professor Byrne recommends using precocious types more extensively in pollinations to move through generations faster suggesting that it underpins most successful stone fruit breeders and their programs. Hence, selection methods will continue to take into account precocity and utilize its advantages.

At the completion of the season all seasonal records are digitised into a single spreadsheet and this annual set of results is appended to previous seasons' data. A combination of data handling packages, Microsoft Access and Microsoft Excel is used to view, manipulate and analyse data. Data is reviewed on an individual tree basis enabling rating and decisions to be made on multiple seasons' results. The weighing of an individual line's prospects and subjective categorisation is as far as possible based on all available data and accumulated experience. Decisions made on the basis of single season's results are avoided where practical. Categorisation is reassessed each season and downstream action is determined by the category attributed. At the time of this report all lines had been categorised from the 2013/14 season.

Categories used:
Category 1- Commercially promising (lines progress directly to national evaluation trials and significant numbers are grafted for evaluation).
Category 2- Good prospects with more evaluation (grafted in small groups for internal evaluation within the program on rootstock).
Category 3- Moderate prospects with more evaluation (some grafted in small groups, most grafted to only two evaluation trees)
Category 4- More evaluation as a final chance (has shown promise but has issues, further poor assessments may end its chances) OR mainly it has a useful genetic character
Category 5- Remove or not worth continuing.

After each harvest season a grafting program of identified promising lines onto Mazzard F12.1 rootstocks for internal secondary evaluation requirements and the National Cherry Variety Evaluation Program (NVCEP) was carried out. Bare rooted grafted trees were then made available to be planted the next winter.

Removal of trees representing genetically inferior germplasm determined to have no further value was conducted in winter each year, allowing adjacent trees extra space and resources in which to flourish.

Evaluation trees planted in previous years are mainly trained during summer, resulting in only a small amount of detail pruning being required late in winter. Remnant seedling trees were encouraged to develop a vase shape for greater fruiting area and minimally pruned except for reducing their overall height to minimize damage to protective nets.

National evaluation and internal evaluation trails

Promising selections identified as having possible commercial potential are forwarded to local evaluation in replicated trials on the commercial rootstock *Prunus mazzard* F12/1. Lines are grafted in replicate numbers reflective of their categorisation and likelihood of commercial success. Category 1 Lines (6 trees), Category 2 Lines (6 trees), Category 3 Lines (3 trees) and Category 4 Lines (2 trees). These trees are planted in blocks at 2m by 4.5m and trained to an industry standard KGB or similar bush growing system

The highest rating advanced lines (Category 1 lines) were up to 2012 forwarded to the National Cherry Variety Evaluation Program (NCVEP). This national evaluation network was established in 2006 with test sites at major cherry growing locations around Australia. The national evaluation network currently consists of 14 sites, Victoria (5), Tasmania (2), New South Wales (3), South Australia (3), and Western Australia (1). In 2011 a further 3 sites were added, Victoria (1), New South Wales (1), South Australia (1) to include a group of younger very proactive cherry growers. Planting material was provided as grafted trees initially and in later years as budwood, allowing growers to graft trees for themselves.

The aim of this network is to expedite the collection of commercially focused production information on the most promising elite lines in the production areas in which they are likely to be grown. This information was be used to promote and support future commercial releases to maximise their uptake by industry. Unfortunately this voluntary system proved very difficult to obtain feedback from and was subsequently abandoned in 2012. Contact continues with several individuals, (mainly recently included grower members) but to date results have been limited. All current Category 1 lines detailed in Table 7 are represented in plantings at all NCVEP trial sites.

A major evaluation trial consisting of 26 advanced lines plus the varieties Stella, Sir Hans, Sir Douglas and Dame Nancy was planted in winter 2002. The trial contained six replicates of each line and is trained using the “Lenswood tie-down system”. Fruiting began in 2006 and the final 3 years results are presented in this report (Table 11).
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# Results

Australian Cherry Breeding and Evaluation-Business Plan

An "Australian Cherry Breeding and Evaluation" business plan was completed by Julie Haslett of 1DAY Pty Ltd consultants in August 2012. It was presented to the Cherry Growers of Australia (CGA) at the August 2012 AGM. A full copy of the plan is attached to this report as a pdf file. A copy of the "Executive Summary" is supplied below.

*Australian Cherry Breeding and Evaluation-Business Plan*
*Executive Summary*

The Australian cherry industry has had a long involvement in varietal breeding. A national breeding program has been conducted by the South Australian Research and Development Institute (SARDI) since 1995, facilitated by a series of HAL projects funded through the Australian Cherry R&D Program.

Six new cherry varieties have been released from the breeding program (Sir Dom – 1998; Dame Roma – 2001; Dame Nancy; Sir Hans and Sir Douglas – 2002). Over the past ten years there have not been any further varieties commercialized for release.

Breeding activities are no longer undertaken in the program, with the current focus being on evaluation of superior lines from existing breeding lines. The current SARDI Evaluation Project (CY11016) is directed at expediting the progress of these superior lines to support potential commercialization with advanced selections currently undergoing secondary evaluation across 19 regional evaluation sites. This current project will conclude at end June 2014.

Under the new National Horticultural RD&E Framework, the Tasmanian Institute of Agriculture (TIA) is the nominated "**Major**" agency for cherry research and development, with SARDI taking a "**Link**" role for cherry improvement from July 2014. As a consequence, SARDI will no longer co-fund cherry breeding and evaluation. It is also unlikely that there will be ongoing access beyond this date to the primary research site located at Lenswood, South Australia.

This change in arrangements requires the Australian cherry industry to review the future direction of breeding and evaluation activities in the context of available funding and other priority initiatives identified in the Australian Cherry Industry Strategic Investment Plan 2012-2017.

It is on this basis that a Business Plan has been developed following extensive consultation with industry stakeholders. This Business Plan presents findings and recommendations arising from a review of the current Australian Cherry Breeding and Evaluation Program conducted March-July 2012. Recommendations are supported by an implementation plan.

As would be expected, the consultation process confirmed that there is not a consensus of views within the industry, with wide ranging opinions around breeding and evaluation. However, a number of key underlying themes emerged during consultations which are important in the context of future strategy development.

During consultation, stakeholders articulated a need for growers to have access to superior varieties in order to retain international competitiveness. The commercial sector is actively working to facilitate this, although some concern was expressed about restricted access to some of these new varieties and the impost of royalties.

Given the limitations of available funding through the Australian Cherry R&D Program, there is an evident lack of support for direct industry investment in any further breeding activities.

The need to retain access to genetic lines from the current breeding program has also been emphasized.

The role for industry investment is less clear in relation to evaluation. It is evident that the commercial sector is actively engaged in a broad range of formal and informal varietal evaluation activities. Consequently there is a lack of consensus regarding any formal requirement for the investment of industry funds.
Before the completion of the current SARDI Evaluation Project, it will be necessary to determine whether further evaluations of any of the superior breeding selections are needed, and whether to implement a commercialization strategy to take these lines to market. It is likely that this will require engagement with third-parties and access to external funding support, given the limited level of funds available through the Australian Cherry R&D Program.
The commercial sector is actively importing and evaluating new cherry varieties. In this context the industry should consider the benefits of increased engagement with commercial providers to support two-way communication between growers, commercialisers and other collaborating parties.
Regardless of the direction taken by industry, future evaluation initiatives will benefit from the confirmation of industry-standard criteria for evaluation.

## 2011 Breeding Program Internal Review

A review by the breeder in 2011 at the beginning of this project identified key processes that would be critical to getting the most value from the breeding program whilst beginning an orderly exit strategy.

The recommendations of the review were-:

- Continue implementing a comprehensive tree identification system.
- Systematically assess all cropping trees each season.
- Determine and seek ratification from industry for the resource allocation (selection vs evaluation) that extracts the most value from the breeding program.
- Tighten retention criteria to limit numbers requiring future evaluation where possible.
- Review and rationalise genetic germplasm (comparator and parental line) holdings.
- Produce and plant a complete set of evaluation trees as quickly as possible at Lenswood Research Centre to ensure the integrity of the breeding program and gain as much evaluation data as possible.
- Facilitate the set up and running of an independently funded comprehensive evaluation site utilising precocious rootstocks to take over and complete the evaluation of breeding program material.
- Begin to graft and store all the promising lines and potentially useful breeding material identified by the breeding program at Nuriootpa Research Centre, a secure site in the Barossa region of South Australia.

Individual labelling of all program trees with plastic labels for increased efficiency and accuracy has continued. The ability to capture and store data reliably and attribute it to individual trees is in itself a powerful tool.

Systematically assessing all cropping trees each season to produce a complete data set has enabled better comparisons and decisions to be made. Prior to 2008, assessment was at the discretion of field staff responsible for picking samples that appeared impressive and to submit them to the laboratory for assessment. Since 2008 all cropping trees have been assessed systematically on a maximum 3 day interval each harvest season to assign a harvest

date. When harvest dates are assigned a determination is also made as to the overall quality of the fruit. If acceptable the tree is listed to have a sub-sample picked for laboratory assessment. If fruit is of unacceptable quality a base level of assessment including crop level, average fruit weight, firmness and colour is also recorded in the field. Trees with excessively small or unsound fruit due to softness or rain cracking are recorded as "field rejects" of no commercial value. Field reject data had previously not been recorded requiring that all trees had to be carried forward incurring unnecessary maintenance costs. Improved identification of individuals of no commercial or genetic value has enabled the annual removal of these trees improving overall efficiencies. Removing trees also has additional benefits because it allows remaining trees in the densely planted primary selection blocks less competition and better growing conditions to promote better growth and expression of their capabilities.

Timely annual categorisation of lines showing improved performance characteristic and the implementation of annual post-season grafting in a field nursery are facilitating tree production for evaluation trials. This system efficiently minimizes the lengthy evaluation timeframe of this perennial tree fruit crop. The lack of a regular grafting and nursery program prior to 2009 meant at the time there was large number of lines requiring multiplication. In March 2009 a significant effort began to multiply the backlog of material awaiting further evaluation (at the time around 1000 trees). The requirement to preference and supply trees of advanced lines to the National Evaluation Program required this process to be spread into the following year (2010). Since this time the effort to produce evaluation trees has dropped to between 100-200 trees annually.

The result of this relatively late accumulation and planting of evaluation trees combined with long establishment and pre-cropping periods on a non-precocious rootstock such as F12/1 Mazzard (4-5 years) and a very poor 2014 harvest season has meant that very few evaluation results from these trees at the Lenswood Research centre have been obtained. The vast majority appear primed to produce crops in the 2015 season, weather conditions permitting. A lack of cropping from these evaluation trees has meant that decisions on the allocation of resources between the remaining selection blocks and evaluation activities were rendered largely redundant and all activities could be accommodated. A minimum of two years of selection has been performed on all seedlings produced and planted in the breeding program and these final selections will be added to the program's identified germplasm resource collection and evaluation trials.

## Germplasm

The breeding program contains a significant germplasm resource collection in the form of old heirloom varieties, commonly grown commercial varieties and recently released fresh market varieties from other international breeding programs. This resource at its largest comprised approximately 88 named varieties from several countries. Subsequent rationalisation in this project currently has this resource consolidated to 41 varieties (Table 12)

This is not a static resource and all lines are evaluated annually. The function within the breeding program is two-fold. Entries are able to be used as source genetics for future breeding and as performance benchmarks for breeding program lines with key characteristics in specific maturity segments throughout the season.

To define the "total" program germplasm resource these varieties should be pooled with the advanced lines identified as Categories 1 to 4. Efforts should be made to preserve the integrity of this complete genetic resource should it be required by industry in future.

Ad-hoc rationalisation has taken place over the life of this project in the form of culling genetic resource varieties unlikely to be useful in breeding, comparison and further evaluation. This work enabled a smaller and more focused resource to be carried forward.

Other Planting Resources

The aim of the breeding project had been to produce approximately 1000 seedlings from crosses and open pollinated seed per annum before crossing was discontinued in 2007. Table 2 details the number of grafted trees planted for evaluation each year from selections of these seedlings. Also detailed is the number of trees removed each season, the vast majority being the seedling plantings themselves.

Trees are grafted and planted on the basis of their most recent categorisations Category 1 Lines (6 trees), Category 2 Lines (6 trees), Category 3 Lines (3 trees) and Category 4 Lines (2 trees). The maximum number of 6 trees was chosen as it is the minimum number required to run a DUS trial for PBR of cherries. This in conjunction with the strategic inclusion of several benchmark comparator varieties will allow PBR to be sought on any line without additional trail setup and the long lead times involved. This approach is both practical and cost effective. Lines which are upgraded to higher categories have extra trees grafted to the maximum of six. Downgraded lines do not have surplus or extra grafted trees removed, all tree replicates remain until the line is downgraded to such an extent that it becomes a removal. At which time all replicates and the original seedling are removed.

Culling of the categorised advanced lines takes place annually following the re-rating process but is difficult to do confidently without evaluation data on multiple grafted evaluation trees or several years of data from the single seedling tree to observe genetic trends.

**Table 1: Summary of breeding program planting resources**

| Block | Area (Ha) | Planted | Tree # 2011 | Tree # 2012 | Tree # 2013 | Tree # 2014 | Notes |
|---|---|---|---|---|---|---|---|
| FMB | 0.15 | 1999 | 24 | 19 | 17 | 14 | Remnant elite seedlings |
| FVB | 0.1 | 2003 | 13 | 9 | 7 | 7 | Remnant elite seedlings |
| FB | 0.16 | 1989-2002 | 34 | 22 | 17 | 15 | Remnant elite seedlings |
| EB | 0.57 | 2002 | 34 | 26 | 20 | 18 | Remnant elite seedlings |
| KS | 0.4 | 2005 | 382 | 17 | 17 | 17 | Remnant elite seedlings |
| L04 | 0.3 | 2000 | 9 | 6 | 6 | 6 | Remnant elite seedlings |
| L07 | 0.64 | 2007 | 1903 | 1541 | 12 | 12 | Remnant elite seedlings |
| L06 | 0.44 | 2008 | 1256 | 1101 | 822 | 26 | Three seasons of selection |
| L08 | 0.2 | 2009 | 953 | 940 | 811 | 6 | Two seasons of selection |
| | | | **4608** | **3681** | **1729** | **121** | *Subtotals of seedlings* |
| PBR2 | 0.1 | 2003&2011 | 180 | 180 | 174 | 163 | Grafted evaluation trial |
| FA1 | 0.1 | To 2013 | 90 | 109 | 167 | 148 | Grafted evaluation block |
| KB | 0.45 | To 2012 | 475 | 493 | 432 | 360 | Grafted genetic collection/evaluation block |
| | | | **745** | **782** | **773** | **671** | *Subtotals of genetic & evaluation lines* |
| **Total** | **3.61** | | **5353** | **4483** | **2502** | **792** | |

**Table legend**
**Block**- block name; **Area**- block area (hectares); **Planted**- year of planting; **Tree # "year"**- number of remaining trees at the end of the calendar year identified; **Note**- brief description of planting type

**Table 2: Trees planted and removed each year**

| Year | Trees Planted | Trees Removed |
|---|---|---|
| 2011 | 315 | 2423 |
| 2012 | 153 | 1043 |
| 2013 | 74 | 2035 |
| 2014 | 0 | 1710 |
| **Total** | **542** | **7211** |

Fruit and tree assessments

Selection from seedlings plantings has been ongoing for many years beginning when seedlings are of sufficient age to produce significant quantities of fruit. Selection over the subsequent years has identified many promising selections. Table 3 details the number of lines that have been assessed seasonally. A significant number of varieties from the germplasm collection have also been assessed and this information is used to benchmark breeding lines and background as to its potential value as a parent. These data are also available to industry and growers providing a significant information resource. Microsoft Access and Excel are two software packages used by the breeding program to increase efficiency in data capture, storage and usage.

**Table 3: Total fruit assessments by year and type**

| Year | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|
| Breeding Lines Lab Assessed | 564 | 184 | 268 | 128 |
| Breeding Lines Field Rejects | 1712 | 580 | 1018 | 46 |
| Named Varieties Lab Assessed | 133 | 82 | 53 | 48 |
| Total | 2409 | 846 | 1339 | 222 |

General seasonal conditions

- 2011- Good winter chilling and a mild fruit development period produced good fruit set and excellent conditions to size the abundant fruit in what looked to be a bumper season. Widespread regular spring rains continued into summer damaging crops and reducing quality. Growing conditions producing softer, often rain cracked fruit with greatly reduced storage potential. Cool spring weather shifted the national harvest window back by up to two weeks making it a much later than average season.
- 2012- Late autumn and early winter conditions at Lenswood were cool and good early chill accumulation was recorded. Late winter and early spring produced a series of mild to warm periods resulting in a slightly earlier harvest season than normal and up to 20 days earlier than the 2011 season. Spring and summer weather was generally mild with regular minor rain events across the harvest season. These rain events caused varied levels of fruit damage. However, for the third year in succession it again provided an excellent opportunity to get differentiation on relative rain cracking susceptibility.
- 2013- Winter conditions at Lenswood were cool with good chill accumulation recorded. Late winter and early spring produced some mild to warm periods resulting in a slightly earlier harvest season than normal season. Spring weather was generally mild to warm with the bulk of summer being warm to hot with only very minor shower events across the harvest season resulting an unusually dry harvest season. The lack of rain events and warm to hot weather resulted in a much greater irrigation requirement and very low levels of fruit damage due to cracking this season. An artificially high number of selections of high quality were identified due to a lack of rain pressure to damage and downgrade fruit.
- 2014- Autumn and early winter conditions were warm and mild, delaying leaf drop and the beginning of chill accumulation. Early to mid-winter coincided with good rainfall recordings however late winter and spring were dry. This weather also carried into summer with only a few small showers being recorded and low levels of fruit

damage. It wasn't until late February and well after harvest was completed that significant rainfall occurred. Autumn and early winter was warm resulting in delayed dormancy and leaf fall. Mid-winter was cool and the majority of chill accumulation was recorded in this period, late winter and spring were relatively mild, overall leading to reduced chill accumulation over the entire winter period. A significant period of bloom was marked by cool and unusually windy weather where bee activity was noticeably reduced. This along with reduced overall chill accumulation and an off-crop cycle set up by a heavy cropping 2013 season had a disastrous effect of fruit set and an extremely light cherry crop was experienced across the Adelaide Hills. The Industry Body, Cherry Growers of South Australia (CGASA) estimate the overall crop was 20% of a normal season with some growers failing to harvest.

Low rainfall conditions during the harvest season at Lenswood during the last two years have not allowed for making selection decisions based on rain crack resistance data. Over the same period Lenswood's high water security, reliable dams and access to bore water that make it a unique, secure and reliable site at which to perform the cherry breeding and evaluation activities of this project have been an increasingly relied upon asset.

**Table 4: Analysis of annual fresh fruit assessments and tree removals**

| **Year** | **2011** | **2012** | **2013** | **2014** |
|---|---|---|---|---|
| **Lines Laboratory Assessed** | 697 | 266 | 321 | 176 |
| **Superior performing** | 53 | 31 | 58 | 60 |
| **Retain** | 315 | 120 | 127 | 85 |
| **Reject** | 329 | 115 | 136 | 31 |
| **Field Rejects** | 1712 | 580 | 1018 | 46 |
| **Total Cropping Trees** | 2409 | 846 | 1339 | 222 |
| **Tree Removals** | 2423 | 1043 | 2035 | 1710 |

Table 4 details the numbers of trees involved seasonally in systematic fresh fruit assessments and the broad categories into which their attributed results fell. "Lines Laboratory Assessed" indicates fruit subsamples from individual trees visually assessed as of suitable quality to require a more rigorous laboratory assessment. The number of trees in the sub-categories "Superior performing", "Retain" and "Reject" make up the total number of "Lines Laboratory Assessed".

"Field Rejects" refers to trees having fruit which on initial visual observation was either small for the crop load present, overly soft on the tree or obviously excessively cracked. Excessive stem length or deformed fruit shapes can also earn a sample field reject status however these defects are in the minority. Field reject samples have harvest date, fruit colour, firmness and size recorded. This data forms a complete data set with which to determine breeding values of potential parents in further breeding without which future breeding would be far less efficient. "Total Cropping Trees" is the sum of "Lines Laboratory Assessed" and "Field Rejects".

"Tree Removals" is a record of the number of trees identified to be removed each season. Although the number is usually similar to the sum of the sub-category "Reject" and "Field Rejects" the reality is that this is not a simple addition. All samples are compared for multiple seasons to make the ultimate decision on whether to remove or keep the individual and this can either work for or go against an individual based on previous results. Previous good

results can mean a tree may be retained until such time as an accumulation of poor results support confidence in its removal. Tree removals may also include a proportion of trees that have never cropped when block use is due to be rationalised. Continuing to assess the main body of germplasm is inefficient as a seedlings maiden (pre-fruiting) period is highly correlated with its maiden period on rootstock and risks working against the efficiency gains in favouring more precocious types

**Table 5: Numbers of cherry lines by yearly classification categories**

| Category | 2012 Season | 2013 Season | 2014 Season |
|---|---|---|---|
| 1 | 17 | 13 | 13 |
| 2 | 26 | 36 | 35 |
| 3 | 57 | 56 | 71 |
| 4 | 26 | 15 | 12 |
| 5 | 22 | 29 | 9 |

**Table 6: Newly classified lines by year**

| Year | Category | Previously assessed | First time assessments |
|---|---|---|---|
| 2012 | 2 | 2 | 1 |
| | 3 | 9 | 2 |
| | 4 | 0 | 0 |
| 2013 | 2 | 3 | 3 |
| | 3 | 4 | 10 |
| | 4 | 1 | 2 |
| 2014 | 2 | 0 | 0 |
| | 3 | 15 | 5 |
| | 4 | 0 | 0 |

Tables 5 & 6 provide a summarised report on the numbers of lines in each category by year and the number of newly classified lines each season and their background. The numbers of lines in Categories 1-4 indicate the potential for new varieties and the scale of evaluation required. The number of lines in Category 5 shows that while overall numbers of advanced lines within evaluation remains relatively stable the situation is far from static with significant numbers of lines exiting the system. Newly classified lines rarely if ever enter evaluation as Category 1 hence it was not included in the table. The reclassification to Category 1 is reserved for lines or reproducible high quality and several seasons of exceptional assessment.

## Table 7: 2014 Category 1 characteristics, annual rating and performance

| Cat. Change | | | | | Harvest week | Line Code | Year | Maturity range | Harvest date | Performance | Rating | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2014 | 2013 | 2012 | 2011 | 2010 | | | | | | | | Av. | Av. | 2014 | | 2013 | | 2012 | | 2011 | | 2010 |
| 1-1 | 1-1 | 1-1 | 1-1 | 1-1 | 1 | **2O.IO** | 09/10 | 14/11-7/12 | 22-Nov | N1N33311 | cfSRNE | 437 | | | | | | | | | | 437 |
| 1-1 | 1-1 | 1-1 | 1-1 | 1-1 | 2 | **4I.KI** | 08/09 | 29/11-16/12 | 4-Dec | 3133333 | CFSRNE | 235 | 27 | 193 | 27 | 200 | 27 | 288 | 28 | 248 | 26 | 247 |
| 1-1 | 1-1 | 1-1 | 1-1 | 1-1 | 3 | **3C.B** | 08/09 | 4/12-24/12 | 10-Dec | 3.3E+07 | CFSRnE | 477 | 29 | 428 | 30 | 378 | 29 | 477 | 28 | 572 | 29 | 531 |
| 1-1 | 1-1 | 1↑2 | 2-2 | New | 3 | **2B.BK** | 10/11 | 5/12-20/12 | 10-Dec | N133311 | CFRnE | 488 | 27 | | | 427 | 27 | 436 | 28 | 537 | 25 | 550 |
| 1-1 | 1-1 | 1-1 | 1-1 | 1-1 | 3 | **1H.RE** | 07/08 | 11/12-21/12 | 15-Dec | PBR Trial | CFSRNE | 427 | 29 | 449 | 29 | 366 | 30 | 429 | 29 | 463 | 30 | |
| 1-1 | 1-1 | 1↑2 | 2↑3 | 3↑4 | 4 | **3I.R** | 09/10 | 5/12-21/12 | 15-Dec | 3333313-1 | CFSRnE | 478 | 28 | 523 | 28 | 453 | 30 | 568 | 28 | 483 | 26 | 361 |
| 1-1 | 1-1 | 1↑2 | New | | 4 | **7BE.BBR** | 10/11 | 6/12-30/12 | 18-Dec | N333 | SFRNE | 490 | 27 | | | 494 | 27 | 512 | 26 | 463 | 28 | |
| 1-1 | 1-1 | 1-1 | 1-1 | 1↑2 | 5 | **4O.CK** | 09/10 | 10/12-30/12 | 22-Dec | 3//3333331-0 | CFsrnE | 542 | 27 | 587 | 28 | 490 | 28 | 501 | 27 | 590 | 26 | |
| 1-1 | 1-1 | 1↑2 | New | | 5 | **7C.BSK** | 10/11 | 16/12-30/12 | 24-Dec | N133 | cSFRNE | 381 | 29 | | | 476 | 28 | 356 | 31 | 312 | 29 | |
| 1-1 | 1-1 | 1↑2 | 2-2 | New | 5 | **3U.HU** | 10/11 | 16/12-3/1 | 24-Dec | 1//3333301 | CFSRNE | 476 | 29 | 574 | 28 | 393 | 30 | 497 | 29 | 511 | 27 | 405 |
| 1-1 | 1-1 | 1-1 | 1-1 | 1-1 | 5 | **5I.HR** | 09/10 | 19/12-30/12 | 24-Dec | 1//NN3N33 | CFSRnE | 354 | 24 | | | | | | | 354 | 24 | |
| 1-1 | 1-1 | 1-1 | 1-1 | 1-1 | 5 | **3R.RS** | 08/09 | 16/12-6/1 | 24-Dec | N3//3333133111 | CFSRNe | 497 | 27 | 500 | 27 | 448 | 28 | 461 | 25 | 577 | 27 | |
| 1-1 | 1-1 | 1-1 | 1-1 | 1-1 | 7 | **5C.KE** | 09/10 | 7/1-10/1 | 7-Jan | NN3N31 | CfSrNe | 380 | 29 | | | | | | | 380 | 29 | |

## Table legend

**Cat. Change**- Category to which it is assigned in a given year and movement from its previous season (e.g. 1-1 denotes Category 1 this season unchanged from Category 1 last season, 1↑2 denotes Category 1 this season promoted from Category 2 the previous season).

**Wk**- Typical harvest season at Lenswood broken into 7 weeks to indicate more clearly spread of timings over the harvest season, Week1 (24 November to 30 November), Week 2 (1 December to 7 November), Week 3 (8 December-14 December), Week 4 (15 December-21 December), Week 5 (22 December-28 December), Week 6 (29 December to 4 January), Week 7(5 January to11 January).

**Line**- Coded line numbers for protection of intellectual property.

**Year**- Harvest season the line was first characterised.

**Maturity**- Range of maturity data recorded at Lenswood Research Centre.

**Harvest**- Estimated date of maturity for a typical season at Lenswood Research Centre.

**Rating**- Quick reference listing of a seedling lines performance for all seasons it has been assessed (from left to right). 3 = Excellent (graft for further evaluation), 1 = OK to average (retain for further assessment) 0 = Poor (consider removal), N = No fruit (no assessment), - = No Assessment recorded, R = Tree removed, D = Tree Died, PBR Trial = Line is included in a separate replicated trial on rootstock and the seedling tree is no longer the primary means of assessment. Data for PBR trial trees is presented in the "Secondary Trial section".

**Attributes**- A quick reference guide to the attributes displayed by a line. Upper case indicates it is excellent for that character, lower case indicates it is marginal for that character, missing indicates it is deficient in that character. C = cropping ability is moderately heavy or higher, c = cropping ability is light moderate to moderate; F = firmness is firm or very firm, f = intermediate; S = size where average fruit weight is 9.5g or more, s = average fruit weight >8.5gm but less than <9.5g; R = ring cracking and side splitting is less than 10%, r = cracking is generally less than 20%; N = nose or apical cracking is less than 10%, n = nose cracking is generally less than 20%; E = eating experience is generally rated as good or very good, e = eating experience is generally rated as fair.

**Fm**- A pooled average of years and annual average firmness measurement for a random sample in that season using a Firmtech 2 apparatus. Readings expressed as force in grams per square centimetre ($gcm^{-2}$)

**Sz**- A pooled average of years and average fruit size expressed as a diameter in millimetres (mm) measured by the Firmtech 2 apparatus.

**Table 8: Category 2 to 4 lines characteristics, annual rating and performance**

| Cat. Change | | | | | Harvest week | Line Code | Year | Maturity range | Harvest date | Performance | Rating | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2014 | 2013 | 2012 | 2011 | 2010 | | | | | | | | Av | Av | 2014 | | 2013 | | 2012 | | 2011 | | 2010 |
| 2-2 | 2-2 | 2-2 | 2-2 | 2-2 | 1 | 4C.KC | 08/09 | 24/11-30/11 | 28-Nov | NNNN013 | CfsRNE | | | | | | | | | | | |
| 2↑3 | New | | | | 1 | 10R.IK | 12/13 | 29/11-4/12 | 29-Nov | 33 | FRNE | 360 | 26 | 360 | 26 | | | | | | | |
| 2-2 | New | | | | 2 | 7U.RES | 12/13 | 4/12 | 4-Dec | N3 | sFRNE | 375 | 27 | | | 375 | 27 | | | | | |
| 2↑3 | New | | | | 2 | 10I.KO | 12/13 | 4/12 | 4-Dec | 33 | fRNE | 365 | 26 | 338 | 26 | 391 | 26 | | | | | |
| 2-2 | New | | | | 2 | 10H.KB | 12/13 | 4/12 | 4-Dec | N3 | sFRNE | 454 | 27 | | | 454 | 27 | | | | | |
| 2-2 | New | | | | 2 | 7I.BCE | 12/13 | 4/12-6/12 | 5-Dec | N31 | SFRNE | 555 | 27 | | | 555 | 27 | | | | | |
| 2-2 | 2-2 | 2-2 | New | | 3 | 5K.IE | 10/11 | 10/12-25/12 | 10-Dec | NNN3N11 | CsFrNE | 351 | 25 | | | | | | | 351 | 25 | |
| 2-2 | 2-2 | 2-2 | 2-2 | 2-2 | 3 | 3H.OR | 08/09 | 5/12-30/12 | 10-Dec | 3311133-1-1 | cFSrnE | 398 | 29 | | | 418 | 30 | | | 378 | 28 | |
| 2-2 | 2-2 | 2↑3 | New | | 3 | 6U.KE | 10/11 | 29/11-20/12 | 10-Dec | NN33 | cSFRnE | 270 | 28 | | | | | 284 | 27 | 255 | 29 | |
| 2-2 | 2↑3 | New | | | 3 | 7U.RER | 11/12 | 6/12-1/12 | 10-Dec | N33 | cFRNe | 444 | 27 | | | 452 | 27 | 435 | 27 | | | |
| 2-2 | 2-2 | 2-2 | 2-2 | 2-2 | 3 | 2O.OB | 07/08 | 5/12/21/12 | 11-Dec | PBR Trial | CSFrNE | 341 | 28 | 345 | 27 | 325 | 28 | 368 | 29 | 291 | 28 | 375 |
| 2-2 | 2-2 | 2-2 | 2↑3 | 3-3 | 3 | 2O.KR | 09/10 | 5/12-30/12 | 11-Dec | 113131 | CFrRNE | 511 | 27 | | | | | | | 508 | 27 | 513 |
| 2-2 | 2-2 | 2-2 | New | | 3 | 6B.RI | 10/11 | 5/12-24/12 | 12-Dec | NN13 | CsFRNE | 461 | 26 | | | | | 520 | 25 | 401 | 27 | |
| 2-2 | 2-2 | 2-2 | 2-2 | New | 3 | 2O.OB | 10/11 | 10/12-21/12 | 11-Dec | M330313111 | CSFrnE | 347 | 28 | 345 | 27 | 312 | 27 | 339 | 30 | | | 393 |
| 2-2 | 2↑3 | 3-3 | New | | 4 | 4C.BC | 10/11 | 5/12-30/12 | 15-Dec | 333111 | SFrNE | 472 | 29 | 430 | 29 | 451 | 30 | 515 | 28 | 493 | 30 | |
| 2↑3 | 3↑4 | 4-4 | New | | 4 | 3C.BK | 10/11 | 5/12-27/12 | 15-Dec | 33(1)1N111 | csFRne | 459 | 30 | 483 | 29 | 434 | 30 | | | | | |
| 2-2 | 2-2 | 2-2 | 2-2 | 2-2 | 4 | 5C.CC | 08/09 | 16/12-30/12 | 16-Dec | NNN1N13 | CFSNE | 480 | 29 | | | | | | | 480 | 29 | |

| Cat. Change | | | | | Harvest week | Line Code | Year | Maturity range | Harvest date | Performance | Rating | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2014 | 2013 | 2012 | 2011 | 2010 | | | | | | | | Av | Av | 2014 | | 2013 | | 2012 | | 2011 | | 2010 |
| 2-2 | 2-2 | 2-2 | 2-2 | New | 4 | 6K.HR | 10/11 | 6/12-24/12 | 16-Dec | NN313 | CFSrnE | 377 | 27 | | | | | 490 | 27 | | | 263 |
| 2-2 | New | | | | 4 | 7BB.S | 12/13 | 16/12 | 16-Dec | N3 | SFRNE | 484 | 31 | | | 484 | 31 | | | | | |
| 2-2 | 2↓1 | 1-1 | 1-1 | 1-1 | 4 | 5C.OI | 08/09 | 12/12-29/12 | 19-Dec | 113/33N333 | CfSRNE | 255 | 29 | 225 | 29 | 265 | 30 | 254 | 28 | 274 | 30 | |
| 2-2 | New | | | | 4 | 2H.H | 12/13 | 5/12-30/12 | 19-Dec | 131311 | cFSrNE | 487 | 29 | 410 | 29 | 534 | 30 | | | 517 | 29 | |
| 2-2 | 2↓1 | 1-1 | 1-1 | 1-1 | 4 | 2BR.BI | 07/08 | 18/12-30/12 | 19-Dec | PBR Trial | CfSRNE | 300 | 28 | 296 | 28 | 323 | 29 | 305 | 29 | 277 | 27 | |
| 2-2 | New | | | | 4 | 2BH.O | 12/13 | 10/12-29/12 | 19-Dec | 3310111 | CSFrNE | 476 | 27 | 454 | 27 | 498 | 27 | | | | | |
| 2-2 | 2↑3 | 3-3 | 3-3 | New | 4 | 2BO.IB | 10/11 | 12/12-3/1 | 19-Dec | 1331311 | CFsRNE | 518 | 27 | 434 | 25 | 555 | 27 | 565 | 28 | | | |
| 2-2 | 2-2 | 2-2 | 2-2 | 2↑3 | 3 | 4K.KK | 09/10 | 10/12-30/12 | 20-Dec | 3330313 | CFSrnE | 410 | 28 | 380 | 29 | 391 | 29 | 458 | 27 | | | |
| 2-2 | 2-2 | New | | | 4 | 6H.OE | 11/12 | 10/12-29/12 | 20-Dec | NN31 | sfRNE | 285 | 27 | | | | | 285 | 27 | | | |
| 2-2 | 2↓1 | 1-1 | 1-1 | 1-1 | 4 | 3I.UH | 08/09 | 10/12/-30/12 | 21-Dec | 1(3)1//33131111-1 | CfSRNE | 307 | 28 | 369 | 29 | 292 | 29 | | | 261 | 27 | |
| 2-2 | 2-2 | 2-2 | New | | 5 | 6BB.OR | 10/11 | 10/12-3/1 | 23-Dec | NN131 | csfnRE | 382 | 28 | | | | | 465 | 27 | 299 | 29 | |
| 2-2 | 2-2 | New | | | 5 | 7C.REE | 11/12 | 16/12-3/1 | 24-Dec | NN30 | SFRNE | 482 | 29 | | | | | 482 | 29 | | | |
| 2-2 | 2-2 | 2-2 | New | | 5 | 5K.CC | 10/11 | 19/12-30/12 | 24-Dec | NNN3N11 | cSfRNe | 320 | 28 | | | | | | | 320 | 28 | |
| 2-2 | 2↑3 | 3↓2 | 2↓1 | 1-1 | 5 | 3I.RE | 08/09 | 16/12-29/12 | 24-Dec | 11//3311133 | CFSnE | 530 | 28 | 644 | 27 | 471 | 31 | | | 507 | 27 | 496 |
| 2-2 | 2-2 | 2-2 | 2-2 | 2-2 | 6 | 5I.REB | 09/10 | 28/12-30/12 | 29-Dec | NNN0N33 | cfSRNe | | | | | | | | | | | |
| 2-2 | 2-2 | 2-2 | 2-2 | 2-2 | 6 | 5C.OO | 08/09 | 19/12-30/12 | 29-Dec | 31//DD0N13 | cFSRNE | 454 | 29 | 477 | 27 | 430 | 31 | | | | | |
| 2-2 | 2-2 | 2-2 | New | | 6 | 5I.BR | 10/11 | 30/12-10/1 | 31-Dec | NNN3N11 | CFRNe | 473 | 25 | | | | | | | 473 | 25 | |
| 2-2 | 2-2 | 2-2 | New | | 7 | 5I.IH | 10/11 | 2/1-17/1 | 10-Jan | NNN3N11 | csFrnE | 485 | 28 | | | | | | | 485 | 28 | |
| 3-3 | New | | | | 1 | 11B.OB | 12/13 | 29/11 | 29-Nov | N3 | fRNE | | | | | | | | | | | |
| 3 New | | | | | 1 | 10I.CE | 13/14 | 29/11 | 29-Nov | N1 | | | | | | | | | | | | |
| 3 New | | | | | 1 | 10K.CI | 13/14 | 29/11-13/12 | 29-Nov | 01 | | | | | | | | | | | | |

| Cat. Change | | | | | Harvest week | Line Code | Year | Maturity range | Harvest date | Performance | Rating | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2014 | 2013 | 2012 | 2011 | 2010 | | | | | | | | Av | Av | 2014 | | 2013 | | 2012 | | 2011 | | 2010 |
| 3 New | | | | | 1 | 10K.CK | 13/14 | 29/11-13/12 | 29-Nov | 10 | | 468 | 25 | 468 | 25 | | | | | | | |
| 3 New | | | | | 1 | 10K.CO | 13/14 | 29/11 | 29-Nov | N1 | | | | | | | | | | | | |
| 3 New | | | | | 1 | 10K.BBB | 13/14 | 29/11 | 29-Nov | N1 | | | | | | | | | | | | |
| 3 New | | | | | 1 | 10O.BBC | 13/14 | 4/12 | 29-Nov | 1 | | 358 | 25 | 358 | 25 | | | | | | | |
| 3-3 | New | | | | 2 | 7K.BRE | 12/13 | 1/12-6/12 | 3-Dec | N30 | SfRNE | 331 | 29 | | | 331 | 28 | | 29 | | | |
| 3 New | | | | | 2 | 10I.KU | 13/14 | 4/12-10/12 | 4-Dec | 11 | cFE | | | | | | | | | | | |
| 3-3 | New | | | | 2 | 10C.UO | 12/13 | 4/12 | 4-Dec | N3 | sFRNE | 439 | 26 | | | 439 | 26 | | | | | |
| 3 New | | | | | 2 | 10K.HH | 13/14 | 3/12-13/12 | 4-Dec | 10 | | | | | | | | | | | | |
| 3-3 | 3-3 | 3-3 | New | | 2 | 5U.BCH | 10/11 | 4/12-8/12 | 4-Dec | NNN3NN1 | sFrNE | 226 | 28 | | | | | | | 226 | 28 | |
| 3-3 | 3-3 | 3-3 | 3↓2 | 2↑3 | 2 | 3I.KS | 08/09 | 29/11-13/12 | 4-Dec | 11N0303 | CFse | 480 | 27 | 433 | 26 | 458 | 27 | | | | | 549 |
| 3-3 | 3-3 | 3-3 | New | | 2 | 6B.O | 10/11 | 24/11-20/12 | 4-Dec | NN03 | csFrNE | 299 | 27 | | | | | | | 299 | 27 | |
| 3-3 | 3-3 | New | | | 2 | 6K.OB | 11/12 | 24/11 | 4-Dec | NN1 | sfRNE | | | | | | | | | | | |
| 3↑4 | New | | | | 3 | 11B.BRK | 12/13 | 10/12 | 5-Dec | N1 | | 437 | 26 | | | 437 | 26 | | | | | |
| 3-3 | 3-3 | 3-3 | New | | 3 | 6K.RR | 10/11 | 29/11-13/12 | 6-Dec | NN03 | SFRNE | 252 | 28 | | | | | | | 252 | 28 | |
| 3 New | | | | | 3 | 10C.KH | 13/14 | 10/12-13/12 | 10-Dec | 11 | cFsRNE | 593 | 24 | 593 | 24 | | | | | | | |
| 3 New | | | | | 3 | 10K.UE | 13/14 | 7/12-13/12 | 10-Dec | 10 | | 390 | 27 | 390 | 27 | | | | | | | |
| 3 New | | | | | 3 | 10H.IO | 13/14 | 12/12 | 10-Dec | N1 | | | | | | | | | | | | |
| 3-3 | New | | | | 3 | 11B.IK | 12/13 | 10/12 | 10-Dec | N3 | FRNE | 476 | 25 | | | 476 | 25 | | | | | |
| 3-3 | New | | | | 3 | 11I.BEI | 12/13 | 10/12 | 10-Dec | N1 | sfRNE | 378 | 27 | | | 378 | 27 | | | | | |
| 3-3 | 3-3 | 3↓2 | New | | 3 | 6R.IU | 10/11 | 29/11-20/12 | 10-Dec | NN03 | CSFnE | 287 | 27 | | | | | | | 287 | 27 | |
| 3-3 | 3-3 | 3-3 | 3-3 | 3-3 | 3 | 5B.BOH | 09/10 | 10/12-30/12 | 10-Dec | NN1N13 | SFrNE | | | | | | | | | | | |

| Cat. Change | | | | | Harvest week | Line Code | Year | Maturity range | Harvest date | Performance | Rating | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2014 | 2013 | 2012 | 2011 | 2010 | | | | | | | | Av | Av | 2014 | | 2013 | | 2012 | | 2011 | | 2010 |
| 3-3 | 3-3 | 3-3 | New | | 3 | 5U.BB | 10/11 | 20/12 | 10-Dec | NNN3 | CsfrNE | 288 | 28 | | | | | | | 288 | 28 | |
| 3-3 | 3-3 | New | | | 3 | 7K.KB | 11/12 | 1/12-15/12 | 10-Dec | N130 | sFRNE | 288 | 28 | | | | | 288 | 28 | | | |
| 3-3 | 3-3 | New | | | 3 | 7BE.BEI | 11/12 | 1/12-30/12 | 10-Dec | N111 | sFRNE | 417 | 26 | | | 417 | 26 | | | | | |
| 3-3 | 3-3 | New | | | 3 | 6.U.IR | 11/12 | 6/12-23/12 | 10-Dec | NN111 | cFRNE | | | | | | | | | | | |
| 3↑4 | New | | | | 3 | 10R.BBB | 12/13 | 10/12-17/12 | 10-Dec | 11 | FRNE | 594 | 25 | | | 594 | 25 | | | | | |
| 3-3 | 3-3 | 3-3 | New | | 3 | 5O.BBE | 10/11 | 21/12 | 11-Dec | DDD3 | cFrNE | 518 | 27 | | | | | | | 518 | 27 | |
| 3 New | | | | | 3 | 10H.BIC | 13/14 | 12/12-13/12 | 12-Dec | 31 | cFsRNE | 549 | 26 | 549 | 26 | | | | | | | |
| 3-3 | 3-3 | 3-3 | 3-3 | 3-3 | 3 | 9BI.IO | 08/09 | 12/12 | 12-Dec | DDDDDD3 | FsRNE | | | | | | | | | | | |
| 3 New | | | | | 3 | 10B.HB | 13/14 | 13/12 | 13-Dec | 1 | FE | | | | | | | | | | | |
| 3 New | | | | | 3 | 10B.BEB | 13/14 | 7/12-13/12 | 13-Dec | 10 | Fe | | | | | | | | | | | |
| 3 New | | | | | 3 | 10R.RH | 13/14 | 10/12-13/12 | 13-Dec | 11 | FE | 322 | 26 | 322 | 26 | | | | | | | |
| 3-3 | 3-3 | 3-3 | 3-3 | 3-3 | 3 | 3I.KH | 08/09 | 5/12-24/12 | 13-Dec | N1/N3101N3-1-11 | CFSrnE | 358 | 29 | | | 387 | 29 | 328 | 29 | | | |
| 3-3 | 3-3 | 3↑4 | 4↓3 | New | 4 | 6U.RK | 10/11 | 6/12-20/12 | 14-Dec | NN303 | cFSrNE | 317 | 26 | | | | | 362 | 26 | | | 271 |
| 3-3 | 3-3 | 3-3 | New | | 4 | 6R.O | 10/11 | 6/12-24/12 | 15-Dec | NN13 | FsRNE | 504 | 27 | | | | | 574 | 26 | 433 | 28 | |
| 3 New | | | | | 4 | 10C.OE | 13/14 | 16/12-17/12 | 16-Dec | 11 | CfsRNE | | | 237 | 27 | | | | | | | |
| 3-3 | New | | | | 4 | 10C.OO | 12/13 | 16/12-20/12 | 16-Dec | 13 | csfRNE | 288 | 25 | 286 | 24 | 289 | 26 | | | | | |
| 3-3 | New | | | | 4 | 7I.BHK | 12/13 | 16/12 | 16-Dec | N3 | sFRNE | 513 | 27 | | | 513 | 27 | | | | | |
| 3-3 | New | | | | 4 | 11I.BEB | 12/13 | 16/12 | 16-Dec | N3 | sfRNE | 333 | 28 | | | 333 | 28 | | | | | |
| 3-3 | 3-3 | 3-3 | 3-3 | 3-3 | 4 | 3I.CB | 08/09 | >13/12 | 16-Dec | N1/DDDDDD3 | CSfRNe | | | | | | | | | | | |
| 3-3 | 3-3 | New | | | 4 | 6C.RE | 11/12 | 6/12-23/12 | 16-Dec | NN11 | CFRnE | | | | | | | | | | | |
| 3-3 | 3-3 | New | | | 4 | 6BB.U | 11/12 | 6/12-3/1 | 16-Dec | NN111 | SFRNE | | | | | | | | | | | |

| Cat. Change | | | | | Harvest week | Line Code | Year | Maturity range | Harvest date | Performance | Rating | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2014 | 2013 | 2012 | 2011 | 2010 | | | | | | | | Av | Av | 2014 | | 2013 | | 2012 | | 2011 | | 2010 |
| 3 New | | | | | 4 | 10B.IO | 13/14 | 16/12 | 16-Dec | 1 | SF | | | | | | | | | | | |
| 3 New | | | | | 4 | 10I.IR | 13/14 | 16/12-17/12 | 16-Dec | 11 | FE | 232 | 24 | 232 | 24 | | | | | | | |
| 3 New | | | | | 4 | 10H.SR | 13/14 | 17/12 | 17-Dec | 1 | | 481 | 24 | 481 | 24 | | | | | | | |
| 3-3 | 3-3 | 3-3 | New | | 4 | 5B.UH | 10/11 | 17/12-23/12 | 17-Dec | NNN1NN1 | FSRNE | 438 | 31 | | | | | | | 438 | 31 | |
| 3-3 | 3-3 | 3-3 | New | | 4 | 5B.SK | 10/11 | 17/12-20/12 | 17-Dec | NNN1N1 | FSRNE | | | | | | | | | | | |
| 3-3 | 3-3 | 3-3 | 3-3 | 3-3 | 4 | 9BE.CE | 09/10 | 17/12-19/12 | 17-Dec | 1//DDNNN03 | cFSRNe | 488 | 27 | 488 | 27 | | | | | | | |
| 3-3 | New | | | | 4 | 7U.UI | 12/13 | 17/12-21/12 | 19-Dec | N11 | cSFRNe | 423 | 29 | | | 423 | 29 | | | | | |
| 3-3 | New | | | | 4 | 2BO.CO | 12/13 | 10/12-30/12 | 20-Dec | N101 | CsFrnE | 556 | 29 | | | 556 | 29 | | | | | |
| 3-3 | 3-3 | 3-3 | 3-3 | 3-3 | 4 | 9BB.IU | 07/08 | 12/12-26/12 | 20-Dec | N1//DDDNN011-1 | fSRNE | 328 | 31 | | | 328 | 31 | | | | | |
| 3-3 | 3-3 | 3-3 | New | | 4 | 6K.SR | 10/11 | 6/12-3/1 | 20-Dec | NN03 | sFRNe | 399 | 27 | | | | | 419 | 26 | 378 | 27 | |
| 3-3 | New | | | | 4 | 11R.BEH | 12/13 | 21/12 | 21-Dec | N3 | csFRNE | 403 | 27 | | | 403 | 27 | | | | | |
| 3-3 | 3-3 | 3-3 | New | | 5 | 5U.BHU | 10/11 | 22/12-23/12 | 22-Dec | NNN1N1 | SFRNE | | | | | | | | | | | |
| 3-3 | 3-3 | 3-3 | 3-3 | 3-3 | 5 | 9BR.IC | 07/08 | 22/12-30/12 | 22-Dec | 11/DDDNN01-N1 | fSRe | 355 | 29 | 382 | 29 | 327 | 30 | | | | | |
| 3-3 | 3-3 | New | | | 5 | 6I.CO | 11/12 | 12/12-29/12 | 22-Dec | NN11 | sRNe | | | | | | | | | | | |
| 3-3 | 3↑4 | 4-4 | 4↑5 | 5↓3 | 5 | 3R.BS | 07/08 | 10/12-30/12 | 22-Dec | N3/33(1)111011-11 | cfSRne | 372 | 28 | 335 | 28 | 349 | 28 | 400 | 28 | 403 | 28 | |
| 3-3 | 3-3 | 3-3 | New | | 5 | 5B.BEE | 10/11 | 24/12-30/12 | 24-Dec | DDD1N01 | SFRnE | 439 | 30 | | | | | | | 439 | 30 | |
| 3-3 | 3-3 | 3-3 | 3↑4 | 4-4 | 5 | 5I.BEB | 09/10 | 24/12-30/12 | 24-Dec | NNN1N13 | CSFrnE | | | | | | | | | | | |
| 3-3 | 3-3 | 3-3 | 3↓2 | 2-2 | 5 | 3U.II | 09/10 | 16/12-30/12 | 24-Dec | 330133 | SFnE | 420 | 29 | 426 | 29 | 376 | 29 | 458 | 29 | | | |
| 3-3 | 3-3 | 3-3 | New | | 5 | 6H.SH | 10/11 | 16/12-3/1 | 25-Dec | NN13 | sFRNE | 412 | 27 | | | | | 387 | 26 | 436 | 28 | |
| 3-3 | 3-3 | 3-3 | 3↑4 | 4↓3 | 5 | 4K.IS | 09/10 | 16/12-31/12 | 25-Dec | N1//131313 | CFsRnE | 432 | 28 | 318 | 28 | 467 | 29 | 513 | 28 | 429 | 27 | |
| 3-3 | 3-3 | 3↓2 | 2-2 | 2↑3 | 6 | 3C.HC | 09/10 | 21/12-10/1 | 29-Dec | 1//3(1)3(1)0313 | CFsnE | 675 | 28 | 802 | 27 | 620 | 30 | | | 664 | 26 | 614 |

| Cat. Change | | | | | Harvest week | Line Code | Year | Maturity range | Harvest date | Performance | Rating | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness | Size | Firmness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2014 | 2013 | 2012 | 2011 | 2010 | | | | | | | | Av | Av | 2014 | | 2013 | | 2012 | | 2011 | | 2010 |
| 3-3 | 3-3 | 3-3 | 3-3 | 3-3 | 6 | 5I.OR | 09/10 | 29/12 | 29-Dec | DSSSS3 | cFRNe | | | | | | | | | | | |
| 3-3 | 3-3 | 3-3 | 3↓2 | 2-2 | 6 | 5U.BBC | 09/10 | 29/12-4/1 | 29-Dec | NNN3N3 | fSRNe | 301 | 31 | | | | | | | 301 | 31 | |
| 3↑4 | New | | | | 6 | 2BH.BI | 12/13 | 22/12-10/1 | 1-Jan | 13N0111 | CFRNE | 544 | 26 | 698 | 25 | 390 | 26 | | | | | |
| 3-3 | 3-3 | 3-3 | New | | 7 | 5U.BBU | 10/11 | 5/1-10/1 | 5-Jan | NNN3N1 | CFRNe | 411 | 26 | | | | | | | 411 | 26 | |
| 3 New | | | | | 7 | 10O.BCC | 13/14 | 15/1 | 15-Jan | 1 | | | | | | | | | | | | |
| 4-4 | 4-4 | 4-4 | 4↓3 | 3-3 | 3 | 3R.BI | 08/09 | 5/12-20/12 | 8-Dec | N1/11013111111 | FSE | 402 | 30 | | | 378 | 31 | | | 372 | 30 | 455 |
| 4-4 | 4↓2 | 2-2 | 2-2 | New | 4 | 4I.KO | 10/11 | 5/12-24-12 | 17-Dec | 1111311 | CsFRnE | 635 | 26 | 529 | 25 | 633 | 26 | 638 | 27 | 601 | 25 | 775 |
| 4-4 | 4-4 | 4-4 | 4-4 | 4-4 | 4 | 8H.BI | 07/08 | 17/12 | 17-Dec | DDDDDD1 | | | | | | | | | | | | |
| 4-4 | 4-4 | 4-4 | New | | 4 | 2BI.CC | 10/11 | 19/12-13/1 | 20-Dec | M0N1000 | CfRNe | | | | | | | | | | | |
| 4-4 | 4-4 | 4-4 | 4-4 | 4-4 | 5 | 8K.BO | 07/08 | 22/12 | 22-Dec | DDDDDD1 | | | | | | | | | | | | |
| 4-4 | 4-4 | 4-4 | 4-4 | 4-4 | 5 | 8C.BK | 07/08 | 24/12 | 24-Dec | DDDDDD1 | | | | | | | | | | | | |
| 4-4 | 4-4 | 4-4 | 4-4 | 4-4 | 5 | 9O.RR | 08/09 | 20/12-24/12 | 24-Dec | DDDDDD11 | cfSRNE | | | | | | | | | | | |
| 4-4 | 4-4 | 4-4 | 4-4 | 4-4 | 5 | 8BE.BK | 07/08 | 26/12 | 26-Dec | DDDDDD1 | | | | | | | | | | | | |
| 4-4 | 4-4 | 4-4 | 4-4 | 4-4 | 5 | 8C.IU | 07/08 | 26/12 | 26-Dec | DDDDDD1 | | | | | | | | | | | | |
| 4-4 | 4-4 | 4-4 | 4-4 | 4-4 | 5 | 9BC.CK | 07/08 | 26/12-30/12 | 26-Dec | DDDDDD1--1 | | | | | | | | | | | | |
| 4-4 | 4-4 | 4-4 | New | | 8 | 5I.B | 10/11 | 7/1-24/1 | 12-Jan | DDD1N11 | FRNe | | | | | | | | | | | |
| 4-4 | 4-4 | 4-4 | New | | 9 | 5U.BOK | 10/11 | 24/1 | 24-Jan | DNN1 | sFRne | 449 | 27 | | | | | | | 449 | 27 | |

## Table legend

**Cat. Change**- Category to which it is assigned in a given year and movement from its previous season (e.g. 1-1 denotes Category 1 this season unchanged from Category 1 last season, 1↑2 denotes Category 1 this season promoted from Category 2 the previous season).

**Wk**- Typical harvest season at Lenswood broken into 7 weeks to indicate more clearly spread of timings over the harvest season, Week1 (24 November to 30 November), Week 2 (1 December to 7 November), Week 3 (8 December-14 December), Week 4 (15 December-21 December), Week 5 (22 December-28 December), Week 6 (29 December to 4 January), Week 7(5 January to11 January).

**Line**- Coded line numbers for protection of intellectual property.

**Year**- Harvest season the line was first characterised.

**Maturity**- Range of maturity data recorded at Lenswood Research Centre.

**Harvest**- Estimated date of maturity for a typical season at Lenswood Research Centre.

**Rating**- Quick reference listing of a seedling lines performance for all seasons it has been assessed (from left to right). 3 = Excellent (graft for further evaluation), 1 = OK to average (retain for further assessment) 0 = Poor (consider removal), N = No fruit (no assessment), - = No Assessment recorded, R = Tree removed, D = Tree Died, PBR Trial = Line is included in a separate replicated trial on rootstock and the seedling tree is no longer the primary means of assessment. Data for PBR trial trees is presented in the "Secondary Trial section".

**Attributes**- A quick reference guide to the attributes displayed by a line. Upper case indicates it is excellent for that character, lower case indicates it is marginal for that character, missing indicates it is deficient in that character. C = cropping ability is moderately heavy or higher, c = cropping ability is light moderate to moderate; F = firmness is firm or very firm, f = intermediate; S = size where average fruit weight is 9.5g or more, s = average fruit weight >8.5gm but less than <9.5g; R = ring cracking and side splitting is less than 10%, r = cracking is generally less than 20%; N = nose or apical cracking is less than 10%, n = nose cracking is generally less than 20%; E = eating experience is generally rated as good or very good, e = eating experience is generally rated as fair.

**Fm**- A pooled average of years and annual average firmness measurement for a random sample in that season using a Firmtech 2 apparatus. Readings expressed as force in grams per square centimetre ($gcm^{-2}$)

**Sz**- A pooled average of years and average fruit size expressed as a diameter in millimetres (mm) measured by the Firmtech 2 apparatus.

**Table 9: Category 1 to 4 lines general breeder comments**

| Line Code | Category | Breeders Comment |
|---|---|---|
| 2O.IO | 1 | Early, Large with very little cracking |
| 4I.KI | 1 | Early and good cropping but softish with intense (tangy) taste, excellent long but robust stems, taste less acidic in 2013. |
| 3C.B | 1 | Very large and very firm, crops well. Sub acid, can be picked at fire engine red or over the next 3 weeks and still have firmness, will nose crack, kidney shaped cherry that hangs very well on the tree |
| 2B.BK | 1 | Tough seedling tree, very firm, can nose crack a bit, size marginal, thin stems |
| 1H.RE | 1 | Excellent firmness, good crop and size, nose cracked in 2011 and 2012 |
| 3I.R | 1 | Large, very firm and crunchy with very low cracking. Cropping levels are reasonable |
| 7BE.BBR | 1 | Very firm and crunchy with good stems, like Kordia, crops are improving, a very nice cherry |
| 4O.CK | 1 | Cracked only minorly in the past, very firm, short stems |
| 7C.BSK | 1 | Large and firm, long but very robust stems, was noticeably acidic in 2013 not so before this |
| 3U.HU | 1 | Good crops, large, very firm, has never recorded a crack in assessment samples from the seedling tree, stores well, flavour slightly acidic 2013 |
| 5I.HR | 1 | Seedling is in poor health, most samples show slightly small fruit size but are firm, showing some slight nose cracking |
| 3R.RS | 1 | Good late maturing , high cropping line, very firm and very little cracking seen, probably only a medium cherry though, early indications on rootstock look good |
| 5C.KE | 1 | Late maturing, firmness is main issue and will ring crack with long stems |
| 4C.KC | 2 | Early white, watch size and firmness, no cracking, Seedling has died |
| 10R.IK | 2 | Early and super firm with good stems but size might be a problem |
| 7U.RES | 2 | Good early white |
| 10I.KO | 2 | Good looking, shape, firmness and taste, watch size |
| 10H.KB | 2 | Firm with large size |
| 7I.BCE | 2 | Good flavour and very firm with large size, needs crop |
| 5K.IE | 2 | Big crops, little cracking, watch size it appears moderate on seedling |
| 3H.OR | 2 | Large and only low levels of cracking, moderate but biennial cropper, watch firmness |
| 6U.KE | 2 | Large and firm but some nose cracking and tangy acidic taste |
| 7U.RER | 2 | Firm heavily blushed white, good crop, some size and firmness but no cracking, does achieve high TSS levels. |

| Line Code | Category | Breeders Comment |
|---|---|---|
| 2O.OB | 2 | Early maturing with good crops of large shiny fruit, some cracking at times, good stems but firmness only moderate, was a standout in 2012. Should be considered for "home garden" if not commercial |
| 2O.KR | 2 | Super firm but moderate size, cropping keeps improving, birds love it so must taste good |
| 6B.RI | 2 | Low acidity only minor cracking, firm but watch size |
| 2O.OB | 2 | Large and crops well but will crack and firmness only moderate, has a tough skin. This is the original seedling of 2O.OB, also assessed in PBR Trial on Mazzard rootstock and performs very similarly |
| 4C.BC | 2 | White cherry, has large size and super firmness but needs crop |
| 3C.BK | 2 | Firm with reasonable crops and capable of good size, shown very little cracking , has short stems but taste can be a bit acidic |
| 5C.CC | 2 | Large size and crops well but did crack 30% in 2011 |
| 6K.HR | 2 | Some cracking on light crop 2011 otherwise very little seen |
| 7BB.S | 2 | Huge size and very firm but needs more crop. Try a precocious rootstock |
| 5C.OI | 2 | Genetics: Large size and no cracking but soft on Mazzard //Very large with no cracking ever, reddish colour, long robust stems but looks too soft. Probably going to be downgraded |
| 2H.H | 2 | Heart shaped and very attractive, large and very firm, little cracking, watch crops, long thin stems its only real detraction |
| 2BR.BI | 2 | Good crops of large fruit and little or no cracking but firmness may be an issue |
| 2BH.O | 2 | Genetics: Good crops on small stressed tree (lacks water and fertility), medium but very firm fruit and less than 5% cracking to date |
| 2BO.IB | 2 | Watch size, good crops and very firm with less than 10% cracking, capable of huge crops but size seems medium, lacked water and nutrition in 2014 |
| 4K.KK | 2 | Huge crop in 2011 and some cracking, crops a bit low, fruit can be very large, long but robust stems |
| 6H.OE | 2 | No cracking, Needs a bit more crop and firmness, excellent taste and very high TSS |
| 3I.UH | 2 | Genetics: small tree, very little cracking, good crops of very large fruit but softness is an issue. On Wieroot stock may be larger and firmer |
| 6BB.OR | 2 | Only minor cracking but watch firmness and size |
| 7C.REE | 2 | Large and very firm, well balanced flavour, Seedling was cut-off and removed by mistake |
| 5K.CC | 2 | Large and shown little cracking but needs crop |
| 3I.RE | 2 | Ring cracking in 2010 and 2011, very firm, crops light to moderate, seedling performance was excellent in 2013 and 2014 |
| 5I.REB | 2 | Diseased tree needs evaluation on rootstock to make determinations |
| 5C.OO | 2 | Large and firm with no cracking in early indications on Mazzard //Seedling died but was looking large and firm |
| 5I.BR | 2 | Very firm, watch size |
| 5I.IH | 2 | Some cracking but late maturing and firm |

| Line Code | Category | Breeders Comment |
|---|---|---|
| 11B.OB | 3 | Early maturing and firm but needs crop and size |
| 10I.CE | 3 | Rescue and check on rootstock. Early maturing |
| 10K.CI | 3 | Rescue and check on rootstock. Early maturing |
| 10K.CK | 3 | Rescue and check on rootstock. Early maturing |
| 10K.CO | 3 | Rescue and check on rootstock. Early maturing |
| 10K.BBB | 3 | Rescue and check on rootstock. Early maturing |
| 10O.BBC | 3 | Rescue and check on rootstock. Early maturing |
| 7K.BRE | 3 | Large, firm white, early maturing but needs crop |
| 10I.KU | 3 | Rescue and check on rootstock. Early maturing |
| 10C.UO | 3 | Needs more crop but firm and tastes great |
| 10K.HH | 3 | Rescue and check on rootstock. Early maturing |
| 5U.BCH | 3 | Handles rain without cracking, watch size and cropping |
| 3I.KS | 3 | Super firm, and crops well, fully blushed white, sweet with tangy finish and a small stone, size is an issue and has nose cracked before |
| 6B.O | 3 | Late harvested sample did ring crack, very firm, watch size |
| 6K.OB | 3 | Excellent flavour, Ok size and no rain cracking but watch crop and firmness |
| 11B.BRK | 3 | Firm but needs crop and size |
| 6K.RR | 3 | Large and firm but needs crop |
| 10C.KH | 3 | Rescue and check on rootstock. Early maturing |
| 10K.UE | 3 | Rescue and check on rootstock. Early maturing |
| 10H.IO | 3 | Rescue and check on rootstock. Early maturing |
| 11B.IK | 3 | Low acid and firm, needs crop |
| 11I.BEI | 3 | Some firmness and size but needs crop |
| 6R.IU | 3 | Has cropped well in the past and is firm but nose cracked one season and ring cracked the next. Checking for a repeat |
| 5B.BOH | 3 | Big but needs crop, seedling has been cut-off by mistake |
| 5U.BB | 3 | Watch cracking |
| 7K.KB | 3 | Little cracking with some size and firmness |
| 7BE.BEI | 3 | Firm, good stems and balanced flavour, needs a bit more crop and size |

| Line Code | Category | Breeders Comment |
|---|---|---|
| 6.U.IR | 3 | Very firm  with good flavour and little cracking watch size |
| 10R.BBB | 3 | Super firm but watch size |
| 5O.BBE | 3 | Very firm, little cracking, marginal size, seedling has died |
| 10H.BIC | 3 | Rescue and check, has firmness and good fruit quality |
| 9BI.IO | 3 | Poor crops could be an issue, seedling tree unusable |
| 10B.HB | 3 | Rescue and check, has firmness and good fruit quality |
| 10B.BEB | 3 | Rescue and check, has firmness and good fruit quality |
| 10R.RH | 3 | Rescue and check, has firmness and good fruit quality |
| 3I.KH | 3 | Very small tree, large firm fruit but can nose crack |
| 6U.RK | 3 | Good crop may need size, some slight cracking, thin stems |
| 6R.O | 3 | Firm with good stems but needs crop |
| 10C.OE | 3 | Rescue and check, has firmness and good fruit quality |
| 10C.OO | 3 | Quite nice but has a n exaggerated suture crack which gives it an interesting shape |
| 7I.BHK | 3 | Very firm and nice tasting, watch size and crop |
| 11I.BEB | 3 | Good size and some firmness |
| 3I.CB | 3 | Seedling died, seems large and firm |
| 6C.RE | 3 | Very firm, can get good size and crop but watch nose cracking |
| 6BB.U | 3 | Most characters are good just needs cropping and watch nose cracking |
| 10B.IO | 3 | Rescue and check, has firmness and good fruit quality |
| 10I.IR | 3 | Rescue and check, has firmness and good fruit quality |
| 10H.SR | 3 | Rescue and check, has firmness and good fruit quality |
| 5B.UH | 3 | Large, no cracking |
| 5B.SK | 3 | Large, no cracking |
| 9BE.CE | 3 | Watch crop and size, very firm, seedling tree in abandoned block, last chance |
| 7U.UI | 3 | Large and firm, watch angular appearance and tartness |
| 2BO.CO | 3 | Very small tree, super firm, size and crops appear OK and very little cracking |
| 9BB.IU | 3 | Huge fruit with excellent stems but softish with some nose cracking and watery acidic taste, has one last chance |

| Line Code | Category | Breeders Comment |
|---|---|---|
| 6K.SR | 3 | Firm with little cracking but size and taste marginal, variable on tree 2012, unsure of rootstock |
| 11R.BEH | 3 | Very nice, firm but with thin stems |
| 5U.BHU | 3 | White Cherry, large and firm but watch cropping |
| 9BR.IC | 3 | Poor crops and nose cracks on seedling, firmness only Ok and looks like it may nose crack on stocks but not seen as yet, one last chance |
| 6I.CO | 3 | Firm with moderate size and no rain cracking damage |
| 3R.BS | 3 | Has shown marginal cropping and sometimes firmness with some slight cracking, good on stocks GM79 2013 (M,422, 28.9mm) |
| 5B.BEE | 3 | Large, needs crop, some nose cracks, seedling has died |
| 5I.BEB | 3 | Large but only cracks minorly |
| 3U.II | 3 | Large and firm with average crops, can rain crack, 30% cracking in 2011 |
| 6H.SH | 3 | Very firm, good fruit and no cracking but long strong stems |
| 4K.IS | 3 | Minor nose cracking, very long stems a problem but no worse than Kordia, Ok firmness and crop |
| 3C.HC | 3 | Later maturing, super firm but modest size, cracked badly in 2012 on light crop. Genetics for firmness if nothing else |
| 5I.OR | 3 | Ok with nice stems, became of dubious health in 2010 so seedling isn't usable |
| 5U.BBC | 3 | Big, watch firmness and cracking |
| 2BH.BI | 3 | Genetics: Good crops on small under watered and nourished tree, fruit appears small but ultra-firm fruit and no cracking to date |
| 5U.BBU | 3 | No cracking but marginal size |
| 10O.BCC | 3 | Rescue and check, very late maturing, genetics for lateness |
| 3R.BI | 4 | Huge early cherry with poor crops, team with precocious stock Giesla 6?, will rain crack. Early and has good size size |
| 4I.KO | 4 | Genetics: Little cracking and ultra-firm, but size is too small |
| 8H.BI | 4 | Rescue from patch transfer, seedling died |
| 2BI.CC | 4 | Genetics, Columnar spur type habit, very little cracking but fruit is a bit sour with thin stems, small and soft |
| 8K.BO | 4 | Rescue from patch transfer, seedling died |
| 8C.BK | 4 | Rescue from patch transfer, seedling died |
| 9O.RR | 4 | Watch crop, seedling died |
| 8BE.BK | 4 | Rescue from patch transfer, seedling died |
| 8C.IU | 4 | Rescue from patch transfer, seedling died |
| 9BC.CK | 4 | Genetics. Very large, seedling died |

| Line Code | Category | Breeders Comment |
|---|---|---|
| 5I.B | 4 | Genetics-Late maturity, seedling cut off |
| 5U.BOK | 4 | Genetics-Late maturity |

Tables 7 and 8 detail the current categorisation of all remaining selections from the breeding program based on 2014 and previous results. Highlighted in blue are "white" or "blushed" selections to distinguish them from the dark cherry selections.

**Table 10: Summary of characterised downgraded removals by year**

| Category | 2012 | 2013 | 2014 |
|---|---|---|---|
| 5↓2 | 6 | 3 | 3 |
| 5↓3 | 10 | 14 | 6 |
| 5↓4 | 6 | 12 | 0 |
| **Total** | **22** | **29** | **9** |

Results of reviewed lines categorised to be "Removed" or "Category 5" appear in Table 9. Since 2012 the category system has been tightened to effectively contain 3 levels of lines being evaluated for commercial potential and category 4 which has transformed into a small number lines displaying a "genetic character" that may be important for breeding but unlikely to be of commercial value. This category has greatly reduced in size as lines with similar characters but greater overall potential are identified and the single character lines are judged to be obsolete. These lines are removed in winter each season to focus on lines with the greatest potential.

Evaluation trials

The following results are from a stand-alone static evaluation trial (PBR2) which originally comprised 26 early generation advanced breeding lines, the released varieties Sir Hans, Sir Douglas and Dame Nancy and the comparator variety Stella on the industry standard rootstock Mazzard F12/1. This trial was planted in 2002 on the Lenswood Research Centre and is trained using the "Lenswood tie-down system" as a randomised design of six replicates (or trees). Each season the individual trees have their entire crop level assessed and weighed with a subsample assessed according to standard breeding program assessment protocols for quality parameters. Accumulated results across several years allow categorisation of lines and determination of appropriate action. Poorly performing lines have been removed at the end of each season as acquired data permitted.

**Table 11: PBR2 Trial line performance averages 2012-2014**

| Line | Date | Shape | Crop | Firmness | Av. Wt | >25mm | Crack Total | CrackCr | CrackRg | Nose Cr | Av.TSS | Sweet | Acid | EatQ | St Len | St Th | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sir Douglas | 5/12/2011 | K | 5.0 | 3.0 | 9.7 | 95 | 17.0 | 0.0 | 17.0 | 3.0 | 20.0 | 3.0 | 2.0 | 3.0 | 2.6 | 2.0 | Better crops than Stella for bigger average size, less cracking and better eating quality |
| | 12/12/12 | K | 2.2 | 2.8 | 10.3 | 100 | 0.8 | 0.8 | 0.0 | 0.0 | 20.8 | 2.6 | 2.8 | 2.6 | 2.0 | 1.4 | Low crop, good firmness and size, low cracking |
| | 17/12/2013 | K | 2.8 | 3.0 | 9.2 | 96 | 1.0 | 0.0 | 1.0 | 0.0 | 22.0 | 2.6 | 2.6 | 2.6 | 2.0 | 1.2 | Good size and firm with little rain damage on a lower crop |
| 2BR.BI | 10/12/2011 | K | 3.8 | 2.0 | 9.7 | 99 | 0.0 | 0.0 | 0.0 | 0.8 | 20.8 | 2.8 | 2.8 | 2.3 | 3.0 | 2.2 | Good stems, OK crops and size and almost no rain cracking, intermediate firmness only issue |
| | 17/12/12 | K | 4.3 | 1.7 | 10.8 | 100 | 0.6 | 0.0 | 0.6 | 0.5 | 21.3 | 2.3 | 2.8 | 2.7 | 2.8 | 1.8 | Ok crop, moderate firmness, good size, low cracking and nose cracking |
| | 23/12/2013 | K | 2.8 | 2.0 | 8.8 | 96 | 0.0 | 0.0 | 0.0 | 0.0 | 24.2 | 3.0 | 2.5 | 2.8 | 3.0 | 1.7 | Ok size and firm with no rain damage on a lower crop |
| 2BH.BO | 10/12/2011 | K | 1.7 | 1.7 | 10.6 | 100 | 2.5 | 1.7 | 0.8 | 8.3 | 22.5 | 3.0 | 2.7 | 3.0 | 2.2 | 2.0 | Poor crops and firmness with up to 20% nose cracking, size is good |
| | 21/12/12 | K | 1.8 | 1.2 | 11.3 | 99 | 0.0 | 0.0 | 0.0 | 0.0 | 20.7 | 2.7 | 2.0 | 2.2 | 3.0 | 2.0 | Poor crop and firmness, very large size, no cracking |
| 2BO.RO | 5/12/2011 | K | 2.2 | 2.2 | 10.8 | 98 | 3.3 | 1.7 | 1.7 | 27.5 | 17.5 | 2.2 | 1.8 | 2.0 | 2.0 | 2.7 | Poor crops and firmness with too many cracks |
| | 17/12/12 | K | 3.3 | 1.2 | 12.0 | 99 | 0.0 | 0.0 | 0.0 | 0.0 | 19.3 | 2.0 | 2.8 | 2.0 | 2.8 | 2.0 | Light moderate crop, poor firmness, very large size, no cracking |
| 2I.K | 5/12/2011 | K | 6.0 | 2.2 | 8.1 | 80 | 5.8 | 0.8 | 5.0 | 8.3 | 18.8 | 2.3 | 2.2 | 2.8 | 1.3 | 1.3 | Good crop and eating quality, some cracking with ordinary firmness and size |
| | 10/12/12 | K | 6.3 | 1.5 | 9.3 | 94 | 1.7 | 0.0 | 1.7 | 4.4 | 20.3 | 2.5 | 2.5 | 2.7 | 1.8 | 1.5 | Good crop, moderate size and firmness, low cracking and moderate nose cracking |
| | 10/12/2013 | K | 2.7 | 2.5 | 8.6 | 86 | 2.5 | 0.0 | 2.5 | 2.5 | 22.3 | 2.5 | 2.7 | 2.7 | 2.0 | 1.0 | Ok size, ok firmness with only minor cracking on a lower crop |
| 2O.OB | 5/12/2011 | C | 3.2 | 2.8 | 10.1 | 99 | 5.0 | 0.0 | 5.0 | 0.0 | 19.5 | 2.5 | 1.8 | 2.8 | 2.8 | 3.0 | Big shiny and firm with good stems and low cracking levels |
| | 12/12/12 | C | 4.8 | 2.3 | 10.0 | 97 | 0.6 | 0.0 | 0.6 | 0.0 | 20.5 | 2.5 | 2.2 | 2.7 | 2.3 | 2.2 | Ok crop, moderate firmness and size, low cracking and no nose cracking |
| | 13/12/2014 | C | 3.2 | 3.0 | 9.1 | 92 | 3.1 | 0.0 | 3.1 | 0.0 | 21.2 | 2.5 | 2.7 | 2.3 | 2.0 | 1.8 | Good firmness and size with some minor rain cracking on lower crop |

| Line | Date | Shape | Crop | Firmness | Av. Wt | >25mm | Crack Total | CrackCr | CrackRg | Nose Cr | Av.TSS | Sweet | Acid | EatQ | St Len | St Th | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1H.RE | 5/12/2011 | K | 4.0 | 3.0 | 10.0 | 99 | 0.0 | 0.0 | 0.0 | 34.0 | 18.1 | 2.8 | 1.2 | 2.8 | 2.0 | 2.4 | Similar crop and nose cracking to Stella but larger with no ring cracking and better eating quality |
| | 12/12/12 | K | 4.2 | 3.0 | 11.0 | 100 | 0.8 | 0.8 | 0.0 | 1.6 | 18.8 | 2.4 | 1.4 | 3.2 | 2.0 | 2.8 | Ok crop, good firmness and size, low cracking and nose cracking |
| | 13/12/2013 | K | 1.4 | 3.8 | 10.4 | 100 | 0.0 | 0.0 | 0.0 | 0.0 | 19.4 | 2.4 | 1.0 | 3.0 | 2.2 | 2.8 | Very large and firm and no cracking but crop poor |
| STELLA | 5/12/2011 | C | 3.8 | 3.0 | 9.3 | 98 | 12.5 | 3.8 | 8.8 | 35.0 | 19.8 | 2.5 | 2.0 | 2.0 | 2.3 | 1.8 | Bland flavour too many cracks both ring and nose |
| | 12/12/12 | C | 5.0 | 2.5 | 10.2 | 100 | 2.0 | 0.7 | 1.3 | 9.3 | 19.8 | 2.2 | 2.2 | 2.3 | 2.2 | 1.7 | Good crop, moderate firmness and size, low cracking and moderate nose cracking |
| | 17/12/2013 | C | 4.8 | 3.0 | 9.9 | 100 | 3.3 | 2.5 | 0.8 | 5.8 | 21.3 | 2.2 | 2.2 | 2.2 | 2.2 | 1.8 | Good crop, firmness and size but still some minor rain cracking |

**Table Legend**
**Line**- Coded line number for IP protection; **Date**- Harvest date; **Shape** (K=kidney, C=cordate); **Crop** (1=Very Light, 2=Light, 3=Light Moderate, 4=Moderate, 5=Moderate Heavy, 6=Heavy, 7=Very Heavy); **Firmness** (1=Soft, 2=Intermediate, 3=Firm, 4=Very Firm); **Av. Wt**- Average fruit (grams); **>25mm**- % fruit above 25mm in diameter; **Crack Total**- % total rain cracked fruit (sum CrackCr and CrackRg); **CrackCr**- % split or side cracked fruit; **CrackRg**- % stem end circular cracked fruit; **Nose Cr**- % apically cracked or open stylar scar cracked fruit; **TSS**- Total soluble solids ($^{o}$Brix); **Sweet**- Sweetness taste (1=Low, 2=Medium, 3=High); **Acid**- Acidity taste (1=Low, 2=Medium, 3=High); **EatQ**- Eating quality (1=Poor, 2=Fair, 3=Good, 4=Very Good); **St Length**- Stem length (1=Short, 2=Medium, 3=Long); **St Th**- Stem thickness (1=Thin, 2=Medium, 3=Thick); **Comment**- Breeders comment for the seasons overall performance. Substandard performance/removal recommendation.

The summary data in Table 11 details averages for remaining lines in the PBR2 evaluation trial during the 2012 to 2014 seasons. This data is typical of the type gathered annually to support downstream decision making.

## Table 12: Breeding program variety germplasm to be preserved

| Line | Comment |
|---|---|
| Bing | Comparator, collection (world standard) |
| Black Douglas | Parental line |
| Blackstar | Comparator, collection (mid-season genetics and fruit quality) |
| Burgsdorf | Parental line, Collection (comparator but little breeding value) |
| Compact Stella | Collection |
| Dame Nancy | Program Release ( no breeding value) |
| Dame Roma | Program Release |
| Earlise | Comparator & collection (early season genetics) |
| English Morello | Collection, Sour cherry type |
| Hidelfingen | Collection, UPOV Comparator (no breeding value) |
| JI2420 | Collection (Stella's parental line) |
| Kordia | Comparator, collection (world standard) |
| Lambert | Parental line, Collection, UPOV Comparator (no breeding value) |
| Lapins | Comparator & parental line |
| Merchant | Comparator & parental line |
| Merton Crane | Collection, UPOV Comparator (no breeding value) |
| Merton Glory | Collection, UPOV Comparator (no breeding value) |
| Nordwunder | Collection |
| PC7614.2 | Collection |
| Rainier | Collection |
| Rons Seedling | Parental line, comparator, collection (early season genetics) |
| Sam | Parental line and collection (tolerance to rain cracking) |
| Shcniders | Collection |
| Simone | Comparator & collection (fruit quality) |
| Sir Don | Program Release |
| Sir Douglas | Program Release |
| Sir Hans | Program Release (no breeding value). Could have "home garden" potential |
| Sir Tom | Program Release |
| Sovereign | Collection (late season genetics) |
| SPC136 | Collection (fruit quality) |
| Spur Lambert | Collection, UPOV Comparator ( no breeding value) |
| Stella | Comparator |
| Staccato | Competitor & collection (late season genetics) |
| Sue | Parental line |
| Sunburst | Comparator, parental line and UPOV comparator |
| Sweetheart | Comparator & parental line |
| Sylvia | Collection (tolerance to rain cracking) |
| Ulster | Collection |
| Van | Parental line and collection |
| Vic | Collection (well adapted) |
| Vitoria | Collection, UPOV Comparator ( no breeding value) |

## Discussion

The Australian National Cherry Breeding project concludes in June 2014 after 30 years of operation. The program has developed 6 varieties and selected 131 promising new large sized, well-adapted cherry lines with improved rain cracking resistance for the Australian cherry industry in that time. The majority of these were selected in the final five years of the program operations and still require evaluation on rootstock to determine their commercial potential.

SARDI will now graft and store all the promising lines and potentially useful breeding material identified by the breeding program at its secure Nuriootpa Research Centre site in the Barossa region of South Australia. Mazzard F12-1 is the rootstock chosen for the storage of this collection.

Cherry Growers of South Australia (CGSA) are undertaking a project (CY12024) "Australian cherry evaluation utilizing precocious rootstocks" that will attempt to complete the evaluation and rationalisation of the remaining national breeding program lines against seven comparators on three rootstocks at a single site in the Adelaide Hills of South Australia. The rootstocks to be used are: the industry standard Mazzard F12/1 and the precocious rootstocks Krymsk 5 (ANFIC) and Giesela 6 (Graham's FacTRee).

It is hoped that this approach will efficiently unlock the value from the national breeding program's three decades of investment delivering new varieties and supporting recommendations about suitable rootstock combinations. The CGSA and collaborating nursery groups are to be commended for their proactive support of this initiative. Ideally, to enable open and direct comparison an expanded version incorporating all international imported varieties contemplated for commercial plantings in Australia at two other major cherry growing states is required. Implementing such a national system would provide clear information on the relative value of the new varieties but to also reduce the risk exposure of grower members to poorly informed planting decisions.

If a coordinated national program such as this can be effectively implemented, the future looks bright for the release of new varieties with reduced rain cracking susceptibility that are adapted to Australian conditions without the traditional high risk profiles associated with new variety plantings.

The "Australian breeding and evaluation-business plan" delivered as an external consultancy in this project. The opportunity exists for the industry to use this business plan to develop a more robust plan for variety improvement in the future.

Current program resources

The SARDI national breeding program has developed a large amount of germplasm since its inception through its breeding activities. Demonstrated in Table 1 is the remaining program resource in terms of tree numbers and land usage. It can be seen this resource remains sizable with overall tree numbers at 792 trees and land usage at 3.61Ha. As previously stated this will be rationalized and warehoused at Nuriootpa Research Centre by SARDI.

Planting of seedling crosses ceased in 2009 and this planting and all preceding it have had the best selections identified from within them. This seedling resource accounts for the vast majority of the land usage (2.96ha) with many blocks having had all but the selected seedlings removed already. Once the selected seedlings have been grafted and included in evaluation blocks or germplasm retention areas the original seedling is of little value except as a single primary source of propagating material. Grafted trees have been produced of all selected lines detailed in Tables 7 & 8. These seedling plantings can now be removed safely without fear of losing the resource or its embedded value.

Table 1 also details a significant resource of 671 grafted evaluation trees on the rootstock Mazzard F12/1, in 3 main blocks on 0.65 hectares, a significant proportion of which are approaching fruit production age. It is unfortunate that the 2014 season was disastrous in terms of yield in the Adelaide Hills as many would have been expected to yield good evaluation data in the final year of this project and allowed further rationalisation of the overall genetic resource. The use of Mazzard F12/1 has also been a significant contributor to the lack of evaluation data obtained to date as it is not precocious. It was however the only widely accepted generic option for these evaluation plantings at the time. The evaluation plantings represent the majority of the selected germplasm, grown in most cases as 6 replicate trees with comparators to facilitate PBR applications should they be required. Table 2 shows these evaluation blocks were still being added to and developed as late as 2013. There is a significant amount of time, effort and capital embedded in these evaluation plantings.

The complete breeding program resource to be secured will include the bred resource described in Tables 7 & 8 (131 lines) and the variety collection listed in Table 12 (41 lines). Duplicate trees of each line are to be grafted and planted.

Breeding and evaluation systems review

The high density assessment block format with single rows 4m apart and tree spacing's of 0.5m in which trees are pruned to a modified free standing central leader system works adequately. It may be advantageous to investigate other high density block formats such as offset double rows at 1m x 1m spacing's in which trees are pruned similarly as an alternative to see if tree growth rates can be improved. This system is favoured by international experts in the field of apricot breeding and may provide similar benefits for cherries.

If further breeding were resumed in future it is advised that germinated seed is grown on for a period in seedling trays under glasshouse conditions. Following this a short period of shade house acclimatisation is advisable before seedlings are planted directly into a field nursery on drip irrigation. The aim is to reduce the significant time and costs incurred in glasshouse operations through re-potting and constant upkeep. Seedlings would be raised in a field nursery for one season before trimming, bare rooting and planting into high density assessment blocks.

The need for chemical fumigation as a component of the block maintenance prior to planting in field nurseries and high density primary assessment blocks is a costly but necessary burden to guard against the effects of non-specific replant disease. Significant cost and cultural benefits would be archived if a cheap biological or cultural alternative could be found to replace the chemical fumigation currently used. The addition and working in of well composted manures to the row line has shown some promise as an alternative and should be further investigated.

Use of mobile technology formats to collect and capture data in the field or laboratory, reducing the need to transcribe data should be embraced.

Annual grafting programs for the timely movement of selected lines into evaluation utilising precocious rootstocks or a range of rootstocks is highly desirable. This will increase throughput in an area that traditionally causes significant time delay.

Future breeding if required should utilise the best lines determined from the continued evaluation of current program resources and mine this breeding program's data for other potentially beneficial parents. This would enable more efficient and targeted breeding reducing the overall number of crosses and resources required. If coupled with the systems described above the process would be faster, more efficient and importantly have greater prospects of success.

2014 season

Much has already been said about the 2013/14 cherry season, crops were almost universally poor in the Adelaide Hills. Industry estimates the crop overall in the area was around 20% or less of average. Cropping on seedling trees was highly variable but generally much lower than expected and universally low for grafted trees on the poorly precocious Mazzard F12/1 rootstock. Autumn and early winter conditions were warm and mild, delaying leaf drop and the beginning of chill accumulation. Early to mid-winter coincided with good rainfall recordings however late winter and spring were dry. This weather also carried into summer with only a few small showers being recorded and low levels of fruit damage. It wasn't until late February and well after harvest was completed that significant rainfall occurred. Autumn and early winter was warm resulting in delayed dormancy and leaf fall. Mid-winter was cool and the majority of chill accumulation was recorded in this period, late winter and spring were relatively mild, overall leading to reduced chill accumulation over the entire winter period. A significant period of bloom was marked by cool and unusually windy weather where bee activity was noticeably reduced. This along with reduced overall chill accumulation and an off-crop cycle set up by a heavy cropping 2013 season had a disastrous effect of fruit set.

Adding to the frustration of poor cropping levels was the lack of in-harvest rain pressure to evaluate rain cracking potential. Thus it was difficult on the 2014 harvest season to make determinations against many of the key program criteria and facilitate the advancement or further rationalisation of the resource. This lead to the relatively low number of 9 characterised lines removed in 2014 as shown in Table 10.

2014 has seen a large rationalisation primarily of seedling resources (Table 1) which reduced from 1729 lines to 121 lines as selection on the remaining two seedling blocks was effectively completed. The discrepancy between the 121 lines in seedling blocks and the 131 line reported total resource is due to 10 lines from earlier plantings that no longer exist in seedling blocks, only being represented in evaluation areas.

Combining all annual data and the current season's poor results has seen no change in the status of Category 1 lines between 2013 and 2104 as shown in table 7. These 12 lines are all physically represented in national evaluation trials around Australia, although there is now no formal network or means to collect and process results. This category has had up to 17 lines represented in 2012 and all are currently still represented in the original 14 national evaluation trial sites. Over time this has reduced to 12 as some lines have shown character defects and been downgraded in local Lenswood assessments. Notably three former Category 1 lines,

2I.K (from PBR2 evaluation trial), 4O.KC and 2BU.H have been successively downgraded to removals based on accumulated evidence in 2014. 2I.K is an early maturing, high cropping line but it has poor firmness and rain cracks and nose cracks quite easily. 4O.KC, seems to have good rain crack resistance and develops better size than 4O.CK, another category 1 sister line, but crops more poorly and can have an acidic and off tannin taste. 2BU.H unusually cracks easily early in its development, damaged fruit then dummies off readily so it appears crack resistant at full maturity. Category movements for other germplasm were minimal in 2014 as shown in Table 8. With the most significant changes being an influx of newly categorised lines as selection closed in the remaining two seedling blocks.

The highest rated dark cherry current seedling selections mainly from category 1 in order of maturity date are detailed below. All information supplied is from seedling trees without the use of GA sprays at Lenswood Research Centre and is provided as a general guide only.

Week 1: 24 November-30 November
Guide varieties-Empress, Earlise

- 2O.IO-Moderate crops (26 November) improving each season, large, 30mm, 10-10.7g, firm fruit, has had some minor cracking but no nose cracking and may harvest earlier.

Week 2: 1 December-7 December
Guide varieties-Chelan, Ron's Seedling

- 4I.KI-Very good crops overall (4 December) of medium 9.2-11.4g, 27mm average but up to 32mm. Intensely flavoured slightly acidic tasting fruit with very robust stems and some minor cracking, below 10%. Firmness may be its biggest problem, averaging 235g/cm$^2$.

Week 3: 8 December-14 December
Guide varieties-Bing, Stella

- 3C.B-Moderate crops (10 December) of medium to large 9-11.6g, 29mm average, very firm fruit (477g/cm$^2$ average). Has recorded some minor cracking, mostly nose cracking. Fruit is low in acid and holds on the tree very well for extended periods, 3 weeks in 2104. Almost sub-acid and at its best picked fire engine red with 20 °Brix total soluble solids. Large shiny and kidney shaped, it should be investigated for Asian markets.
- 2B.BK- Good crops (10 December) on a seedling tree that is in a tough area. Medium size fruit 7.1-8.7g on seedling, 27mm average, kidney shaped and very firm (488g/cm$^2$ average). Some nose minor cracking and does have thin stems. Looking for a lift in size on a rootstock in a better area from evaluation.
- 2O.OB (Category 2 line)- Good crops (11 December) on Mazzard in evaluation trials. Large, 28mm average, moderately firm (341g/cm$^2$ average), shiny but dark fruit with good quality stems. If this line is not commercialised for growers it should be considered for the "Home Garden" retail sales market.
- 1H.RE- Moderate crops (14 December) of large fruit, 10.2-12.7g, 29mm average, very firm (427g/cm$^2$ average), only slight cracking except for significant nose cracking in 2011 and 2012. One of the most advanced in terms of overall testing on Mazzard rootstock and on average a solid performing cherry. Excellent low acid sweet taste and very solid stem. Currently in limited commercial trials.

Week 4: 15 December-21 December

- 3I.R- Moderate crops (15 December) of large fruit, 7.9-10.7g, 28mm average, very firm (478g/cm$^2$ average), very low cracking and crunchy texture. Has improved annually in ratings from 2010 when competing seedlings were removed.
- 7BE.BBR- Moderate crops (18 December) of medium fruit, 8.3-8.9g, 27mm average, very firm (490g/cm$^2$ average), only minor cracking. Consistent high performer with a crunchy texture and long stems like Kordia. Looking for further improvement on rootstock as seedling has plenty of competition. New introduction from 2011.
- 2BH.O (Category 2 line)- Moderate crops (19 December) of medium fruit, 7.9-11.0g, 27mm average, very firm (446g/cm$^2$ average), very little cracking. Improving seedling performance from a very small tree. Looking for further improvement on rootstock as seedling has plenty of competition. New introduction from 2013.

Week 5: 22 December-28 December

Guide varieties-Lapins

- 4O.CK- Good consistent crops (22 December) of medium 8.0-11.4g, 27mm average fruit. Extremely firm (587g/cm$^2$ average) and shortish stems with only slight cracking on lighter crops. Looked good in 2014, with limited crop in its first season on Mazzard rootstock.
- 7C.BSK- Moderate crops (24 December) of large fruit, 10.0-11.7g, 29mm average, firm (381g/cm$^2$ average), only minor cracking and no nose cracking recorded. Consistent high performer with long but robust stems. Looking for further improvement on rootstock as seedling has plenty of competition. Seeding has a flatter spreading and docile habit. New introduction from 2011.
- 3U.HU- Good consistent crops (24 December) of large 8.4-12.9g, 29mm average fruit. Firm (476g/cm$^2$ average) fruit that stored well and has never recorded a crack in assessment sub-samples to date. Looked Ok in 2014, with limited crop in its first season on Mazzard rootstock when size was down but it was still very firm.
- 5I.HR-Heavy crops (24 December) of medium to large, 8.9-11.9g, firm (354g/cm$^2$ average) fruit. Has had minor nose cracking but showed three very nice seasons before the tree succumbed to root pathogens. Looked Ok in 2014, with limited crop in its first season on Mazzard rootstock when size was down but it was still very firm.
- 3R.RS- Has had moderate to heavy crops (24 December) of medium to large 9.5-11.5g, 27mm average, very firm (497g/cm$^2$ average), fruit with almost no cracking recorded and a very well-sealed stylar scar. A consistently, large, low cracking cherry.

Week 6: 29 December-4 January

Guide varieties-Kordia

- 3I.RE (Category 2 line)-Has had moderate crops (29 December) of large 9.8-10.6g, 28mm average, very firm (530g/cm$^2$ average) fruit. Seedling recorded significant ring cracking in 2010 and 2011 and was downgraded but produced excellent results in 2013 and 2014 and was again promoted. It needs to be considered that 2013 and 2014 were low rain pressure seasons. Quality was reasonable in 2014, with limited crop in its first season on Mazzard rootstock when size was down but it was still very firm. Fruit hangs on the tree extremely well and is of excellent quality but cracking may prove its downfall.

Week 7: 5 January-12 January
Guide varieties-Sweetheart

- 5C.KE-Moderate crops (7 January) of large, 8.9-11g, 29mm average, intermediately firm (380g/cm$^2$ average) fruit. Has long but robust stems and shown only minor cracking in past seasons. Waiting to see it on rootstock but not entirely convinced it will make it.

In 2010 the breeding program reported the discovery of some genetic oddities which periodically appear by chance and may have commercial application. While most are never ultimately likely to be commercially released, a select few show enough potential to explore further whether they might carve out a commercial niche. The remaining lines reported and reasoning for doing so are detailed below along with their subsequent performance to date.

- 3C.B (Cat.1)- (December 10) Described technically in detail elsewhere in this report this line is super sweet and almost sub-acid in character. Its colour will develop to black while staying very firm; however it is a line that can truly be picked at "fire engine red" colour without compromising on eating quality. Would this style be attractive to the Asian palate? Performed reasonably well in 2011 under significant rain pressure showing 10% cracking and 15% nose cracking.
- 4I.KO (Cat.4)- (December 17) A super firm and sweet dark cherry, measured by Firmtech at an average of 635g/mm$^2$ (Chelan, 620g/mm), takes crunchiness to a new level. Moderate to heavy crops of marginal sized fruit to 8.3g (75% above 25mm) but only averaging 26mm with very little cracking harvested in week 3. Can the crisp crunchy texture offset its marginal size?
- 3I.KS (Cat.3)- (December 4) Early maturing (week 2), super firm (480g/ mm$^2$), sweet white cherry. Moderate to heavy crops to 9.3g (95% above 25mm), 27mm average cherries that are resistant to bruising and store very well but has rain cracked and nose cracked in one of six seasons. Looking for an increase in size on rootstock. Could this early white improve market acceptance of white cherries?

<u>Seedling Assessments</u>

At the beginning of this project a large quantity of evaluation lines were either in evaluation blocks and yet to begin fruit production or grafted for addition to evaluation blocks. This meant that a short term focus could remain on selection but rapid shift to evaluation would likely be required in the final year of the project as cropping evaluation trees become available. This scenario did not eventuate due to an extremely poor 2013/14 harvest season allowing the focus to remain on seedling selection and avoiding the need to redistribute resources.

Assessment results from primary seedling blocks are inherently unreliable due to the fickle seasonal nature of fruit growing and the added complexity of localised conditions in high density plantings.

The climatic conditions of the past three seasons 2012-2014 produced a series of early seasons due to mild winter conditions but only one significantly wet harvest season. This was 2012 which afforded the opportunity to get differentiation on relative rain cracking susceptibility, a major objective of the breeding program. Seasons such as these, whilst problematic for fruit growing in general, provide the conditions (biological filters) by which to differentiate the best performing varieties under adverse conditions in a cost effective manner.

Table 1 shows seedling numbers decreasing 4608, 3681, 1729, 121 year on year, as seedling selection has taken place and inferior or non-cropping lines are removed 2011 to 2014. Table shows the number of newly classified "selected" seedlings for each year. Newly classified lines rarely if ever enter evaluation as Category 1 hence it was not included in the table. The reclassification to Category 1 is reserved for lines or reproducible high quality and several seasons of exceptional assessment. 2014 entries are dominated by lines selected from the final seedling plantings for which relatively little is known hence the vast majority enter the system at Category 3 level awaiting, improved or further consistency in results.

No breeding is currently targeted towards developing white fleshed or blushed cherries, however from the dark cherry crosses a significant proportion of white fruited progeny appeared. Several good quality white cherries have been discovered over time with a sub-group notable for their exceptional firmness and a crunchy eating texture being highly favoured in recent years. Notable blushed white fleshed cherries discovered include Category 2 cherries 4C.KC (28 November), 7U.RES (4 December), 7U.RER (10 December, very firm), 4C.BC (15 December, very firm) and Category 3 cherries 7K.BRE (3 December), 3I.KS (4 December, very firm), 5U.BHU (22 December).

Evaluation trials

In all breeding programs the performance of the seedling trees is only a guide to possible future performance. True performance needs to be judged when grafted onto the rootstock on which it is to be grown and even then possibly on a region by region basis. Several different rootstocks are now available including some that are known to be both dwarfing and more precocious than the traditional stocks Mazzard or Mahaleb. Evaluation of the currently available germplasm pool across a selection of these stocks is a significant undertaking. Into the future it is proposed that emphasis be placed on evaluation of the current pool of germplasm before any further breeding is contemplated. Working towards this aim a greater emphasis was placed on grafting identified lines quickly onto Mazzard F12/1 rootstock and placing them into evaluation. As a result, a shift in resource allocation occurred from selection to evaluation with greater amounts of resources incurred in setting up, maintaining and assessing evaluation blocks. A significantly drop in the land space required to achieve this aim is demonstrated in Table 1, as the breeding program is rationalised into a compact evaluation and germplasm retention resource.

Precocious rootstocks if used judiciously may prove in the future to be a major asset to improving the speed of evaluation, a traditionally slow process with non-dwarfing and non-precocious rootstocks. This is the focus of a new Cherry Growers of South Australia (CGSA) project (CY12024) "Australian cherry evaluation utilizing precocious rootstocks" that will attempt to complete the evaluation and rationalisation of the remaining national breeding program lines against seven comparators on three rootstocks at a single site in the Adelaide Hills of South Australia. The rootstocks to be used are: the industry standard Mazzard F12/1 and the precocious rootstocks Krymsk 5 (ANFIC) and Gisela 6 (Graham's FacTRee).

There is a significant amount of time, effort and capital embedded in evaluation plantings at Lenswood which are well advanced towards cropping. Industry should investigate ways to maintain access to these plantings as it would eliminate the need to replicate them in another place at some time in the future, saving significant resources.

Table 11 detailing the average performance of the remaining lines in the PBR2 evaluation trial highlights the high attrition rate through evaluation of advanced selection. This trial originally comprised 26 early generation advanced breeding lines, the released varieties Sir Hans, Sir Douglas and Dame Nancy and the comparator variety Stella on the industry standard rootstock Mazzard F12/1. It was planted in 2003 and fruiting began in 2006 at the end of 2011, 20 lines had been removed including the varieties Dame Nancy and Sir Hans. In 2013 a further 2 lines 2BH.BO and 2BO.RO were removed for being low cropping and although quite tolerant of rain cracking were quite soft. 2BO.RO is also prone to collapse and shrivel in hot weather. In 2014 based on several years of accumulated performance 2I.K was removed for its lack of size, firmness and relative susceptibility to rain cracking. This leaves just 3 lines remaining 1H.RE (Cat 1) and 2O.OB (Cat 2) described previously, as well as 2BR.BI (Cat 2), the already released Sir Douglas and the comparator Stella. It also highlights the advantage of a judicious evaluation system.

Each season the individual evaluation trees have their entire crop harvested and weighed with a subsample assessed according to standard breeding program assessment protocols for quality parameters. Accumulated results across several years allow categorisation of lines and determination of appropriate action. Poorly performing lines are removed at the end of each season as supporting data permits.

Table 11 details the averages for remaining lines during the 2012-2014 seasons. All lines remaining are dark cherries and the data pertaining to damage type and level along with the quality parameter of under colour fruit in subsamples has been omitted. This was done to reduce table size and because it was of limited value in this context. The data presented is typical of the type gathered annually to support downstream decision making.

From this trial the already released variety Sir Douglas appears a regular moderate cropping dark cherry (15 December) on Mazzard F12/1 with good size and excellent firmness. Its overall characteristics are not dissimilar to the popular new variety Blackstar. This line has shown good resistance to rain cracking generally and rarely if ever nose cracks. Its attractive dark shiny appearance, sweet well balanced flavour profile and pre-Stella maturity time make it an attractive commercial proposition. Unlike Blackstar it has likely never had the opportunity to be evaluated on a rootstock such as Gisela 6 whose precocious nature may further enhance its prospects.

National evaluation program

Prior to 2013 the highest rating advanced lines (Category 1 lines) were grafted and forwarded to the National Cherry Variety Evaluation Program (NCVEP). This national evaluation network was established in 2006 with test sites at major cherry growing locations around Australia. Originally the national evaluation network consisted of 14 sites, Victoria (5), Tasmania (2), New South Wales (3), South Australia (3), and Western Australia (1). In 2011 a further 3 sites were added, Victoria (1), New South Wales (1), South Australia (1) to include a group of younger very proactive cherry growers.

This program aimed to-:

- Provide comparative data on variety performance in several cherry growing regions.
- Provide industry with information on which to base future variety planting decisions.
- Promote the program's activities and outcomes and support future commercial releases.
- Decrease lead times to commercialisation of varieties.

In 2006 original sites received four trees of each of the breeding programs six released varieties and an advanced selection. A further 16 and 2 advanced selections were added in 2009 and 2010 respectively. In 2011 the new growers and 4 existing growers who had rootstocks on hand received newly promoted lines, 4O.CK & 4O.KC from 2010 and several other promising lines in lower categories as budwood to graft. In 2012 the remaining growers receive the recently promoted and current Category 1 lines, 7BE.BBR, 7C.BSK, 3U.HU, as budwood to graft.

All current Category 1 selections are now planted in the National Variety Evaluation Network although later evaluators have not received some of the subsequently downgraded lines. These lines include 4C.CK, 2BU.H, 3I.UU and 2I.K which have had their expectations downgraded from Category 1 lines on the basis of accumulated results. Participating growers have been given the opportunity to keep downgraded lines they are currently growing and/or take on new evaluation lines in future.

The CGA should take steps if it is to realise the investment it has made in national evaluation plantings by gathering and analysing evaluation results by whatever means practical. A third party provider to visit and physically evaluate these plantings may be required.

Variety releases

On the 1st February 2010 a meeting of National Evaluation Committee took a decision to support and coordinate via the CGA a semi-commercial trial release of line 1H.RE ahead of national evaluation trial results and a possible full commercial release. The concept being to allow trial growers selected via open advertisement and expression of interest semi-commercial numbers of trial trees (50-100) depending on budwood availability. This would enable sufficient quantities of fruit to be produced in a commercial setting to evaluate market and consumer reaction. The breeding program has compiled significant information about this line's quality and performance on Mazzard F12/1 rootstock locally, indicating the line has reasonable prospects for commercial success based on currently available information.

Five growers nationally took up the offer of limited commercial trial of line 1H.RE in winter 2010. The growers represented were two from New South Wales and South Australia and one from Tasmania.

No further variety releases are planned until favourable results and recommendations are obtained, hopefully driven by observations from National Evaluation Program. If further limited releases were attempted purely on accumulated evidence from the breeding program itself then 3C.B, 3I.R, 7BE.BBR, 4O.CK, 7C.BSK and 3U.HU would be suggested candidates.

Budwood will then be made available to nurseries the following autumn for tree propagation.

Initially signed non-propagation agreements would be required by participating growers before the planting of trees. Plant Breeders Rights (PBR) protection would be sought if interest were such that a variety should proceed to full commercial release.

Current results suggest that further variety releases are likely in the next 4-6 year time frame pending future favourable assessments and trials on rootstocks.

## Technology Transfer

Technology transfer is undertaken in a variety of formats by the Cherry Breeder, Mr D Graetz.

Presentations are made where appropriate in the following forums.

- Annual Cherry Industry Conference, usually as a program review presentation during either the levy payers meeting or trade day
- State AGM and grower meetings – reports and data displays
- Local breeding program site visits and fruit displays
- National variety evaluation program site visits and coordinated variety evaluation program
- Promotional media
    - Annual review article in Tree Fruit Magazine
    - Annual short HAL report
    - newspaper articles
    - radio interviews
- International conferences and study tours

Tours of the program are regularly conducted for growers, industry, interstate and international visitors. Demonstrations of program activities and the provision of extension advice on cherry production (e.g. varieties, rootstocks, pruning etc.) are also provided on request.

## Recommendations

The SARDI national breeding program has developed a large amount of germplasm since its inception through its breeding activities. This material needs to be evaluated and rationalised before further breeding is contemplated.

The cherry breeding program contains significant material of commercial interest. An Australian sweet cherry breeding program supported by industry remains the best method of obtaining locally adapted varieties. .

It is recommended that support be provided to the Cherry Growers of South Australia (CGSA) and their new project (CY12024) that will evaluate the remaining national breeding program lines against seven comparators on three rootstocks at a single site in the Adelaide Hills of South Australia.

Ideally, an expanded cultivar evaluation program, which includes local and international varieties in plantings in two other major cherry growing states, would enable open and direct comparison. Implementing such a national system would provide clear information on the relative value of the new varieties but to also reduce the risk exposure of grower members to poorly informed planting decisions.

If a properly coordinated national program such as the CGSA project can effectively be implemented nationally the future looks bright for the release of new varieties with demonstrated and translatable commercial impact on the Australian cherry industry.

Should future breeding be attempted it is recommended that this occur on a targeted basis utilising the superior germplasm and parental information accumulated in this breeding program. The processes and systems should incorporate the efficiencies of field nursery and bare-rooted tree production systems utilised in the later years of this breeding program. Critically grafting programs for promotion of identified material into evaluation should begin as early as practical and should incorporate the use of precocious rootstocks.

If the Australian cherry industry growers are interested in fast-tracking and evaluating small scale semi-commercial plantings of the breeding program's most advanced material then the following lines are suggested as candidates (3C.B, 3I.R, 7BE.BBR, 4O.CK, 7C.BSK and 3U.HU).

It is also strongly recommended that CGA take steps to realise the investment it has made in national evaluation plantings by gathering and analysing evaluation results. A third party provider to visit and physically evaluate these plantings may be required.

It is also strongly recommended the breeding program genetics and variety collection is warehoused at a secure site. This has been actioned and the National Cherry Germplam collection is being developed at Nuriootpa Research Centre.

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