A COMPUTER-AIDED SYSTEM FOR THE SELECTION OF SIEVE DIAMETERS TO SIZE SORT CLING PEACH HALVES FOR CANNING

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A COMPUTER-AIDED SYSTEM FOR THE SELECTION
OF
SIEVE DIAMETERS TO SIZE SORT
CLING PEACH HALVES
FOR CANNING

BY
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Abstract

This dissertation reports on a three prong approach to obtain new knowledge on the interdependent effects which buyers' specifications, peach crop attributes and sieve stack arrangement have on the masses of peach halves sorted into classes of average diameter. Applying statistical methods and using suitable application computer programs, a computer-aided system was developed to improve on the manual selection of sieve diameters. It was concluded that size sorting peach halves for the purpose of mass classification is inaccurate and counter-productive. It is suggested that modern technology be employed to develop a method to determine peach half masses individually.
Summary

Can ingoing mass and count specifications are largely controlled by classifying peach halves into mass classes. A reciprocating sieve stack is employed to sort the prepared peach halves into size classes, according to sieve hole diameters. The diameters are manually selected to approximate the masses needed. This study was undertaken to improve on the efficiency of the manual methods used.

A four prong research approach was followed. Firstly the buyers' specifications were analysed. Secondly the attributes of the peaches available were studied. Thirdly the effects of sieve diameter on peach half masses were evaluated. Fourthly a computer-aided system using the application program Framework III\(^1\) was developed to include the constraints of the three aforementioned variables. This method permits the quick computation of sieve diameters and stack rearrangements according to changing circumstances.

Data were gathered during the 1988/89 and 1989/90 summer peach crop, sampling from Oom Sarel, Neethling, Woltemade and Kakamas cling peach varieties.

It was found that the frequency distribution of peach half masses determined followed a lognormal distribution skewed towards a greater proportion of lighter halves. For Kakamas peaches, 67.5\% of the halves were estimated to have a mass between\(^2\) 25 g and 75 g, while 82.11\% of the Oom Sarel variety was found to be within this mass class. No attempt was made to distinguish between growing areas.

The regression of peach half mass on half diameter was found to be exponential. At 40 mm diameters peach halves had a mass of about 0.7 g for each millimetre of its diameter, while halves of 60 mm diameter had a mass of about 1.5 g for every millimetre of that diameter. Furthermore, peach halves of different varieties of the same diameter had significantly disparate average masses. The slopes of the regression equation for different varieties were also dissimilar.

\(^1\) Registered Trademark Of The Ashton-Tate Corporation
\(^2\) Minimum and maximum peach half masses demanded by buyers.

Size Sorting
Summary

To include the effects of all these factors a computer-aided system using the FRED programming language of Framework III was developed. This system was successfully applied to calculate the sieve stack arrangement for the 1990/91 season with sorting efficiency increasing by as much as 13%.

It was concluded that the current practice of size sorting peach halves on a horizontal plate with holes of a specific diameter is ineffective as it does not readily permit accurate and continuous control of peach half masses.

However, as no alternative method for sorting peach half masses is presently available, it is recommended that the computer-aided system developed in this study be applied routinely and that the following procedures be introduced to permit reliable sorting.

1. Select, store and process peaches received according to variety.

2. Determine regression constants for peach half mass on sieve diameter as often as possible.

3. Regularly evaluate sieve efficiency against changing fruit and buyers' parameters and compute new sieve stack arrangements as often as appropriate.
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A word of appreciation is due to Mr. Koos Barnard, the owner of Ashton Canning Co., who kindly agreed that the information be made available for dissertation purposes. To the following members of his company my indebtedness; Mr. Wynand du Plessis and Mr. Ernie Oosthuizen for their consistent encouragement and interest in the progress of this project; Mr. Blackie Swart, who with years of peach half sorting experience, was especially difficult to satisfy.

During the preparation of such a dissertation there is always someone close with forbearance; Maritha you did well!

\textsuperscript{3} Gratitude Is A Fruit Of Great Cultivation; You Do Not Find It Among Gross people - Samuel Johnson
I, Herman Barend van der Merwe, declare herewith that the contents of this dissertation represent my own work and opinions expressed and recommendations made are my own and are not necessarily those of the Cape Technikon.

Signed ........................ at ........................

on ............... day of ...................... 1991.
Introduction

1 Introduction

1.1 General

Uniformity\(^4\) in appearance of canned peach halves appeals to the consumer when a can of fruit is opened and transferred into a domestic receptacle. A feel of brand loyalty unfolds when such a can is hedonically acceptable to the consumer. The next purchase will determine whether this initial brand preference shall be rooted or rejected by the user. Uniformity in sensory attributes relates to size, count and colour on first examination and to flavour, taste and texture when consumed (South Africa, 1976). Of these quality attributes, the count has an important influence on the brand choice when shopping for family meals (Oosthuizen, 1991). The shopper associates the number of appetizing peach halves in a can with the family members and will buy the brand and can size in accordance (Oosthuizen, 1991; Robertshaw, 1989).

Brand owners of canned peaches specify and declare on the label the drained mass and net mass for each can size. However, for the same can size and mass requirements, different counts are specified by the buyer and if deemed of economic importance also indicated on the label accordingly. It follows that an array of peach half masses is in fact demanded. In effect, the optimum mass of individual peach halves can be calculated by dividing the count into the drained mass.

Production staff, together with sales and marketing teams, are aware of the need to maintain the uniformity of branded product ranges and meet daily to plan production schedules in advance. Due consideration is given to the three major areas of influence viz buyers' specifications, fruit properties and machinery characteristics.

Of the three important factors mentioned, seasonal influences and those associated with different varieties can be considered uncontrollable due to macro and micro climatic variations of

\(^4\) Having always the same form; not changing in shape, appearance, or character (Kellerman, 1981).
Introduction

different growing areas. However, peach maturity, which to an important extent determines colour variation, can to a large degree be controlled through careful picking procedures on the farm.

To pack economically canners need to select halves in multiples which together will form a group with both count and total mass according to a particular pack specification. The closer the group mass is to that demanded, the smaller the over-fill amount will be and thus the better the economics of the packing process. The following example illustrates this point. During the 1989/90 fruit canning season it cost 52.1 c to fill an A2½-can with cling peaches to a label drained mass declaration of 500 g (Oosthuizen, 1991). Orders for this peach pack size amounted to 1200 tonne. The projected cost savings of a potential reduction in variation between half masses are demonstrated in Table 1-3.

Prevailing technology uses a series of custom made sieve plates selected according to their hole diameter. These sieves are assembled in a reciprocating stack arrangement. This sieve stack sorts peach halves into classes of comparable uniform diameter (Fig 2-1). Selecting peach halves in this way has limitations due to the natural variations associated with fruit properties and the size of the sieve diameter (Peleg & Bagley, 1987).

With multiple line operations manual mass determination of individual peach halves is not feasible and uneconomical at speed requirements of about 1500 to 2000 peach halves per minute per A2½-pack size line. The development of modern high speed electronic devices is not yet in sight, thus traditional sieve sorting remains the only acceptable operation available at present.

The arrangement of sieve stack, screen diameters and sieve intervals depends on the expertise of individuals having gained experience in canneries through the years. Although their decisions are influenced by the well known fact that peach half masses vary with their diameter, market requirements and perceived effects of fruit properties, such judgments remain estimates at best because the exact nature of these relationships have not been addressed in the literature.
Introduction

It was visualised that these decisions could be greatly improved on with the aid of modern computer systems, which utilise input data pertaining to both buyers' specifications and fruit characteristics. It is not the objective of this study to derive prediction models for the variations in fruit attributes, but rather to point out statistically significant differences. These factors could then be included in the computations when selecting screen diameters.

Consequently, this study sets out to develop a computer aided system for improving the selection of screen diameters. It compares, evaluates and adjusts the nature of buyers' specifications and secondly, establishes the most important fruit attributes associated with mass variation at a set diameter. Thirdly, it applies modern systems in the interest of improved control, productivity and efficiency.

1.2 Export Markets

Table 1-1 shows that between 74% and 98% of all canned peaches produced in the RSA since 1985 were sold abroad (Canning Fruit Board, 1991). As a result foreign specifications dominate the quality of canned peaches produced in the RSA. They also influence the standards for good manufacturing practices in the day-to-day operation of most canneries and certainly where the data for this project were collected.

Although canned peaches as a commodity is small in relation to the total food manufacture in the RSA (South Africa, 1991) it realised a steady increase in foreign exchange earnings up to 1986 whereupon it remained relatively constant, at a value in excess of R95 million per year (Canning Fruit Board, 1991). The RSA produces 20% of the world trade in canned fruit and is second to Greece which accounts for 41% (Victor, 1991).
Introduction

Table 1-1. Canned Peach Statistics For RSA

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Turnover million R1,000</td>
<td>Turnover million R1,000</td>
<td>Turnover million R1</td>
<td>Turnover million crtn's</td>
<td>Turnover million crtn's</td>
</tr>
<tr>
<td>1982</td>
<td>57.57</td>
<td>7.80</td>
<td>44.61</td>
<td>3.059</td>
<td>80.770</td>
</tr>
<tr>
<td>1983</td>
<td>62.29</td>
<td>9.30</td>
<td>49.87</td>
<td>3.123</td>
<td>88.311</td>
</tr>
<tr>
<td>1984</td>
<td>71.67</td>
<td>10.40</td>
<td>62.39</td>
<td>3.162</td>
<td>94.936</td>
</tr>
<tr>
<td>1985</td>
<td>79.00</td>
<td>15.10</td>
<td>77.08</td>
<td>2.474</td>
<td>3.063</td>
</tr>
<tr>
<td>1986</td>
<td>89.70</td>
<td>17.10</td>
<td>94.08</td>
<td>3.144</td>
<td>3.198</td>
</tr>
<tr>
<td>1987</td>
<td>103.74</td>
<td>19.90</td>
<td>95.12</td>
<td>2.526</td>
<td>3.121</td>
</tr>
<tr>
<td>1988</td>
<td>126.36</td>
<td>22.77</td>
<td>95.43</td>
<td>2.502</td>
<td>3.290</td>
</tr>
<tr>
<td>1989</td>
<td>151.32</td>
<td>26.75</td>
<td>95.14</td>
<td>2.254</td>
<td>3.011</td>
</tr>
<tr>
<td>1990</td>
<td>166.39</td>
<td>30.61</td>
<td>98.56</td>
<td>2.400</td>
<td>2.686</td>
</tr>
</tbody>
</table>

1.3 Content Control

The statutory implications of net content control to South African fruit canners not only embrace national regulations (South Africa, 1977), but because of South Africa’s traditional international involvement in supplying the world market with high quality canned fruit (Oosthuizen, 1991), canners are compelled to adhere to standards set by buyers operating in the European Economic Countries (EEC). There are thus both national (South Africa, 1977) and international standards (CPPRA, 1985; Robertshaw, 1989) to obey, but even more apt, controls over manufacturing costs within these ardent parameters are essential to maintain pricing competitiveness. The need for knowledge and the implementation of systems geared to improve productivity and effect cost savings seem imperative.

---

5 Turnover Total Manufacture RSA (Central Statistical Services, 1991)
6 Turnover Food Manufacture RSA (Central Statistical Services, 1991)
7 Turnover Canned Peaches RSA (Canning Fruit Board, 1991).
8 Total Canned Peach Exports RSA (Canning Fruit Board, 1991)
9 Total Canned Peach Production RSA (Canning Fruit Board, 1991)
10 Cartons of 24 x A2 1/4 cans.

Peach Halves
Introduction

When the filling operation is characterised by a large variation in mass as opposed to small deviations and if standard deviation values of say 10.0 g and 0.5 g, are measured for two different filling lines, both with nominal masses of 500 g, it is important to note that the calculated target masses are quite different (Van der Merwe, 1987) as presented in Table 1-2.

Table 1-2. Influence Of Standard Deviation On Target Mass

<table>
<thead>
<tr>
<th>Standard Deviation</th>
<th>10.0 g</th>
<th>0.5 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_U^{11}$</td>
<td>513.0</td>
<td>494.0</td>
</tr>
<tr>
<td>$T_A^{12}$</td>
<td>506.3</td>
<td>500.3</td>
</tr>
</tbody>
</table>

As control over the filling process improves, smaller standard deviations will be obtained and Table 1-2 shows that the target mass will tend closer to the stated nominal mass. The other interesting observation from Table 1-2 indicates that for a large standard deviation, $T_U$ is greater than $T_A$, while for an improved control process the requirements of a single unit $T_U$ become smaller than the stipulations for the average sample $T_A$. It also means that sample size may be reduced (Snedecor & Cochran, 1987). In order to be 95% confident that the total production conforms to the mandatory preconditions, the largest of $T_U$ and $T_A$ is selected as the target mass for filling purposes.

Because the standard deviation is determined by variations in factors associated with the product, fillers, operators, and maintenance of various machines, the standard deviation will vary from filling line to filling line and product to product. Utilising the most representative standard deviation available, target masses as well as control limits have to be calculated for each line and of course, recalculated for major variations in product attributes related to density, shape, size and other geometric changes.

\[ n = 1 \quad n = 10 \]
Canned fruit exported to the European Economic Countries require a statement of net mass, as well as a statement of drained mass (Robertshaw, 1989). The net mass is of course the sum total of fruit packed (ingoing mass), plus the mass of the covering liquid added. The ingoing mass of a can of peach halves is the sum total of the individual masses of each half contained in that can. The number of halves is commonly known as the count. The variation of masses between the individual masses of peach halves will influence the standard deviation (Van der Merwe, 1987). If it were possible to select halves with identical masses the contribution caused by the variation between individual peach half masses towards the line standard deviation would be nil. Target ingoing masses (DrnWt) will tend smaller with expected corresponding cost savings as demonstrated in Table 1-3.

Table 1-3. Mass Variation\textsuperscript{13} and Packed Peach Cost For A2½-Packs

<table>
<thead>
<tr>
<th>NomWt</th>
<th>n</th>
<th>sTNE\textsuperscript{14}</th>
<th>DrnWt\textsuperscript{15}</th>
<th>Cost\textsuperscript{16}</th>
<th>TonCost\textsuperscript{17}</th>
<th>SeasonCost\textsuperscript{18}</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>8</td>
<td>40</td>
<td>535</td>
<td>55.75</td>
<td>R1,114.94</td>
<td>R1,337,928.00</td>
<td>R.00</td>
</tr>
<tr>
<td>500</td>
<td>8</td>
<td>35</td>
<td>525</td>
<td>54.71</td>
<td>R1,094.10</td>
<td>R1,312,920.00</td>
<td>R25,008.00</td>
</tr>
<tr>
<td>500</td>
<td>8</td>
<td>30</td>
<td>522</td>
<td>54.39</td>
<td>R1,087.85</td>
<td>R1,305,417.60</td>
<td>R32,510.40</td>
</tr>
<tr>
<td>500</td>
<td>8</td>
<td>20</td>
<td>515</td>
<td>53.66</td>
<td>R1,073.26</td>
<td>R1,287,912.00</td>
<td>R50,016.00</td>
</tr>
<tr>
<td>500</td>
<td>8</td>
<td>10</td>
<td>508</td>
<td>52.93</td>
<td>R1,058.67</td>
<td>R1,270,406.40</td>
<td>R67,521.60</td>
</tr>
<tr>
<td>500</td>
<td>8</td>
<td>0</td>
<td>500</td>
<td>52.10</td>
<td>R1,042.00</td>
<td>R1,250,400.00</td>
<td>R87,528.00</td>
</tr>
</tbody>
</table>

Although the net mass of the can remains constant, the drained mass changes from the time the covering liquid is added (Smit \textit{et al.}, 1961). Usually, sugar syrup at about 30° Brix or fruit juice at about 20° Brix is added to the peach halves. Water then moves from the fruit to the more concentrated liquid phase. This decreases the actual mass of the peach halves and thus the

\textsuperscript{13} As Measured By The Standard Deviation
\textsuperscript{14} Tolerable Negative Error
\textsuperscript{15} At The Packing Stage: DrnWt = Ingoing Mass = Target Mass
\textsuperscript{16} Filled Peaches Cost (cents); Excluding Can (Oosthuizen, 1991)
\textsuperscript{17} At Nominal 500 g Ingoing Mass
\textsuperscript{18} For 1200 t Season (Oosthuizen, 1991)

\textit{Peach Halves}
drained mass of the pack. These changes are due to differences in osmotic pressure. However, when the fruit is cooked as part of the canning process, the fruit cells plasmolise and adsorption forces take over to eventually equilibrate the concentrations of fruit and liquid phases. This final state of equilibration is only reached approximately three months after canning and determines the cut-out mass of the peach half. For peaches Smit et al. (1961) found that the drained mass could increase to more than 100% of the original fruit ingoing mass. On the other hand, with apricots the percentage retention of the fruit originally packed, can vary from as low as 80% to about 90% (Stiekema et al., 1960) and is due to the tendency of canned apricots to soften (Van Der Merwe et al., 1966) possibly due to the removal of structural calcium from the cell wall by chelating organic acid anions (French et al., 1989). These changes in fruit mass also vary between different fruits and with variety, the maturity, the growing area and the actual water content of the fruit, amongst others.

Data pertaining to changing drained masses are not available for modern peach and other fruit varieties grown in different areas and canned for local and export sales. This complicates accurate forward estimates of drained masses and corresponding adjustments to target ingoing masses.

Statistical content control and Shewart-charts were first introduced in South Africa by Goosen (1961) at a Tulbagh fruit canning plant and at a Paarl fruit cannery by Van der Merwe (1963). These systems were based on statistical methods recommended by the National Canners' Association (1956) and Kramer & Twigg (1961) and depend on transforming many figures into graphs permitting hand packers to respond appropriately. Kock (1984) extended the techniques to piece sorting during pineapple canning at an East London operation.

Shewart-charts have however, inherent limitations if applied to high speed filling operations with multihead fillers, because of the vast amount of manual data transfer and associated computations. Such difficulties were overcome through the development of the Mettler Filling Process Control (1983) system which linked one or more manually operated balances to data processing units varying from simple calculators to computers with sophisticated software. These
Introduction

Systems are costly and although excellent statistical record keeping is maintained, the hand packer is precluded from on-line immediate action, thus reacting to an after-the-event activity. The use of Shewart-charts produces excellent results (Van der Merwe, 1987) in the hands of trained supervisors who are also versed in management by objective techniques for improving productivity (Riggs & Felix, 1983).

In order to maintain vigilant content control, high speed check weighers were designed and operated to divert over-mass and under-mass filled cans from the main stream. Mechanical mass determination limits line speeds to around 250 cans per minute (cpm) (Hi-Speed Check Weigher Co., 1983), while the use of low level gamma rays to measure fill volume (Peco, 1989) coupled to computerised control and data acquisition systems permit much improved line speeds of up to 2200 cpm and certainly has application with liquids. These mass control machines can be seen as a necessary affirmation for maintaining mass standards.

The application of advanced statistical methods like Duncan's multiple range test by Maxcy & Lowry (1984) to multihead fillers, provides valuable information, but its implementation is limited by the vast number of calculations.

The use of linear programming (LP) in optimising food unit operations was discussed at a symposium chaired by Saguy & Karel (1982). These subjects were largely influenced by the use of LP in animal feed applications designed to establish minimum cost formulations (Bender et al., 1976). Recently De Kock (1988) developed a computer program for feed mixtures which runs on less sophisticated PC installations and thus brings about significant cost savings to the industry. Using LP techniques, Norback & Evans (1983) studied food mix formulations like ice cream, processed meat products, and cereal based foods.

These systems are suitable for net mass control, but do not lend themselves to effective peach half mass control and thus the requirements of ingoing mass control of canned peach half packs. A system to sort peach halves according to individual masses is needed,
but not yet available for the high speeds of 1500 to 2000 peach halves per minute per packing line of 250 cpm.

1.4 Size Sorting

Peach half uniformity control has not been studied in any great detail. In the literature almost nothing is available, apart from an effort made by Kotze & Smit (1961) who, in co-operation with a fruit canner, addressed the importance of Kakamas peach halves in respect to production costs, canning capacity of factories and the attainment of certain quality grades. They subsequently investigated the size and number of fresh whole peaches per hundred pounds (45.36 kg) of fresh mass. It was found that the average coefficient of variation was as low as 3.84 % and concluded that once the number of peaches per mass unit of 100 lbs (45.36 kg) is known, it will be possible to estimate the average size of Kakamas peaches accurately. This meant counting peach halves per 100 lb (45.36 kg) lot and reading it off a graph produced through regression analysis. They warned that this information cannot be applied to peaches of different varieties19 because of inherent shape differences.

The most prevailing method for quantitative shape description involves calculations of similarity to a sphere (Peleg & Bagley, 1987). The higher the number, the greater the similarity to a sphere. Oblong shaped products such as rice, will exhibit a low value of sphericity20. Published values for the sphericity of fruits are of the order of 89 % to 97 % (Peleg & Bagley, 1987). The geometry of a fresh peach as received at the canning factory is round and its sphericity probably close to 97 %. During the process of peach canning the geometrical properties of the fresh whole peach change from a round to an oblate shape (Peleg & Bagley, 1987). The influence of ambient temperature on size variations of peaches could be quite large during the last few weeks of growth on the tree (Bergh, 1991).

19 Variety Details In Appendix A-9
20 Defined in glossary of terms
1.5 **Problem Statement**

A reciprocating sieve stack consisting of sieve plates each with holes of different diameter is currently the only technology available to sort prepared peach halves into mass classes for the purpose of controlling count and ingoing can masses. The sieve diameters are customarily selected manually with varying success.

The problem at hand is to improve on the efficiency of the manual methods presently employed for the selection of sieve diameters.

2 **Materials And Methods**

2.1 **Peach Canning**

A synopsis of salient peach canning operations is presented here while a flow sheet, in the next section of the various processes employed in the plant where this study was conducted, completes the description. During the canning operation fresh peaches are dumped into a water dump washer from where they are elevated through a roller elevator which also evens out material flow to an even string. From here the round peaches are conveyed on a roller sorter which grades them into four nominal selected different sizes according to the distance the rollers are varied from start to the end of this conveyor. Again the peaches are dumped into water holding bins from where they are roller elevated to the pitting machines. Two kinds of pitting machines were used: The first type is the twist pitter\(^{21}\) with automatic suture aligner feeding the pitting head. In the pitting process the peach is cut along the suture line and the pit held together by the two clamping dividing knives. Two cup hands on either side of the peach half twist the halves in opposite directions, breaking them loose from the pip. The net result is a clean pip cavity. The second kind of pitter used is the knife pitter\(^{22}\). These pitters are also equipped with suture aligners. The peach is grabbed by mechanical hands and moved to be sawn in half and transferred to the scooping knife which then scoops out the pip.

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\(^{21}\) Atlas Pacific Corporation.

\(^{22}\) Food Machinery Corporation.
Materials and Methods

section from both peach halves. Because knives break when they are too small for the pip diameter, the tendency is to fit slightly larger knives to scoop clearly and cleanly around the pip. Claims are made that this cutting operation brings about greater losses of peach flesh material than would be the case with the twist pitter (Molenaar, 1989). The difference in appearance resulting directly from the use of two types of pitters influences product uniformity, but this has not deterred from the general buyers' appeal of the peaches produced at this factory (Oosthuizen, 1991).

All mispitted halves are then sent to the mispit-pitter, which orientates the peach half with its pip uppermost and feeds this into the depipping head relying on circular knife action. These knives are of greater diameter than described earlier and fairly big pip cavities are characteristic of halves pitted in the mispit-pitter. Peach halves having passed this operation were excluded from this study.

Subsequent to pitting all halves go through an inspection station upon which they are orientated cup down onto the belt feeding the continuous lye peeler where caustic soda chemically removes the peel at temperatures of about 90° C. Peach halves are subsequently washed and graded for defects before they are pumped in water flume onto the reciprocal sieve stack. This sieve stack is used to sort the peach halves into sizes as determined by the diameter of the openings of the sieve through which halves will or will not pass.

During peach preparation pip and peel removal accounts for 25% of the total mass, while trimmings reduce the yield by an additional 4% (Canning Fruit Board, 1991). Thus only 71% of the peaches actually accepted for processing is utilized in the end product. Pip losses for the knife pitters were found to be between 10% and 12% for Kakamas peaches (Van Der Merwe, 1961).
2.2 Flow Sheet

PEACH CANNING FLOW LINE

**Materials and Methods**

2.3 Sieve Sorting

Present technology sorts peaches halves into classes according to their diameter. A series of seven sorting sieves (Fig. 2-2) mounted one above the other in a reciprocating shaking machine was employed. These were mounted in such a way that each screen overlaps the other by about half its length. The undersized peach halves of the upper screen which become the oversized fruit of the screen immediately underneath, were diverted via exit ducts and spouts to the respective packing lines. The average diameter of the upper and the lower screens thus represented the arithmetic average diameter (Brennan et al., 1979) of the two screen apertures and thus of the diverted peach halves. This average diameter value best described the diameter of the peach halves in that particular sieve interval. Figure 2-1 shows peach halves being sorted on the sieve stack from Peach Halves.
which peach half data were gathered for this investigation. Peach halves sorted into such diameter classes were accepted as having been sorted into mass classes and this operation formed the basis for controlling fruit ingoing mass according to pack specifications.

Thus, seven screens with diameters usually varying between 70 mm and 35 mm at 2 - 5 mm intervals have to be selected in accordance with the masses of peach halves demanded for the different pack configurations ordered. This sieve stack configuration would be quite different in the beginning of the season to that demanded a few weeks later as effects of variety and sales requirements of finished products evolve during the production period.

Although widely used for sorting peach halves, this method has considerable disadvantages, because it will separate the units according to the narrowest dimension (Brennan et al., 1979). It is appropriate for products with a high sphericity value, but the sphericity of a halved peach according to the formula\textsuperscript{23} of (Pelag & Bagley, 1987), calculates to approximately 50 % and about half that of the whole fruit.

---

\textsuperscript{23} sphericity = \( d_c/d_e \); defined in glossary of terms

Size Sorting
Fig. 2-1  Peach Halves Being Size Sorted
2.4 Sieve Stack

Fig. 2-2 Schematic Diagram Of Peach Sorting Sieve Stack

Size Sorting
2.5 Peach Varieties

The Kakamas cling peach and the Keimoes, Goosen and Walgant were the major varieties available to canners during the Second World War period when re-armament provided a major impetus to the canning industry of the RSA (Canning Fruit Board, 1991).

These varieties ripened in short succession in the summer months of January to February in the Boland. A need to lengthen the fruit ripening season and to utilise plant and machinery over a longer period encouraged plant breeders to produce new varieties which would extend the season with fruit of both earlier and later ripening dates (Canning Fruit Board, 1991). The culmination of these efforts led to the introduction of some very successful canning cling peach varieties and the extension of the peach canning season to about four months from late December to early April. A total of 87167 t with a value of R42,119,254 was canned and sold in 1990 (Canning Fruit Board, 1990). Clingstone peach tree plantings in the RSA for 1989 are presented in Table 2-1. (Apricot Peach Growers Association, 1990).

Table 2-1. Clingstone Peach Tree Plantings

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Total (Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kakamas</td>
<td>2201</td>
</tr>
<tr>
<td>Prof Neethling</td>
<td>2004</td>
</tr>
<tr>
<td>Oom Sarel</td>
<td>1546</td>
</tr>
<tr>
<td>Woltemade</td>
<td>824</td>
</tr>
<tr>
<td>Prof Malherbe</td>
<td>673</td>
</tr>
<tr>
<td>Prof Black</td>
<td>274</td>
</tr>
<tr>
<td>Walgant</td>
<td>183</td>
</tr>
<tr>
<td>Goudmyn</td>
<td>NA²⁶</td>
</tr>
</tbody>
</table>

²⁴ Details Of South African Peach Varieties Can Be Found in Appendix A-9
²⁵ Variety Details In Appendix A-9
²⁶ New Variety; Not Available

Peach Halves
2.6 Choice Of Peach Varieties

Because the ripening dates of the different cling peach varieties available to a factory overlap it is difficult to separate varieties during a production run. This is so because fresh peaches are utilised both directly from the field and from cold storage on a first-in-first-out basis and as production requirements demand. Table 2-2 shows the micro climatic influences on ripening dates of different varieties, even in neighbouring areas as observed during the experimental period.

Table 2-2. Ripening Dates Of Neighbouring Production Areas

<table>
<thead>
<tr>
<th>Growing Area</th>
<th>Variety</th>
<th>Ashton</th>
<th>Montagu</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oom Sarel</td>
<td>14 Dec, 88</td>
<td>27 Dec, 88</td>
</tr>
<tr>
<td></td>
<td>Malherbe</td>
<td>14 Dec, 88</td>
<td>2 Jan, 89</td>
</tr>
<tr>
<td></td>
<td>Neethling</td>
<td>9 Jan, 89</td>
<td>19 Jan, 89</td>
</tr>
<tr>
<td></td>
<td>Keimoes</td>
<td>31 Jan, 89</td>
<td>8 Feb, 89</td>
</tr>
<tr>
<td></td>
<td>Kakamas</td>
<td>13 Feb, 89</td>
<td>15 Feb, 89</td>
</tr>
</tbody>
</table>

As a consequence it was decided to conduct sieve sorting tests with only the most important varieties and only on days when they were available in sufficient quantities to ensure variety processing and the reliability of the data gathered. Four of the commercially important varieties in terms of available tonne and their consecutive ripening dates were selected for this study. They were Oom Sarel, Neethling, Woltemade and Kakamas.

A brief description of their origin (Canning Fruit Board, 1990) is presented in Table 2-3 while Table 2-4 presents physical detail of the experimental material (Canning Fruit Board, 1990). Further detail can be found in Appendix A-9.
Materials and Methods

Table 2-3. Origin Of Peach Varieties

<table>
<thead>
<tr>
<th>Variety</th>
<th>Ripening</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oom Sarel</td>
<td>mid-Dec</td>
<td>RSA; Kakamas &amp; Early Dawn cross; FFRI</td>
</tr>
<tr>
<td>Neethling</td>
<td>mid-Jan</td>
<td>RSA; Kakamas &amp; Early Dawn cross; FFRI</td>
</tr>
<tr>
<td>Woltemade</td>
<td>late-Jan</td>
<td>RSA; Kakamas seedling; Nel-Brothers</td>
</tr>
<tr>
<td>Kakamas</td>
<td>mid-Feb</td>
<td>RSA; Kakamas seedling; Reinecke &amp; Collins</td>
</tr>
</tbody>
</table>

Table 2-4. Physical Properties Of Peach Varieties

<table>
<thead>
<tr>
<th>Variety</th>
<th>Mass</th>
<th>Shape</th>
<th>Released</th>
<th>Flesh Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oom Sarel</td>
<td>125g</td>
<td>round</td>
<td>1961</td>
<td>yellow</td>
</tr>
<tr>
<td>Neethling</td>
<td>130g</td>
<td>round</td>
<td>1961</td>
<td>yellow</td>
</tr>
<tr>
<td>Woltemade</td>
<td>140g</td>
<td>ovate with point</td>
<td>-</td>
<td>orange-yellow</td>
</tr>
<tr>
<td>Kakamas</td>
<td>140g</td>
<td>round to ovate</td>
<td>1938</td>
<td>yellow</td>
</tr>
</tbody>
</table>

2.7 Sampling

Peach halves were sampled for four different varieties during the 1989/90 and 1990/91 summer fruit seasons. Because the factory uses two kinds of peach pitting machines, samples from each type were collected separately. Each sample consisted of 100 peach halves. A sample was taken at each of the spout streams in use, respectively. The final number of halves actually used for mass determination per spout varied according to the number of sieves and the kinds of pitters employed at the time of sampling. This resulted in differences in the

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27 Variety Details In Appendix A-9
28 Variety Details In Appendix A-9
29 Average For Canners Grade Fruit (Canning Fruit Board, 1990)
Materials and Methods

final number of halves available per variety as indicated in Table 2-4. The masses of halves were determined on a top loading balance and recorded to the nearest gram.

Varieties were sampled separately for each observation series on the dates summarised in Table 2-5. Masses of 2440 peach halves were determined, recorded and statistically analysed.

Table 2-5. Sampling Dates For Size Sorted Peach Halves

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Date</th>
<th>STSC file</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed</td>
<td>15 Feb 89</td>
<td>PSRT89MD</td>
<td>320</td>
</tr>
<tr>
<td>Kakamas</td>
<td>8 Mar 89</td>
<td>PSRT89KD</td>
<td>280</td>
</tr>
<tr>
<td>Oom Sarel</td>
<td>8 Jan 90</td>
<td>PSRT90OD</td>
<td>520</td>
</tr>
<tr>
<td>Neethling</td>
<td>24 Jan 90</td>
<td>PSRT90ND</td>
<td>520</td>
</tr>
<tr>
<td>Woltemade</td>
<td>7 Feb 90</td>
<td>PSRT90WD</td>
<td>560</td>
</tr>
<tr>
<td>Kakamas</td>
<td>7 Mar 90</td>
<td>PSRT90KD</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>2440</td>
</tr>
</tbody>
</table>

2.8 Computer Ware

For economic reasons the computer-aided system had to be limited to an AT and application software to that available commercially. A central processing unit with 1000 Mb RAM and a 20 Mb hard drive was considered appropriate. The application required an integrated program for database and spreadsheet linking together with word processing capabilities. The program Framework III\textsuperscript{30} was selected. The various databases and spreadsheet were suitably programmed, using the FRED programming language. The Statgraphics\textsuperscript{31} application program was used for statistical analyses. Print-outs of tables and figures therefore vary according to software. Where appropriate, files were exported and imported via ASCII as needed.

\textsuperscript{30} A registered trade mark of Ashton-Tate Corporation
\textsuperscript{31} Registered Trade Mark Of The Statistical Graphics Corporation.
2.9 FRED Language

The FRED\textsuperscript{32} language is a relatively complete program language that contains functions to perform the common operations of input, output, assignment, decision, looping and string manipulation. In addition, FRED contains a number of functions to access and manipulate the various types of frames. Individual statements in the FRED language are function calls. The syntax of the FRED function is: @$<\text{function name}>(\text{parameter list})@$.

The function may be predefined as a part of the FRED language, or may be defined as required. The parameter list will contain zero or more parameters. If there are more than one parameters in a list, then the parameters will be separated by comma's (,). Some FRED functions have an optional parameter list. When FRED function is executed, it returns a value. The value may be a number, a character, or a system constant (Dinerstein, 1986; Hergert and Kamin, 1987; Simpson, 1985).

2.10 Data Recording And Reporting

Raw data were punched into STSC version 3.01 data files with file names as listed in Appendix A-4. All subsequent data reduction and statistical analyses were carried out using STSC routines as detailed in Appendix A-3. Organised raw data are contained on the enclosed 1.2 Mb floppy disk. These STSC files are arranged for frequency distribution analyses and the file names are listed in Appendix A-5.

To study frequency distribution all data, including masses obtained at the overflow spout No. 8, were included. The data files for Oom Sarel (PSRT90OD), Neethling (PSRT90ND), Woltemade (PSRT90WD) and Kakamas (PSRT90KD) for the 1989/90 season were joined to investigate the overall frequency distribution curve for all four varieties sampled during that season (PSRJ90DV). Data for the Kakamas varieties for the two seasons, 1988/89 and 1989/90 were also joined to compare the distribution of this variety over two seasons (PSRJ89DV). The frequency distributions were determined using the

\textsuperscript{32} FRED is a registered trade mark of the Ashton-Tate Corporation.
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STSC distribution fitting option. Appendix A-5 tabulates the different data files together with appropriate descriptive annotation.

Spout No. 8 delivered units which pass through the holes of the last sieve and end up on the final sieve stack plate. The nominal hole diameter of such a plate equals zero and as such provides units of nondescriptive average diameter. Unit mass data obtained from spout No.8 were therefore only included in studies of the population frequency distribution, but omitted from all other statistical analyses. Data files were accordingly modified and renamed. These are distinguished by the letter "R" as the last identifying digit of the file name. Appendix A-7 and A-8 list these files.

2.11 Statistical Analyses

Frequency distributions of peach half masses were determined with STSC and subjected to the Kolmogorov-Smirnov one sample test\(^{33}\) (STSC, 1988).

Multifactor analyses of variance (STSC, 1988), were used to test the difference between mean masses. For this purpose the data files containing mass data for the four different varieties were joined to form file PSRTJ90 for the purpose of multifactor analysis of variance to study the influence of the factors of sieve diameter, peach pitter type and varieties. The data obtained for the Kakamas variety over the season 1990 and 1989 were joined to form the file PSRTJ89 for multifactor analysis of variance to test the effect of sieve diameter and season. The Scheffe range test was used to test for significance between means (STSC, 1988; Snedecor & Cochran, 1987).

Regression of peach half mass on sieve diameter was computed using the simple regression analyses option (STSC, 1988) to establish the model of best fit.

---

\(^{33}\) Comparison of empirical and hypothesised distributions.
3 Results

3.1 The Market

It was found that buyers' specifications (Table 4-2) are uniform with respect to the fact that all stipulated the number of peach halves per can (count) and the drained mass which should be attained on cutting of the container at the point of usage.

The count specifications of different buyers for particular can sizes are quite unlike (Table 4-2). These varied widely and were compared according to their respective coefficient of variation (CV) values. Buyers' specifications were in non-homogeneous population groups. In order to reduce the large divergent count requirements, specifications were modified to reduce variation between buyers, as measured by the CV.

3.2 The Peach Crop

3.2.1 Overall View

Figure 3-1 presents a three dimensional histogram of the relative frequencies\(^{34}\) of peach halves distributed in each of the mass classes for four varieties of prepared peach halves during the 1990/91 peach season. The diagram indicates that peach halves of the same diameter yield different masses. Factors associated with these differences are presented in Tables 3-1 to 3-7.

3.2.2 Mass Frequency Distribution

The results show that the masses of prepared peach halves, ready for quality grading and packing followed the lognormal frequency distribution. These statistics are summarised in Table 3-1.

\(^{34}\) Expressed As A Percentage Of All Halves Measured

Peach Halves
Fig. 3-1  Mass Distribution Of Peach Halves During 1989/90

![3D Bar Chart showing mass distribution of peach halves. The x-axis represents sieve diameter (mm), the y-axis represents percentage, and the z-axis represents mass (g).]
Results

Table 3-1. Kolmogorov-Smirnov \(^{35}\) Values For Peach Half Masses

<table>
<thead>
<tr>
<th>File</th>
<th>Variety</th>
<th>Year</th>
<th>DN (^{36})</th>
<th>Significance (^{37})</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSRT89KDT</td>
<td>Kakamas</td>
<td>1989</td>
<td>.093228</td>
<td>.015390</td>
</tr>
<tr>
<td>PSRT90KDT</td>
<td>Kakamas</td>
<td>1990</td>
<td>.071381</td>
<td>.173211</td>
</tr>
<tr>
<td>PSRT90NDT</td>
<td>Neethling</td>
<td>1990</td>
<td>.059847</td>
<td>.048230</td>
</tr>
<tr>
<td>PSRT900DT</td>
<td>Oom Sarel</td>
<td>1990</td>
<td>.054771</td>
<td>.088321</td>
</tr>
<tr>
<td>PSRT90WDT</td>
<td>Woltemade</td>
<td>1990</td>
<td>.060440</td>
<td>.033433</td>
</tr>
</tbody>
</table>

Figures 3-2 to 3-6 present the relative frequency \(^{38}\) histograms of the mass distribution of peach halves for the four varieties studied. It is interesting to note that the lognormal distribution is skewed towards a greater frequency of smaller peach halves with corresponding lighter masses. It follows that the quantity of smaller peach halves available for canning exceeds the number of larger units. Frequency distribution tables can be found in Appendix A-5, and provide further detail regarding average class masses of the different varieties.

3.2.3 Variety

Table 3-2 shows that the average masses of peach halves with the same diameter are significantly different between the four peach varieties investigated. Oom Sarel at 54 g had the lightest average mass while the Kakamas variety was found to be the heaviest at an average mass of 68 g; a difference of 14 g per peach half on average.

\(^{35}\) See Glossary Of Terms
\(^{36}\) Overall Estimated Statistic
\(^{37}\) Significant if >.01
\(^{38}\) Expressed As A Percentage Of All Halves Measured
Fig. 3-2  Mass Distribution Of Kakamas

Variety Peach Halves During 1988/89
Fig. 3-3 Mass Distribution Of Kakamas

Variety Peach Halves During 1989/90
Fig. 3-4 Mass Distribution Of Oom Sarel

Variety Peach Halves During 1989/90
Fig. 3-5 Mass Distribution Of Neethling

Variety Peach Halves During 1989/90
Fig. 3-6  Mass Distribution Of Woltemade

Variety Peach Halves During 1969/90
Table 3-2. Average Half Masses Of Four Peach Varieties

<table>
<thead>
<tr>
<th>Level</th>
<th>Count</th>
<th>Average</th>
<th>Homogeneous Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oom Sarel</td>
<td>480</td>
<td>54.193750</td>
<td>*</td>
</tr>
<tr>
<td>Woltemade</td>
<td>520</td>
<td>60.388462</td>
<td>*</td>
</tr>
<tr>
<td>Neethling</td>
<td>480</td>
<td>63.493750</td>
<td>*</td>
</tr>
<tr>
<td>Kakamas</td>
<td>240</td>
<td>68.412500</td>
<td>*</td>
</tr>
</tbody>
</table>

* Multiple Range Analysis For PSRTJ90.UNITWT by PSRTJ90.VARIETIES at 95 Percent Confidence Intervals (STC, 1988)

Means tables for different sieve diameters and varieties derived from the multiple ANOVA analyses provide further detail and are presented in Appendix A-7.

To illustrate the full meaning of the actual mass differences observed between peach halves of different varieties, Table 3-3 was prepared. The tabulated masses were estimated from the respective regression equations for the two nominal sieve diameters chosen. It was found that during the 1989/90 season, the mass of 40 mm diameter halves varied from 27 g for Kakamas to 34 g for Neethling; for 60 mm diameter halves the mass varied from 84 g for Kakamas to 87 g for the Oom Sarel varieties.

Table 3-3. Computed Peach Half Mass\(^{39}\) For Different Peach Varieties At Two Diameters

<table>
<thead>
<tr>
<th>File</th>
<th>Variety</th>
<th>Year</th>
<th>Intercept</th>
<th>Slope 40</th>
<th>Slope 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSRT89MR</td>
<td>Mixed</td>
<td>1989</td>
<td>1.4701</td>
<td>.0475</td>
<td>29.12</td>
</tr>
<tr>
<td>PSRT90KR</td>
<td>Kakamas</td>
<td>1990</td>
<td>.9851</td>
<td>.0573</td>
<td>26.54</td>
</tr>
<tr>
<td>PSRT90NR</td>
<td>Neethling</td>
<td>1990</td>
<td>1.6766</td>
<td>.0461</td>
<td>33.85</td>
</tr>
<tr>
<td>PSRT90WR</td>
<td>Woltemade</td>
<td>1990</td>
<td>1.3577</td>
<td>.0518</td>
<td>30.86</td>
</tr>
<tr>
<td>PSRT90OR</td>
<td>Oom Sarel</td>
<td>1990</td>
<td>1.3877</td>
<td>.0514</td>
<td>31.28</td>
</tr>
<tr>
<td>PSRT89KR</td>
<td>Kakamas</td>
<td>1989</td>
<td>1.3308</td>
<td>.0525</td>
<td>30.92</td>
</tr>
</tbody>
</table>

\(^{39}\) \(Y = \exp(a + bX); \ Y = \text{Mass (g)}; \ X = \text{Diameter (mm)}\)
Peach varieties should be a major consideration in arranging size sorting sieve stacks.

3.2.4 Seasons

Data obtained on Kakamas peach halves for the 1989 and 1990 seasons indicate that the average peach half mass for the 1990 season was significantly higher at 68.42 g in comparison to the average mass of 64.17 g obtained during 1989 (Table 3-4).

<table>
<thead>
<tr>
<th>Level</th>
<th>Count</th>
<th>Average</th>
<th>Homogeneous Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>240</td>
<td>64.170833</td>
<td>*</td>
</tr>
<tr>
<td>1990</td>
<td>240</td>
<td>68.412500</td>
<td>*</td>
</tr>
</tbody>
</table>

* Multiple Range Analysis For PSRTJ89.UNITWT by PSRTJ89.SEIVDIA at 95 Percent Confidence Intervals (STC, 1988)

As shown in Table 3-4, peach half masses change from one season to the next for the same diameter. Peach size is known to be influenced by ambient temperature, especially shortly after fruit-set and during the last few weeks before harvesting (Bergh, 1991).

3.2.5 Relative Distribution

Buyers' specifications for peach half masses could be adjusted to be between 28 g and 75 g (Table 4-10). For estimating purposes this portion of the peach crop was considered as having a normal distribution. The relative proportions of prepared peach halves falling within and outside these mass parameters can then be estimated using STSC (1988) techniques.
Results

These results are summarised in Table 3-5 and detailed in Appendix A-5. It can be seen that during the 1990/91 peach crop most peach halves had masses varying between 25 g and 75 g. The relative proportions for this mass class varied between 68 % for Kakamas to 82 % for the Oom Sarel varieties. The proportion heavier than 75 g similarly varied from 13 % for Oom Sarel to 33 % in the case of Kakamas. The Kakamas variety is not expected to produce small peach halves suitable for canning.

Table 3-5. Relative Mass Distribution of Peach Halves

<table>
<thead>
<tr>
<th>File</th>
<th>Variety</th>
<th>Year</th>
<th>&lt;25 g</th>
<th>25-75 g</th>
<th>&gt;75 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSRF90OD</td>
<td>Oom Sarel</td>
<td>1990</td>
<td>4.81%</td>
<td>82.11%</td>
<td>13.08%</td>
</tr>
<tr>
<td>PSRF90WD</td>
<td>Woltemade</td>
<td>1990</td>
<td>2.68%</td>
<td>74.46%</td>
<td>22.86%</td>
</tr>
<tr>
<td>PSRF90ND</td>
<td>Neethling</td>
<td>1990</td>
<td>.96%</td>
<td>72.17%</td>
<td>26.92%</td>
</tr>
<tr>
<td>PSRF90KD</td>
<td>Kakamas</td>
<td>1990</td>
<td>.00%</td>
<td>67.50%</td>
<td>32.50%</td>
</tr>
</tbody>
</table>

Greater detail of the frequency distribution and a deeper insight into the actual distribution of peach half masses within the eight diameter classes sorted on a seven sieve stack can be found in the computed frequency distribution tables presented in Appendix A-5.

3.3 The Plant

3.3.1 Peach Pitters

The twist pitters as used in the plant gave significantly lighter average masses for the same peach half diameter as detailed in Table 3-6.
Table 3-6. Mean Masses Of Peach Halves Of Identical Diameter Obtained From Two Types Of Pitters

<table>
<thead>
<tr>
<th>Pitter</th>
<th>Count</th>
<th>Average</th>
<th>Homogeneous Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twist(^40)</td>
<td>1000</td>
<td>59.456000</td>
<td>*</td>
</tr>
<tr>
<td>Knife(^41)</td>
<td>720</td>
<td>62.298611</td>
<td>*</td>
</tr>
</tbody>
</table>

*Multiple Range Analysis For PSRTJ90.UNITWT By PSRTJ90.PITTERS At 95 Percent Confidence Intervals

3.3.2 Regression Of Mass On Sieve Diameter

The sieve stack forms the heart of the sorting operation and an understanding of the regression of peach half mass on sieve diameter is thus an imperative part to this study. The regression statistics are summarised in Table 3-7. These were all significant at P.01 level. \( R^2 \)-values obtained varied between 86.55 \% and 90.78 \%, indicating that mass variation was well described by differences in sieve diameter. The exponential model \( y = \exp(a+bX) \) provided the best fit to the peach half mass data (STSC, 1988).

\(^{40}\) Atlas Pacific Twist Pitter
\(^{41}\) Food Manufacturing Corporation Knife Pitter

Size Sorting
Table 3-7. Summary Of Regression Statistics For Four Varieties

<table>
<thead>
<tr>
<th>File</th>
<th>Var</th>
<th>Year</th>
<th>d.f</th>
<th>Intercept</th>
<th>Slope</th>
<th>R² %</th>
<th>F</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSRT89KR K</td>
<td>1989</td>
<td>239</td>
<td>1.3308</td>
<td>.0525</td>
<td>89.6800</td>
<td>2068.4470</td>
<td>.9470</td>
<td></td>
</tr>
<tr>
<td>PSRT89MR M</td>
<td>1989</td>
<td>279</td>
<td>1.4701</td>
<td>.0475</td>
<td>90.7800</td>
<td>2736.4260</td>
<td>.9528</td>
<td></td>
</tr>
<tr>
<td>PSRT90KR K</td>
<td>1990</td>
<td>239</td>
<td>.9851</td>
<td>.0573</td>
<td>86.5500</td>
<td>1531.0460</td>
<td>.9303</td>
<td></td>
</tr>
<tr>
<td>PSRT90NR N</td>
<td>1990</td>
<td>479</td>
<td>1.6766</td>
<td>.0461</td>
<td>88.7100</td>
<td>3755.7250</td>
<td>.9419</td>
<td></td>
</tr>
<tr>
<td>PSRT90OR O</td>
<td>1990</td>
<td>479</td>
<td>1.3877</td>
<td>.0514</td>
<td>88.9800</td>
<td>3861.0490</td>
<td>.9433</td>
<td></td>
</tr>
<tr>
<td>PSRT90WR W</td>
<td>1990</td>
<td>519</td>
<td>1.3577</td>
<td>.0518</td>
<td>89.7500</td>
<td>4536.4790</td>
<td>.9474</td>
<td></td>
</tr>
</tbody>
</table>

The detailed regression statistics are listed in Appendix A-8. The regression constants provide important information regarding the association of peach half mass and sieve diameter. These values were used to compute the sieve diameters and stack arrangement according to buyers' orders during the subsequent development of the computer-aided system.

To explain the exponential effects of mass change with increasing half diameter, the masses for peach halves of 40 mm and 60 mm diameters were calculated from the respective regression equations. The mass of a half was divided by its diameter to obtain the mass per millimetre of its diameter. These values are tabulated in Table 3-8. The estimated peach half masses varied from 0.7 g per mm for a half at 40 mm diameter to 1.5 g for a peach half at 60 mm diameter.

---

42 $Y = \exp(a + bX)$
43 K=Kakamas; M=Mixed Varieties; N=Neethling; O=Oom Sarel; W=Woltemade
44 Significant At P<.01
45 Significant At P<.01

Peach Halves
Table 3-8. Masses Per mm Of Peach Half Diameter At Two Sieve Sizes

<table>
<thead>
<tr>
<th>File</th>
<th>Variety</th>
<th>Year</th>
<th>Intercept</th>
<th>Slope</th>
<th>40</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSRT89MR</td>
<td>Mixed</td>
<td>1989</td>
<td>1.4701</td>
<td>.0475</td>
<td>.73</td>
<td>1.26</td>
</tr>
<tr>
<td>PSRT90KR</td>
<td>Kakamas</td>
<td>1990</td>
<td>.9851</td>
<td>.0573</td>
<td>.66</td>
<td>1.39</td>
</tr>
<tr>
<td>PSRT90NR</td>
<td>Neethling</td>
<td>1990</td>
<td>1.6766</td>
<td>.0461</td>
<td>.85</td>
<td>1.42</td>
</tr>
<tr>
<td>PSRT90WR</td>
<td>Woltemade</td>
<td>1990</td>
<td>1.3577</td>
<td>.0518</td>
<td>.77</td>
<td>1.45</td>
</tr>
<tr>
<td>PSRT90OR</td>
<td>Oom Sarel</td>
<td>1990</td>
<td>1.3877</td>
<td>.0514</td>
<td>.78</td>
<td>1.46</td>
</tr>
<tr>
<td>PSRT89KR</td>
<td>Kakamas</td>
<td>1989</td>
<td>1.3308</td>
<td>.0525</td>
<td>.77</td>
<td>1.47</td>
</tr>
</tbody>
</table>

The non-linearity of the mass to diameter relationship has to be considered an important factor when assembling the sieve stack. Appendix A-8 presents the detailed statistical results for the regression analyses of peach half mass on sieve diameter for the four varieties studied.

4 The Computer-aided System

4.1 Planning A System

In the first instance, the computer-aided system should be able to select sieve diameters more efficiently than an experienced person is able to achieve manually. Furthermore, it has to include as variables constraints determined by buyers specifications, mandatory requirements, plant restrictions, the influences of peach characteristics and the skills of those operating it. It seems impossible to take accurate decisions based on detailed inputs from sales data together with the influences of fruit character and the need for the optimum balancing of materials flow in the factory, without modern computer aids. This is simply true because of the great number of calculations needed in a short space of time.

Optimising is one of the objectives to meet and linear programming (LP) with all its usefulness comes to mind. However, with changing target parameters and with undefined and varying peach attributes, this approach seems hypothetical. It also requires mathematical skills from the user which are not always available. A
selection procedure using the high computation speed of modern computers appeared more appropriate. Also, applying user-friendly commercially available computer application software, allows practical and relevant technology transfer to this very important export industry.

A process of computer-aided selection was opted for. The RAM resident applications program Framework III with its FRED programming capability and interlinking database and spreadsheet facilities was chosen.

Consequently buyers' data were stored in databases, one for each can size, which in turn were inter-linked to a single spreadsheet for organising and controlling the computations. This configuration formed the basis of the computation system. FRED programs to compute and select the sieve stack diameter series most suited to the combined effects of the peach characteristics and a specific set of buyers' orders were written. The FRED programs are listed in Appendixes B, C and D. To avoid duplication in print-outs the FRED program for only one database was listed in Appendix C. The database for the A21/2-can size, file SPECA2.FW3 was chosen. Details regarding buyers' specifications for the A21/2-can are given in Appendix C. The FRED routine for the 1M and A10 can sizes are only available on the 1.2Mb floppy disks enclosed in the sub-frames named SPEC1M and SPECA10. The FRED programs handling the menu routine are listed in Appendix B while Appendix D lists the FRED programs for the spreadsheet computations. The program flow diagram is presented in section 4.2.
Load FW3 And Bring File Sievdiam.FW3 To The Desktop.

Recalculate Menu: Cursor On Frame Border And "f5"

Select Menu Item And Follow Prompt.

Enter Buyers' Order Parameters Into Databases (Dbs) And Follow Prompt. Enter Packing Line And Sampling Parameters Into Dbs

Enter Peach Variety Data In Spread Sheet. Follow Spread Sheet Instruction Notes And Enter Parameters.

Spread Sheet (Ss) Recalculates New Nominal Sieve Diameters From Regression Constants; Select The Available Sieves Of Equal Or Next Smaller Size From The Sieve List In The Ss; Calculate Mass Intervals From Regression Constants.

Run SIEVDIAM.FW3 By Choosing Menu Item: Recalculate All Frames.

Dbs' Calculate Target Ingoing Masses
Dbs' Read Count Range (AdjR) From Ss And Adjust Buyers' Count Specs.

Dbs' Calculate Optimum Peach Half Masses By Dividing Adjusted Counts Into Target Masses.

Dbs' Compare Optimum Target Masses With Selected Sieve Mass Intervals In Ss And Records Actual Tonne At Each Mass Class.

Dbs' Summate Optimum Sorted Tonne Per Mass Class.

Ss Summates Optimum Sorted Tonne For Each Spout And Can Size. Sorting Efficiency Is Expressed As A Percentage Of The Tonne On Order

Ss Beeps At The Cells Indicating The Percentage Sorting Efficiencies.

Save Frames And Return To Menu

4.2 Program Flow Diagram
4.3 Operating The Program

This is a menu driven program and the operator should have the new input data at hand if updating is to be done, or accept the default. The objective is to obtain the highest percentage sorting efficiency (SE) for a particular can size, or of course, for a general improved overall SE or as may be otherwise required. There is also an option for recalculation which must be performed after each and every modification to the data in any of the databases or in the spreadsheet.

To execute the program select the file SIEVDIAM.FW3 from the disk in accordance with the usual Framework III procedures. Once the frame is on the desktop, open it and Table 4-1 with both Choices and SEL90A sub-frames will be displayed within the frame. Verify that the cursor is on the frame border and press "f5" to recalculate the menu. Only the "Choices" menu in zoomed view will now appear. By moving the "cursor" keys up or down select the menu item required and press the "return" key to execute the option. Alternatively menu items may also be selected by pressing the first letter of the item eg "R" for recalculate. The menu items are descriptive.

Table 4-1. Menu Of Program To Calculate Sieve Diameters

<table>
<thead>
<tr>
<th>Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1Mcan Edit</td>
</tr>
<tr>
<td>A2.5can Edit</td>
</tr>
<tr>
<td>No10can Edit</td>
</tr>
<tr>
<td>Input Sieve Data</td>
</tr>
<tr>
<td>Current Sieve Diameters</td>
</tr>
<tr>
<td>Recalculate All And Quit</td>
</tr>
<tr>
<td>Quit</td>
</tr>
<tr>
<td>SEL90A</td>
</tr>
<tr>
<td>SPEC1M</td>
</tr>
<tr>
<td>SPECA2</td>
</tr>
<tr>
<td>SPECA10</td>
</tr>
<tr>
<td>SIV</td>
</tr>
<tr>
<td>DATA</td>
</tr>
</tbody>
</table>

Peach Halves
Example: To update buyers' specifications merely select the can size demanded in the "Choices" menu and press "E" at the prompt. Select the database cell in accordance with usual Framework III procedures and enter data. Once data entry has been completed save the frame. If data entry to more than one frame (database or spreadsheet) is required, press "f5" between each operation to recalculate the menu. The item "Recalculate All And Quit", recalculates all the databases and spreadsheet twice in succession because they are linked and interdependent. A few minutes are taken. The item "Current Sieve Diameters" merely displays the sieve diameters in use.

4.4 Databases

4.4.1 Main Functions

Databases were selected because of their usefulness in storing data required for repetitive calculations. It is necessary to establish a database for each can size, because nominal masses and net masses are constant for a particular can size and forms the basis for the sieve diameter computation and selection system. Thus a database was developed for each of the three important can sizes under consideration.

Should it be required to include new can sizes, another database must be created. The database programs may be copied directly to the newly created database. However, fairly extensive modifications to the FRED programs are required to rename the new region references in the linked database spreadsheet system and to adjust for technical differences.

4.4.2 Buyers' Orders

Buyers' orders as detailed in Table 4-2, are always uniform in their statements, specifying can size, grade, the kind of covering liquid and its cut-out concentration. The maximum and minimum number of peach halves per can, commonly known as "count" specifications, are also given. The sum of the masses of the individual peach halves making up the count shall conform to a minimum ingoing mass which is representative of the drained mass stated on the label. In addition,
the net mass is also declared on the label. These label declarations are mandatory statements intended to protect consumers against fraud and to promote fair trading. To complete the order, the quantity asked for is stipulated and is expressed in cartons, each containing 24 x A2½-cans.

Table 4-2. Detailed Buyers' Orders For A2½-Cans at 825g NtWt

<table>
<thead>
<tr>
<th>Market</th>
<th>Grade</th>
<th>CovrLiqd</th>
<th>Brix</th>
<th>MinCnt</th>
<th>MaxCnt</th>
<th>Cartns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>stndrd syrup</td>
<td>17-19</td>
<td>5</td>
<td>18</td>
<td>15360</td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td>substd syrup</td>
<td>17-19</td>
<td>5</td>
<td>18</td>
<td>22272</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>choice syrup</td>
<td>17-19</td>
<td>14</td>
<td>18</td>
<td>1536</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>choice syrup</td>
<td>17-19</td>
<td>12</td>
<td>14</td>
<td>17000</td>
<td></td>
</tr>
<tr>
<td>Libby</td>
<td>fancy syrup</td>
<td>17-19</td>
<td>8</td>
<td>12</td>
<td>4654</td>
<td></td>
</tr>
<tr>
<td>PettyWood</td>
<td>fancy syrup</td>
<td>17-19</td>
<td>5</td>
<td>6</td>
<td>1162</td>
<td></td>
</tr>
<tr>
<td>Swiss</td>
<td>choice syrup</td>
<td>17-19</td>
<td>10</td>
<td>12</td>
<td>5720</td>
<td></td>
</tr>
<tr>
<td>Swiss</td>
<td>choice syrup</td>
<td>17-19</td>
<td>8</td>
<td>10</td>
<td>6912</td>
<td></td>
</tr>
<tr>
<td>Taiwan</td>
<td>choice syrup</td>
<td>18-20</td>
<td>7</td>
<td>8</td>
<td>17000</td>
<td></td>
</tr>
<tr>
<td>Taiwan</td>
<td>choice syrup</td>
<td>18-20</td>
<td>8</td>
<td>10</td>
<td>6912</td>
<td></td>
</tr>
</tbody>
</table>

4.4.3 Target Ingoing Mass

The influence of natural variation due to fruit mass, can size and other packing line characteristics has to be considered. This variation is adequately represented by the standard deviation (s) around the mean for a particular line set-up. The importance of close control over the standard deviation of a line for achieving target mass and cost savings was explained (Van der Merwe, 1987).

---

46 Oosthuizen (1989)
47 Net Mass
48 Covering liquid
49 Minimum count
50 Maximum count
51 Cartons each with 48 cans

Peach Halves
Computer-aided System

It remains essential (Van der Merwe, 1987) to measure the standard deviation regularly, especially if modifications to unit operations affecting peach half masses and packing efficiency were made. New values should be entered into the respective databases in the same way as buyers' orders would be modified.

Tolerances associated with ingoing mass requirements are discussed in the detailed description of the current EEC mass system summarised in Appendix A-2. The application of this system was previously discussed in great detail by Van der Merwe (1987).

In order to be 95% confident that the production conforms to the mandatory requirements the largest value of Rule 4 and Rule 5 shall be used as the target ingoing mass (DrndWt) for filling purposes. Table 4-3 provides the details contained in the database for A2½-cans. Although the nominal mass (NomWt) in this example is constant and typical of most orders for a particular can size, it may vary with changes in the covering liquid requirements. It is assumed that the standard deviations for all A2½-lines in use are the same, hence the constant DrndWt values.
The calculated target mass (DrndWt) is used for determining the different optimum peach half masses corresponding to the respective count values specified. The DrndWt is merely divided by the count.

### 4.4.4 Count Analysis

The count specified for a particular can size varies significantly between the different buyers as shown in Table 4-4.

---

**Table 4-3. Target Ingoing Mass**

<table>
<thead>
<tr>
<th>Market</th>
<th>NomWt</th>
<th>sw</th>
<th>n</th>
<th>TNE</th>
<th>Rule4</th>
<th>Rule5</th>
<th>DrndWt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>500</td>
<td>14</td>
<td>8</td>
<td>15</td>
<td>510</td>
<td>483</td>
<td>510</td>
</tr>
<tr>
<td>Austria</td>
<td>500</td>
<td>14</td>
<td>8</td>
<td>15</td>
<td>510</td>
<td>483</td>
<td>510</td>
</tr>
<tr>
<td>Germany</td>
<td>500</td>
<td>14</td>
<td>8</td>
<td>15</td>
<td>510</td>
<td>483</td>
<td>510</td>
</tr>
<tr>
<td>Germany</td>
<td>500</td>
<td>14</td>
<td>8</td>
<td>15</td>
<td>510</td>
<td>483</td>
<td>510</td>
</tr>
<tr>
<td>Libby</td>
<td>500</td>
<td>14</td>
<td>8</td>
<td>15</td>
<td>510</td>
<td>483</td>
<td>510</td>
</tr>
<tr>
<td>PettyWood</td>
<td>500</td>
<td>14</td>
<td>8</td>
<td>15</td>
<td>510</td>
<td>483</td>
<td>510</td>
</tr>
<tr>
<td>Swiss</td>
<td>500</td>
<td>14</td>
<td>8</td>
<td>15</td>
<td>510</td>
<td>483</td>
<td>510</td>
</tr>
<tr>
<td>Swiss</td>
<td>500</td>
<td>14</td>
<td>8</td>
<td>15</td>
<td>510</td>
<td>483</td>
<td>510</td>
</tr>
<tr>
<td>Taiwan</td>
<td>500</td>
<td>14</td>
<td>8</td>
<td>15</td>
<td>510</td>
<td>483</td>
<td>510</td>
</tr>
<tr>
<td>Taiwan</td>
<td>500</td>
<td>14</td>
<td>8</td>
<td>15</td>
<td>510</td>
<td>483</td>
<td>510</td>
</tr>
</tbody>
</table>

---

52 Nominal Weight  
53 Standard Deviation For Line Ingoing Masses  
54 Number Of Units In Sample  
55 Tolerable Negative Error  
56 Appendix A; EEC Minimum Average Drained Mass Requirement  
57 Appendix A; EEC Minimum Single Unit Mass Requirement  
58 Target Ingoing Mass For Filling

Peach Halves
Table 4-4. Counts For A2½-Cans

<table>
<thead>
<tr>
<th>Market</th>
<th>Minimum Count</th>
<th>Maximum Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Austria</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Germany</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Germany</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Libby</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>PettyWood</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Swiss</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Swiss</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Taiwan</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Taiwan</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

The coefficient of variation (CV) (Snedecor & Cochran, 1987) describes the degree of variation in the population. The CV (CntCV) for the different counts specified varied from as low as 13 % to as much as 109 % in the case of A2½-can sizes (Table 4-5). In order to bring the populations closer together the count specifications were adjusted by the database program. A Range correcting factor (Rcor) was used for calculating the count correction factor (CntCorr). This value of Rcor may be changed up or down by changing the AdjR value in the linked spreadsheet during editing.

Because the target drained mass for a particular can size is usually the same, the net effect of a more homogeneous specification permits the selection of peach halves of more uniform masses. This rearrangement brings the count requirements closer to the reality of production capabilities, uniformity objectives and attainable sorting sieve stack arrangements. The buyers' count specifications as presented in Table 4-5, were subsequently adjusted by the database programs to the corresponding CntCorr values of a more homogeneous nature.

Size Sorting
Table 4-5. Count Analysis Of A2\frac{1}{2}-Cans

<table>
<thead>
<tr>
<th>Market</th>
<th>CntAv&lt;sup&gt;59&lt;/sup&gt;</th>
<th>CntR&lt;sup&gt;60&lt;/sup&gt;</th>
<th>CntCV&lt;sup&gt;61&lt;/sup&gt;</th>
<th>RCor&lt;sup&gt;62&lt;/sup&gt;</th>
<th>CntCorr&lt;sup&gt;63&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>12</td>
<td>13</td>
<td>109</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Austria</td>
<td>12</td>
<td>13</td>
<td>109</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Germany</td>
<td>16</td>
<td>4</td>
<td>25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Germany</td>
<td>13</td>
<td>2</td>
<td>16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Libby</td>
<td>10</td>
<td>4</td>
<td>40</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PettyWood</td>
<td>6</td>
<td>1</td>
<td>17</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Swiss</td>
<td>11</td>
<td>2</td>
<td>19</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Swiss</td>
<td>9</td>
<td>2</td>
<td>23</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Taiwan</td>
<td>8</td>
<td>1</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Taiwan</td>
<td>9</td>
<td>2</td>
<td>23</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The count correcting factors may be varied according to the size of the CV by modifying the AdjR value in the linked spreadsheet while in the edit mode and in accordance with the nature of trends in buyers' specifications. This section of the databases computes the preferred CV. Table 4-6 provides a typical example of specified counts in comparison with the adjusted counts as used in forward computations.

---

59 Count Average  
60 Count Range  
61 Count Coefficient Of Variation  
62 Range Corrector  
63 Count Corrector; Reads From Spreadsheet Input
Table 4-6. Adjusted Count Values For A2½-Cans

<table>
<thead>
<tr>
<th>Market</th>
<th>CorMinCnt</th>
<th>CorMaxCnt</th>
<th>CorCntAv</th>
<th>CorCntR</th>
<th>CorCntCy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>13</td>
<td>14</td>
<td>14</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Austria</td>
<td>13</td>
<td>14</td>
<td>14</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Germany</td>
<td>14</td>
<td>18</td>
<td>16</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Germany</td>
<td>12</td>
<td>14</td>
<td>13</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>Libby</td>
<td>8</td>
<td>12</td>
<td>10</td>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>PettyWood</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Swiss</td>
<td>10</td>
<td>12</td>
<td>11</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>Swiss</td>
<td>8</td>
<td>10</td>
<td>9</td>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>Taiwan</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Taiwan</td>
<td>8</td>
<td>10</td>
<td>9</td>
<td>2</td>
<td>23</td>
</tr>
</tbody>
</table>

4.4.5 Optimum Mass Determination

Buyers do not specify a constant count, but rather maximum and minimum values. This means that when the specified ingoing mass (drained mass) is divided by the counts specified for a particular can size, optimum peach half masses for each of the counts specified, are determined.

These masses are calculated in this section of the database under the respective heading of Wt 1, Wt 2, .... Wt 6. For example, one set of specifications could have respective ideal half masses of 36 g, 34 g, 31 g, 30 g, and 28 g for the A2½-can size with a target mass of 510 g as shown in Table 4-7. These values were used by the next database section as inputs to obtain the tonne of halves expected to be exiting each spout.

---

64 Corrected Minimum Count
65 Corrected Maximum Count
66 Corrected Count Average
67 Corrected Count Range
68 Corrected Count Coefficient Of Variation

Size Sorting
Table 4-7. Optimum Masses Required

<table>
<thead>
<tr>
<th>Market</th>
<th>Wt1</th>
<th>Wt2</th>
<th>Wt3</th>
<th>Wt4</th>
<th>Wt5</th>
<th>Wt6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>39</td>
<td>36</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Austria</td>
<td>39</td>
<td>36</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Germany</td>
<td>36</td>
<td>34</td>
<td>31</td>
<td>30</td>
<td>28</td>
<td>.</td>
</tr>
<tr>
<td>Germany</td>
<td>42</td>
<td>39</td>
<td>36</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Libby</td>
<td>63</td>
<td>56</td>
<td>51</td>
<td>46</td>
<td>42</td>
<td>.</td>
</tr>
<tr>
<td>PettyWood</td>
<td>102</td>
<td>85</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Swiss</td>
<td>51</td>
<td>46</td>
<td>42</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Swiss</td>
<td>63</td>
<td>56</td>
<td>51</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Taiwan</td>
<td>72</td>
<td>63</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Taiwan</td>
<td>63</td>
<td>56</td>
<td>51</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>

4.4.6 Spout Tonne

This section of the database calculates the tonne (t) of peach halves expected to be selected according to the mass classes specified in the linked spreadsheet. The different W1, W2, ..., W6 values are used by the next database section as inputs to obtain the tonne of halves expected to be exiting each spout. For example, the system compares each of the masses in Table 4-7 with that of the mass class in the spreadsheet. If the half mass is heavier than that for a mass class i.e. the peach half will not fall through the next sieve hole, it computes and enters the tonne on order for that count mass combination. This routine is repeated for each order. To illustrate from Table 4-8, 72 g in the Wt1 column was found to be heavier than class No2 (spout No2) and the corresponding quantity of 104 t was entered in the No2 column of Table 4-8. In this way Table 4-8 forms a matrix of tonne quantities corresponding to optimum masses for each order and at the same time indicates which spout will deliver the corresponding amount. This table shows that spout No6 will deliver halves of selected optimum mass against six different orders, while in comparison spout No2 is expected to output 104 t and spout

---

Peach Halves

---
No3, also 104 t against a Taiwanese order of 17000 cartons (Table 4-2). Thus, to obtain a near optimum ingoing mass of 510 g for the A2½-can size, 7 halves per can should be packed from spout No2 and 8 halves per can from spout No3 respectively, to complete the order.

Table 4-8. Tonne Of Sorted Peach Halves Exiting From Different Spouts According To Buyers Orders

<table>
<thead>
<tr>
<th>Market</th>
<th>No1</th>
<th>No2</th>
<th>No3</th>
<th>No4</th>
<th>No5</th>
<th>No6</th>
<th>No7</th>
<th>No8</th>
<th>Opt</th>
<th>Exd</th>
<th>TonOpt</th>
<th>TonOvr</th>
<th>Tonne</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austr</td>
<td>.</td>
<td>.</td>
<td>188</td>
<td>.</td>
<td>2</td>
<td>1</td>
<td>94</td>
<td>94</td>
<td>188</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Austr</td>
<td>.</td>
<td>.</td>
<td>272</td>
<td>.</td>
<td>2</td>
<td>1</td>
<td>136</td>
<td>136</td>
<td>273</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>German</td>
<td>.</td>
<td>.</td>
<td>9</td>
<td>9</td>
<td>5</td>
<td>2</td>
<td>7</td>
<td>11</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>German</td>
<td>.</td>
<td>.</td>
<td>208</td>
<td>.</td>
<td>3</td>
<td>1</td>
<td>69</td>
<td>138</td>
<td>208</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Libby</td>
<td>.</td>
<td>.</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>5</td>
<td>4</td>
<td>45</td>
<td>11</td>
<td>57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PetWod</td>
<td>14</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>2</td>
<td>1</td>
<td>7</td>
<td>7</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swiss</td>
<td>.</td>
<td>.</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>.</td>
<td>3</td>
<td>3</td>
<td>70</td>
<td>0</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swiss</td>
<td>.</td>
<td>.</td>
<td>42</td>
<td>42</td>
<td>.</td>
<td>.</td>
<td>3</td>
<td>2</td>
<td>56</td>
<td>28</td>
<td>85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taiwan</td>
<td>104</td>
<td>104</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>2</td>
<td>2</td>
<td>208</td>
<td>0</td>
<td>208</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taiwan</td>
<td>.</td>
<td>.</td>
<td>42</td>
<td>42</td>
<td>.</td>
<td>.</td>
<td>3</td>
<td>2</td>
<td>56</td>
<td>28</td>
<td>85</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This next column of this section in Table 4-8 calculates and provides the operator with quantitative data on how effective the sieve stack selection was. The number of mass options are specified in the "Opt" column and the mass options for which suitable sieve diameters were available in the current sieve arrangement (Table 4-12), are shown in the "Exd" column. The next two columns provide the tonne optimally sorted (TonOpt) and the tonne that were not optimally sorted (TonOvr). The last column (Tonne) provides the tonne ordered by the specific buyer. By comparing these figures an estimate is made of the efficiency of any particular sieve stack arrangement.

A sorting bias towards smaller or larger can sizes can be readily monitored and adjusted. Adjustments are made by changing maximum and/or minimum peach half masses in the spread sheet. The tonne quantities for each can size are summated in the spreadsheet, Table 4-13 and expressed as the percentage of the quantity on order. This ratio describes the sorting efficiency (SE) of any particular sieve stack set-up.
4.5 Spreadsheet

4.5.1 Data Entry

When the spreadsheet is selected from the menu it zooms to display the section shown in Table 4-9. These directives guide data entry into the spreadsheet for subsequent computations.

Table 4-9. Data Entry Notes

<table>
<thead>
<tr>
<th>ENTRY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Set AdjR For Comparable AvgCV's</td>
</tr>
<tr>
<td>2. Heaviest And Lightest Masses</td>
</tr>
<tr>
<td>3. Regression Constants &amp; Variety</td>
</tr>
<tr>
<td>4. Quantity Of Sieves</td>
</tr>
</tbody>
</table>

Entry 1, "AdjR" is needed to recalculate the maximum feasible Range permitted for counts specified by the buyers. If the difference between maximum and minimum count specified by buyers is too large the specification actually requires peach half masses not available in the population of prepared halves and can be considered unrealistic and is to be adjusted. The Range (R) is used to calculate the CV values for the different databases and the average values are displayed in the spreadsheet. This entry is only required when a new specification differs widely from those under consideration.

Entry 2, "Heaviest And Lightest Masses" must be stipulated in accordance with the minimum, maximum and average masses specified by the buyers and tabulated in the spreadsheet Table 4-10. These inputs are demanded to compute the largest and smallest screen diameters required for the sieve stack arrangement and then the screen interval.

Entry 3, "Regression Constants & Variety" should be adjusted as varieties change with the progression of the fruit season, but also when modifications to the pitting operation is made eg. a switch to a new type of pitter or to a different type of mechanical component of the pitting or sorting operations. Also important to consider are seasonal and variety changes which influence fruit size and mass relationships. The regression constants will require modification to Peach Halves
ensure proper size sorting of the four varieties investigated. However, with mixtures of unknown character, regression constants should be estimated or ideally computed from new mass and diameter data.

Entry 4, "Quantity Of Sieves" may be modified according to the mass interval required. This value may be reduced when the maximum and minimum mass requirements are brought closer together for smaller Ranges in specifications. This value is not often changed and seven sieves describe the sieve stack well.

The program finds the lightest and heaviest optimum masses from the linked databases and displays the values in the cells corresponding to the rows marked "Lightest" and "Heaviest" of the columns labelled "1M", "A2½" and A10 of the spreadsheet (Table 4-10). Two of these values, or two others are chosen and entered into the cells "Lightest =" and "Heaviest =" (Table 4-10).

The count Ranges may be adjusted to achieve more consistent CV values between the counts specified by different buyers. This can be done by entering different Range values into the respective cells corresponding to a particular can size in row "AdjR" (Table 4-10). The Range of the maximum and minimum count specifications contained in the different linked databases will be modified accordingly to the values entered in these cells. This completes the entries required for subsequent computation.

Table 4-10 provides an example of a typical set of data for Neethling peach halves as entered into the spreadsheet.
Table 4-10. Typical Spreadsheet Data

\[ Y = \exp(a+bX) \]
\[ a = 1.6766 \]
\[ b = .0461 \]

**Variety** = Neethling

- **MinDia** = 35
- **MaxDia** = 57
- **Sieves** = 7
- **AvrgWt** = 48

<table>
<thead>
<tr>
<th></th>
<th>1M</th>
<th>A2 1/2</th>
<th>A10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lightest</strong></td>
<td>28 g</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td><strong>Heaviest</strong></td>
<td>75 g</td>
<td>64</td>
<td>102</td>
</tr>
<tr>
<td><strong>AvSpecWt</strong></td>
<td>47 g</td>
<td>39</td>
<td>52</td>
</tr>
<tr>
<td><strong>SieveCV</strong></td>
<td>98</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td><strong>WtIntervl</strong></td>
<td>8</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td><strong>AdjR</strong></td>
<td>2</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td><strong>Max R</strong></td>
<td>6</td>
<td>13</td>
<td>56</td>
</tr>
<tr>
<td><strong>Min R</strong></td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

4.5.2 *Sieve Stack*

The available sieve plates were manufactured with hole diameters specified in inches and sixteenths of an inch in accordance with the imperial system. For cost saving reasons these were remarked to the calculated metric equivalent. Table 4-11 provides detail of the sieve plates available for selection.
Sieve hole diameters are calculated from the regression equation and displayed in the "mark" column. The program searches the sieve plate list (Table 4-11) and selects the diameter specified if available, else the next one smaller than specified is selected. The actual sieve diameter selected from the table of available sieves is displayed in column "mm" of Table 4-12.

Mass classes are then computed by substituting actual sieve diameters into the active regression equation. The computed mass classes are displayed in the section "Derived Values" of Table 4-12. These mass classes provide the input to the various databases when spout tonne values are computed (Section 4.4.6).

---

**Table 4-11. Sieve Plates Available**

<table>
<thead>
<tr>
<th>Sieve mark</th>
<th>Nominal Diameter mm&lt;sup&gt;70&lt;/sup&gt;</th>
<th>Sieve mark</th>
<th>Nominal Diameter mm&lt;sup&gt;72&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in&lt;sup&gt;71&lt;/sup&gt;</td>
<td></td>
<td>in&lt;sup&gt;73&lt;/sup&gt;</td>
</tr>
<tr>
<td>28</td>
<td>28.58 1/2/16</td>
<td>50</td>
<td>50.80 20/16</td>
</tr>
<tr>
<td>30.16</td>
<td>52</td>
<td>52.39 21/16</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>31.75 1/3/16</td>
<td>54</td>
<td>53.98 22/16</td>
</tr>
<tr>
<td>33</td>
<td>33.34 1/4/16</td>
<td>57</td>
<td>55.56 23/16</td>
</tr>
<tr>
<td>34.93</td>
<td>1/5/16</td>
<td>58</td>
<td>58.74 24/16</td>
</tr>
<tr>
<td>35</td>
<td>1/6/16</td>
<td>58</td>
<td>58.74 25/16</td>
</tr>
<tr>
<td>36</td>
<td>36.51 1/7/16</td>
<td>60</td>
<td>60.33 26/16</td>
</tr>
<tr>
<td>38</td>
<td>38.10 1/8/16</td>
<td>60</td>
<td>60.33 26/16</td>
</tr>
<tr>
<td>39</td>
<td>39.69 1/9/16</td>
<td>61</td>
<td>61.91 27/16</td>
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<tr>
<td>41</td>
<td>41.28 1/10/16</td>
<td>63</td>
<td>63.50 28/16</td>
</tr>
<tr>
<td>42.86</td>
<td>1/11/16</td>
<td>67</td>
<td>66.68 210/16</td>
</tr>
<tr>
<td>44</td>
<td>44.45 1/12/16</td>
<td>69</td>
<td>69.85 212/16</td>
</tr>
<tr>
<td>46.04</td>
<td>1/13/16</td>
<td>74</td>
<td>73.03 214/16</td>
</tr>
<tr>
<td>47</td>
<td>47.63 1/14/16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49.21</td>
<td>1/15/16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4-12. Typical Sieve Stack With Estimated Mass Classes

<table>
<thead>
<tr>
<th>Selected Sieve Diameter</th>
<th>Derived Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>mark</td>
<td>mm</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>34.93</td>
</tr>
<tr>
<td>41</td>
<td>39.69</td>
</tr>
<tr>
<td>45</td>
<td>44.45</td>
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<tr>
<td>49</td>
<td>47.63</td>
</tr>
<tr>
<td>52</td>
<td>50.80</td>
</tr>
<tr>
<td>55</td>
<td>53.98</td>
</tr>
<tr>
<td>57</td>
<td>55.56</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.5.3 Spout Outputs

The mass interval based on the number of sieves in use is then calculated. Although the sieve stack can take a maximum of seven sieves, fewer may be used from time to time to suit the requirements. The number of sieves should be entered into the spreadsheet as demanded.

The last section of the spreadsheet summates the output of each spout for each of the can sizes packed. The output quantities optimally sorted for each can size is expressed as a percentage of that on order. These ratios indicate the sorting efficiency achieved for each can size, as well as that for the total operation.

For a particular can size the tonne peach halves optimally sorted in the assembled sieve stack were expressed as a percentage of that on order. This was termed Sorting Efficiency (SE). Table 4-13 shows that a 86% SE was obtained for the 1206 t ordered for the A2½-can size, while an overall SE of 86% was obtained for the total pack of 2291 t on order.
Table 4-13. Detail Of Tonne Sorted

<table>
<thead>
<tr>
<th>Spout #</th>
<th>1M t</th>
<th>A2½ t</th>
<th>A10 t</th>
<th>Totals t</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>7</td>
<td>266</td>
<td>18</td>
<td>70</td>
<td>354</td>
</tr>
<tr>
<td>6</td>
<td>230</td>
<td>564</td>
<td>20</td>
<td>814</td>
</tr>
<tr>
<td>5</td>
<td>24</td>
<td>564</td>
<td>88</td>
<td>676</td>
</tr>
<tr>
<td>4</td>
<td>47</td>
<td>147</td>
<td>166</td>
<td>360</td>
</tr>
<tr>
<td>3</td>
<td>23</td>
<td>188</td>
<td>106</td>
<td>317</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>118</td>
<td>0</td>
<td>118</td>
</tr>
</tbody>
</table>

OptSort = 561 1036 365 1962
Requird = 596 1206 489 2291

% SE = 94.15 85.91 74.63 85.64

4.6 System Evaluation

4.6.1 System Efficiencies

The computer-aided system proved to be more efficient in specifying sieve diameters in a stack arrangement. Tables 4-14 compares the SE value of 86% obtained with the computer-aided system sorting the Neethling variety to the SE of 72% (Table 4-15) in a manually arranged sieve stack with regression constants not used for sieve diameter determination. This manually selected sieve stack was used for different varieties for most of the 1988/89 and 1989/90 seasons (Swart, 1991).


Table 4-14. Computer-aided Sorting Sieve Arrangement

<table>
<thead>
<tr>
<th>Select Sieve Diam mark mm</th>
<th>Derived Values</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wt Classes</td>
<td>AvrgWt</td>
<td>Spout #</td>
</tr>
<tr>
<td></td>
<td>g</td>
<td>g</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>up to</td>
<td>26</td>
<td>8</td>
</tr>
<tr>
<td>41</td>
<td>26 to</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>45</td>
<td>33 to</td>
<td>41</td>
<td>37</td>
</tr>
<tr>
<td>49</td>
<td>41 to</td>
<td>48</td>
<td>45</td>
</tr>
<tr>
<td>52</td>
<td>48 to</td>
<td>55</td>
<td>52</td>
</tr>
<tr>
<td>55</td>
<td>55 to</td>
<td>64</td>
<td>60</td>
</tr>
<tr>
<td>57</td>
<td>64 to</td>
<td>69</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>69 and larger</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

\( Y = \exp(a+bX) \)

| a = | 1.6766 | |
| b = | 0.0461 | |

<table>
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<tr>
<th>Variety = Neethling</th>
<th>Spout #</th>
<th>1M</th>
<th>A2\frac{1}{2}</th>
<th>A10</th>
<th>Totals</th>
</tr>
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<tbody>
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<td></td>
<td>7</td>
<td>266</td>
<td>18</td>
<td>70</td>
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</tr>
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<td></td>
<td>6</td>
<td>230</td>
<td>564</td>
<td>20</td>
<td>814</td>
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<td>5</td>
<td>24</td>
<td>564</td>
<td>88</td>
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<td>4</td>
<td>47</td>
<td>147</td>
<td>166</td>
<td>360</td>
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<tr>
<td>Sieves = 7</td>
<td>3</td>
<td>23</td>
<td>188</td>
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<td>0</td>
<td>15</td>
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<td>1</td>
<td>0</td>
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<tr>
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<td>1036</td>
<td>365</td>
<td>1962</td>
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</tr>
<tr>
<td></td>
<td>Requird = 596</td>
<td>1206</td>
<td>489</td>
<td>2291</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% SE = 94.15</td>
<td>85.91</td>
<td>74.63</td>
<td>85.64</td>
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Peach Halves
4.6.3 Manually Arranged Sieve Stack

Table 4-15. Manual Sorting Sieve Arrangement

<table>
<thead>
<tr>
<th>Select Sieve Diam mark mm</th>
<th>Derived Values</th>
<th>Wt Classes</th>
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<th>Spout #</th>
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<tr>
<td>39.69</td>
<td>up to</td>
<td>26</td>
<td>8</td>
<td></td>
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<tr>
<td>44</td>
<td>26 to</td>
<td>31</td>
<td>29</td>
<td>7</td>
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<tr>
<td>47</td>
<td>31 to</td>
<td>37</td>
<td>34</td>
<td>6</td>
</tr>
<tr>
<td>50</td>
<td>37 to</td>
<td>44</td>
<td>41</td>
<td>5</td>
</tr>
<tr>
<td>54</td>
<td>44 to</td>
<td>59</td>
<td>52</td>
<td>4</td>
</tr>
<tr>
<td>58</td>
<td>59 to</td>
<td>70</td>
<td>65</td>
<td>3</td>
</tr>
<tr>
<td>63</td>
<td>70 to</td>
<td>93</td>
<td>82</td>
<td>2</td>
</tr>
<tr>
<td>93 and larger</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
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\[ Y = \exp(a+bX) \]

<table>
<thead>
<tr>
<th>Variety= Peaches74</th>
<th>Spout #</th>
<th>1M</th>
<th>A2½</th>
<th>A10</th>
<th>Totals</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>t</td>
<td>t</td>
<td>t</td>
<td>t</td>
<td></td>
</tr>
<tr>
<td>a =</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>b =</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MinDia = 40</td>
<td>7</td>
<td>45</td>
<td>18</td>
<td>70</td>
<td>133</td>
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<td>MaxDia = 58</td>
<td>6</td>
<td>451</td>
<td>564</td>
<td>0</td>
<td>1015</td>
</tr>
<tr>
<td>Sieves = 7</td>
<td>5</td>
<td>24</td>
<td>564</td>
<td>20</td>
<td>608</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>47</td>
<td>175</td>
<td>346</td>
<td>568</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>23</td>
<td>188</td>
<td>30</td>
<td>241</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0</td>
<td>111</td>
<td>0</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>AvrgWt = 50</td>
<td>OptSort = 400</td>
<td>1015</td>
<td>243</td>
<td>1658</td>
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</tr>
<tr>
<td></td>
<td>Requird = 596</td>
<td>1206</td>
<td>489</td>
<td>2291</td>
<td></td>
</tr>
<tr>
<td></td>
<td>% SE = 67.13</td>
<td>84.16</td>
<td>49.69</td>
<td>72.37</td>
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</tr>
</tbody>
</table>

5 Discussion

The canning peach industry processed 87 167 t clingstone peaches during 1989/90 season (Canning Fruit Board, 1990) as opposed to the estimated 15 000 t sold on the fresh fruit market (Canning Fruit Board, 1991) and remains a major outlet to peach growers. Canned

74 Variety Characteristics Not Considered

Size Sorting
Discussion

peaches realised a steady increase in foreign exchange earnings currently exceeding R95 million per year (Canning Fruit Board, 1991). Between 74% and 98% of all canned peaches produced in the RSA since 1985 was sold abroad (Canning Fruit Board, 1991). As a result, foreign buyers' specifications dominate the standards to which canned peaches are produced in the RSA. In reality canners have to conform to both national and international statutory standards, but even more apt, they have to have tight control over manufacturing costs to meet price competition.

Canned fruit exported to the European Economic Countries require a statement of net mass, as well as a statement of drained mass on the label. The net mass is the sum of the mass of fruit packed (ingoing mass) and the mass of the covering liquid added. The ingoing mass of a can of peach halves is the sum total of the individual masses of each half contained in that can. The variation in ingoing masses is a direct result of differences between the mass of individual halves. This variation in mass between the individual peach halves influences the standard deviation (Van der Merwe, 1987). It also follows that the method used to sort halves into mass classes will have a major influence on the standard deviation of the average class mass. If it were possible to select halves with identical masses the contribution towards the standard deviation would be zero. Target ingoing masses will resultantly tend lower, with expected corresponding savings. This is so because the influence of the standard deviation in the target mass estimation is diminished. When the filling operation is characterised by a large standard deviation value of say 10.0 g and a small standard deviation of 0.5 g respectively, for two different powder filling lines, it is important to note that the calculated target masses to ensure 95% confidence limits are quite different at 506 g and 500 g respectively for a declared nominal mass of 500 g and a sample size of 10 units (Van der Merwe, 1987). Target masses have to be calculated for each line and of course, recalculated when product attributes related to density, shape, size and other geometric properties change.

Checkweighers (Hi-Speed Check Weigher Co., 1983) are designed to determine the mass of filled cans. When applied to peach half canning it could be employed to check net masses. However, it cannot control the mass variation between individual peach halves and if used to control ingoing masses, only the group masses are measured.
No additional advantages are thus achieved. The only way to reduce the fluctuation of ingoing masses would be to reduce the mass differences between individual peach halves as expressed by the standard deviation (Table 1-2 and 1-3). This in turn can only be attained through an improved method of sorting peach halves into masses which when multiplied by the count, will yield the desired ingoing mass with its standard deviation tending to the hypothetical zero value (Table 1-3).

A system to sort peach halves according to individual masses is required, but not yet available for the high speeds of 1500 to 2000 peach halves per minute per A2½-packing line of 250 cpm at which canners operate.

Peach half uniformity control has not been studied in any great detail recently. In the literature almost nothing is available, apart from an effort made by Kotze & Smit (1961) who, in co-operation with a fruit canner, addressed the importance of Kakamas peach halves in respect to production costs, canning capacity of factories and the attainment of certain quality grades.

A reciprocating sieve stack consisting of sieve plates each with holes of different diameter is currently the only technology available to sort prepared peach halves into classes for the purpose of controlling ingoing can masses. The smaller the difference in diameter between two sieves, the less the expected standard deviation of the average mass in each of the classes would be.

The use of sieve plates with holes through which the product passes or does not pass is appropriate for products with a high sphericity value (Peleg & Bagley, 1987). Although the geometry of a fresh peach as received at the canning factory is round and its sphericity probably close to 97% (Peleg & Bagley, 1987), it changes during the process of peach canning. The peach is cut along its suture line into two halves in order to remove the pip, thus changing its geometrical properties from a round to an oblate shape (Pelag & Bagley, 1987). The sphericity of a halved peach calculates to approximately 50%, which is about half that of the whole fruit and will be separated according to its narrowest dimension with expected poor repeatability.
Discussion

Peach halves sorted into these diameter classes are accepted as having been sorted into mass classes and form thus the basis for controlling fruit ingoing mass according to pack specifications. The sieve stack and its arrangement can be looked upon as the heart of the mass sorting operation. Accordingly, the most suitable screen diameters must be selected in relation to the masses of the peach half masses needed for the various count specifications.

Although it is well known that peach half masses vary with their diameter and also with the variety of peach, with ambient temperature conditions (Bergh, 1991) and other uncontrollable factors, the exact nature of these relationships are not readily available to canners. This void in information has possibly led to the perception amongst some canners that it would be a futile exercise to endeavour an exact sieve stack set-up, due to the unpredictable variation in fruit properties (Swart, 1991). The sieve diameters are currently selected manually with varying degrees of success. The problem dealt with in this dissertation was directed towards increasing the efficiency of the manual methods presently employed for the selection of sieve diameters. It was visualised that such decisions could be greatly improved on with the aid of modern computer-aided systems having ready access to input data pertaining to both buyers' specifications and fruit characteristics.

In accordance with its objectives this study in the first place set out to develop a computer-aided system for improving the selection of screen diameters. It consequently compared and evaluated the nature of buyers' specifications. Secondly, it established the most important fruit attributes associated with peach half mass variation at a set diameter. In the third instance a computer-aided manufacturing system was developed and evaluated.

The results of this study show that the mass distribution of prepared peach halves ready for quality grading and packing followed the lognormal frequency distribution, skewed towards halves with smaller diameters (Table 3-1). Because peach halves are packed in specified multiples (count) to a target mass constraint, an understanding of the distribution of peach half masses available for canning from a

75 Variety Details In Appendix A-9
seasonal crop is necessary. Such information is invaluable in the assessment of the quantity of halves suitable for packing into small and large can sizes. It also assists in deciding which half masses should be packed as halves and which should be size reduced for sliced peach packs. Larger sized peach halves with masses greater than 76 g are usually size reduced to slices for sale in a different, but equally important sector of the market (Swart, 1991).

It was of interest to observe from Table 3-5, that the relative quantity of peach halves within the mass range of 25 g to 75 g specified by buyers, varied from 68 % for Kakamas to 82 % for the Oom Sarel varieties. The relative proportion found heavier than 75 g varied from 13 % for Oom Sarel to 33 % in the case of Kakamas accordingly. The quantity of large halves available for size reduction and slices packs can be gauged from Table 3-5. Oom Sarel variety had the greatest proportion of small halves (4.8 %) while the Kakamas variety is not expected to produce small peach halves suitable for canning (Table 3-5).

The significant regression of peach half mass on sieve diameter found in this study (Tables 3-8) was expected. This observation together with the significant differences in mean masses of halves with the same average diameter but from four different varieties (Table 3-2), suggests that for the same ingoing mass and count specifications altered sieve diameter configurations should be used when different varieties are to be sorted.

Contrary to the claims made by twist pitter machine suppliers (Molenaar, 1989), the twist pitters used in the plant gave significantly lighter average masses for the same peach half diameter than the knife pitters (Table 3-6). These machines were designed in the United States of America for their peach varieties and there are no reliable comparable data for USA and RSA peach varieties. Any attempt at an explanation will remain conjecture. It is worthwhile noting though that yield does not seem to be a good reason for replacing the old knife pitters with twist pitters.

To reduce mass variation between individual peach halves selected for a particular count and target mass combination the sieve interval should be kept as small as possible. Also the effect of variety, season, pitters and although not investigated, the growing locality,
Discussion

has to be constantly incorporated as important variables. This means that constant adjustments to the sorting sieve set-up is needed. With the acceptance of new buyers' orders as the season progresses the overall problem becomes even more complex and reliable sieve selection more impossible without computer assistance.

The computer-aided system required in this application had to incorporate input data of all the relevant variables and be more reliable in selecting the various sieve diameters required for assembling the sieve stack than an experienced operator was capable of achieving. In meeting this objective it was decided to store data pertaining to buyers' orders in different databases (one for each can size). These databases were linked to a spreadsheet which allowed the input of peach and plant attributes and parameters. The appropriate FRED programs were developed and used to calculate the sieve diameters for the stack arrangement. Incorporating the independent variables in the computations improved the estimated sieve sorting efficiency from 72 % to 86 % (Tables 4-14 and 4-15). In fact, the only difference in input data between the two sieve selecting procedures was that sieve diameters were calculated from the regression equation in the computer-aided sieve arrangement, shown in Table 4-14, while the sieve diameters in Table 4-15 were issued by an experienced operator (Swart, 1989).

In the process of developing this computer-aided sieve selection system the integrated applications program Framework III with its FRED language proved to be versatile and easily adaptable as the concepts of the system evolved. It also demonstrated adequate word processing capabilities during the preparation of this dissertation, permitting ready importation of STSC files in ASCII form to arrange tables in the text. It was not possible to handle graphs and graphic files in this way and these were consequently printed directly from Statgraphics (STSC, 1988).

Statistics play an important part in a research study dealing with biological materials and large samples. The Statgraphics computer application program was found to be very suited to handle, reduce and analyse the data statistically.

76 STSC (1988)
The data shown in the tables associated with databases and the spreadsheet of this dissertation are those actually used to arrange the sieve stack set-up in January 1991 and were based on the results of this study obtained during the 1988/89 and the 1989/90 seasons.

Flexibility in adjusting the sieve stack arrangements is poor, because of the machine design. To change the sieve diameter a sieve plate has to be replaced. This requires stopping the plant and replacing the plate manually with resultant loss of production. It follows that there is great reluctance to use this procedure when operating at full capacity during the short summer fruit season. In practice thus, rearrangement of the stack is periodic and only when major changes in fruit variation becomes blatantly obvious.

Perhaps the most significant conclusion reached in this dissertation points to the inadequacies of the current practice of size sorting peach halves on horizontal plates with holes of a specific diameter. It does not permit quick adjustments for known changes in peach half attributes and is insufficiently reliable as it does not readily permit accurate sorting of peach half masses.

Although it was not the objective of this study to derive prediction models for all possible variations in fruit attributes, the data gathered provide a new approach to quantifying natural variation in the physical attributes of peach halves.

The results obtained and the subsequent computer-aided system developed here however, provide a reliable means for calculating sieve stack arrangements which could be effected during production down-time periods, despite the inflexibility of the operating machine. The timely use of this system is especially important in view of the significant influence of ambient temperature on fruit diameter during the last few weeks on the tree (Bergh, 1991).

There is a need to develop a new technique\textsuperscript{77} for the accurate measurement of peach half masses and subsequent line process

\textsuperscript{77} There is danger in reckless change; but greater danger in blind conservatism - Henry George
controlled grouping of sorted halves into appropriate count-in Going
mass combinations.

6 Conclusions And Recommendations

The current practice of size sorting peach halves on a horizontal
plate with holes of a specific diameter is ineffective as it does not
readily permit continuous control of peach half masses. It is not
sufficiently flexible to permit quick adjustments for known changes
in peach half attributes. This size sorting operation is inaccurate,
inefficient and counter-productive.

Considering the three prong approach for interdependence effects
which buyers' specifications, peach crop attributes and sieve stack
arrangement have on the mass classes into which peach halves are to
be sorted, the following procedures are recommended to provide
reliable input data to the computerised sieve selection system
developed and described in this dissertation.

1. Select and store peaches received according to variety and origin
where possible. Maintain location records to permit the drawing of
peaches of a similar kind from cold store.

2. Determine regression constants for peach half mass on sieve
diameter as often as possible for each kind of peach on hand. Enter
regression data into spreadsheet for computation purposes.

3. Enter all buyers' specifications into the respective databases as
they become available during the season.

4. Enter the appropriate constraints into spreadsheet to bias the
sorting towards the pack size most important to the market. Run
computer program to obtain highest sieve efficiency value.

5. Rearrange sieve stack with sieve plates of computed diameter as
often as computed sieve stack arrangements change. This could be
effected during down-time.

Peach Halves
6. Regularly evaluate sieve efficiency against changing fruit and buyers' parameters and compute new sieve stack arrangements as often as appropriate.

7 Suggested Future Research

The results of this dissertation demonstrated the void in technology for high speed mass sorting of large units of food and the need for further research into the development of suitable machines.

In order to mass sort peach halves accurately, a completely new approach is called for. With the high sorting speed of 1500 - 2000 peach halves per minute needed to supply a 250 cpm canning line, single file mass determination of halves at such speeds is not possible. Multiple mass determination and filling machines as used in dried fruit and peanut filling and packaging in the RSA, have not been developed for peach half mass determination.

The determination of fruit diameter and height could be used as size sorting criteria, but to be effective, electronic devices utilising rapid optical dimension determination together with fast density measurements and line process control computers for directing diversion control and subsequent grouping, may be an approach to such a future upshot.

Research and development of appropriate methodologies for the rapid measurement of peach half density and volume is required. Line process controllers to compute the individual half masses for diversion purposes and subsequent re-grouping of halves into specified count and ingoing mass combinations need in depth attention.

Research has also been lacking in establishing data pertaining to changing drained masses for modern peach varieties grown in different areas and canned for local and export sales. This void in data complicates accurate forward estimates of drained masses and corresponding adjustments to target ingoing masses.

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Bibliography


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APPENDIX

A

1 In This Life We Want Facts, Sir; Nothing But Facts - Charles Dickens

Size Sorting Peach Halves
# Appendix A

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## Appendix A

### Glossary Of Terms

<table>
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<th>Term</th>
<th>Meaning</th>
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<tr>
<td>Attribute:</td>
<td>any property, quality, or characteristic that can be ascribed to a foodstuff</td>
</tr>
<tr>
<td>Average Sieve Diameter:</td>
<td>mean of the diameters of the sieve passing a fraction and the next retaining it</td>
</tr>
<tr>
<td>Balance:</td>
<td>an instrument for mass determination</td>
</tr>
<tr>
<td>Computer Software:</td>
<td>programs and programming support needed to put a computer through assigned tasks</td>
</tr>
<tr>
<td>Content:</td>
<td>that which is contained, power of containing; capacity, volume, mass</td>
</tr>
<tr>
<td>Count:</td>
<td>the number of peach halves in a can</td>
</tr>
<tr>
<td>Covering Liquid:</td>
<td>liquid used to fill can after solid product has been packed</td>
</tr>
<tr>
<td>Deciduous Fruit:</td>
<td>falling off or shed at a particular season or stage of growth</td>
</tr>
<tr>
<td>Drained mass:</td>
<td>mass of solid product after separating off the covering liquid</td>
</tr>
<tr>
<td>Duncan's Multiple Range Test:</td>
<td>minimises the loss due to repeated decisions made from tests of significance</td>
</tr>
<tr>
<td>Ingoing Mass:</td>
<td>mass of solid product packed into a can</td>
</tr>
<tr>
<td>Kolmogorov-Smirnov:</td>
<td>compares goodness of fit of a distribution against a hypothetical distribution</td>
</tr>
<tr>
<td>Linear Programming:</td>
<td>a mathematical technique designed to help in planning and decision making</td>
</tr>
<tr>
<td>Management:</td>
<td>the act of directing, using, treating, carrying on for a purpose</td>
</tr>
<tr>
<td>Multihead-filler:</td>
<td>filling machine having a number of filling heads</td>
</tr>
<tr>
<td>Net Mass:</td>
<td>mass of can contents measured according to a standard method</td>
</tr>
<tr>
<td>Objective:</td>
<td>being the object of perception or thought</td>
</tr>
<tr>
<td>Optimising:</td>
<td>to make or arrange something in order to be highly functional or effective</td>
</tr>
<tr>
<td>Piece Count:</td>
<td>see unit count</td>
</tr>
<tr>
<td>Piece Sorted:</td>
<td>see size sorted</td>
</tr>
<tr>
<td>Residue Level:</td>
<td>that amount of substance which remains after a part is dealt with in some way</td>
</tr>
<tr>
<td>Scheffe Range Test:</td>
<td>test for significance &gt; 5% level between means in multiple ANOVA unequal n&lt;sub&gt;i&lt;/sub&gt;</td>
</tr>
<tr>
<td>Sensory:</td>
<td>relating to the whole sensory apparatus of the body</td>
</tr>
<tr>
<td>Shewart-charts:</td>
<td>Dr Shewart (1920's) was the first to apply statistics to QC with control charts</td>
</tr>
<tr>
<td>Size Reduced:</td>
<td>to diminish in size like preparing slices from whole fruits</td>
</tr>
<tr>
<td>Size Sorted:</td>
<td>to arrange units according to classes of size</td>
</tr>
<tr>
<td>Unit Count:</td>
<td>to enumerate the units in a group</td>
</tr>
<tr>
<td>Unit Operation:</td>
<td>a process in food production bringing about physical changes</td>
</tr>
<tr>
<td>Sphericity:</td>
<td>dc/de; where dc = diameter of sphere of same volume as test object and de = diameter smallest circumscribing sphere</td>
</tr>
</tbody>
</table>
Appendix A

2 EEC Requirements

EEC "AVERAGE MASS" SYSTEM

The following rules (Robertshaw, 1989) are applicable to the "average mass" system and will be adhered to when exporting to EEC members:

RULE 1: Average net mass = label declaration, QN.

RULE 2: At least 98% of net masses = QN - TNE.

RULE 3: Every net mass = QN - 2TNE.

RULE 4: Average drained mass = label declaration, QN.

RULE 5: Every drained mass = QN - 3TNE.

QN = Nominal quantity
TNE = Tolerable negative error.

1 The Minimum Mass System Traditionally Used In The Uk Has Been Discontinued
## Appendix A

### STSC Applications

<table>
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Peach Halves
Appendix A

4 Contents Raw Data Files

4.1 Introductory Remark

The content of STSC raw data files before data reduction is summarised. The actual data is also available on the enclosed 1.2Mb floppy disk ID "HERMAN".

4.2 PSR89KRV

The following variables are currently in the file PSR89KRV:

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<td>C</td>
<td>2</td>
<td>480</td>
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<td>21:23</td>
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</tr>
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<td>7</td>
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<td>I</td>
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Size Sorting
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Peach Halves
Appendix A

5 Frequency Distribution Tables

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Mean = 59.9163  Standard Deviation = 24.3343  Median = 52

5.2 PSRF9000

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Mean = 51.9731  Standard Deviation = 21.3656  Median = 47

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Size Sorting
### Frequency Tabulation

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Mean = 58.0054  Standard Deviation = 23.6695  Median = 53.5

#### 5.5 PSRF90KD

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<td>3</td>
<td>42.00</td>
<td>50.50</td>
<td>46.25</td>
<td>28</td>
<td>.11667</td>
<td>63</td>
<td>.26250</td>
</tr>
<tr>
<td>4</td>
<td>50.50</td>
<td>59.00</td>
<td>54.75</td>
<td>37</td>
<td>.15417</td>
<td>100</td>
<td>.41667</td>
</tr>
<tr>
<td>5</td>
<td>59.00</td>
<td>67.50</td>
<td>63.25</td>
<td>24</td>
<td>.10000</td>
<td>124</td>
<td>.51667</td>
</tr>
<tr>
<td>above</td>
<td>76.00</td>
<td>76.00</td>
<td>71.75</td>
<td>78</td>
<td>.32500</td>
<td>240</td>
<td>1.00000</td>
</tr>
</tbody>
</table>

Mean = 68.4125  Standard Deviation = 23.507  Median = 66

---

Peach Halves
Appendix A

Kolmogornov-Smirnov Statistics

6.1 Remarks

The Kolmogorov-Smirnov one sample statistic (STSC, 1988) tests the overall goodness of fit of a data set to determine if the data follow a specified distribution. This statistic compares the empirical cumulative distribution function with that of the hypothesised distribution, using the maximum absolute distance between the two to test for conformance of the two cumulative distribution functions (c.d.f.).

6.2 PSR89KDT

Estimated KOLMOGOROV statistic DPLUS = 0.0932275
Estimated KOLMOGOROV statistic DMINUS = 0.0692422
Estimated overall statistic DN = 0.0932275
Approximate significance level = 0.0153904

6.3 PSR90DDT

Estimated KOLMOGOROV statistic DPLUS = 0.0547709
Estimated KOLMOGOROV statistic DMINUS = 0.0311472
Estimated overall statistic DN = 0.0547709
Approximate significance level = 0.0883208

6.4 PSR90I.DT

Estimated KOLMOGOROV statistic DPLUS = 0.0346763
Estimated KOLMOGOROV statistic DMINUS = 0.0598468
Estimated overall statistic DN = 0.0598468
Approximate significance level = 0.0482302

6.5 PSR90WDT

Estimated KOLMOGOROV statistic DPLUS = 0.0368393
Estimated KOLMOGOROV statistic DMINUS = 0.06044
Estimated overall statistic DN = 0.06044
Approximate significance level = 0.0334332

6.6 PSR90KDT

Estimated KOLMOGOROV statistic DPLUS = 0.0713814
Estimated KOLMOGOROV statistic DMINUS = 0.0502031
Estimated overall statistic DN = 0.0713814
Approximate significance level = 0.173211

Size Sorting
### Appendix A

#### 7.2 Varieties and Pitters

##### 7.2.1 PSRTJ90

The Analysis of Variance for PSRTJ90.UNITWT includes the following sources of variation:

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-ratio</th>
<th>Sig. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN EFFECTS</td>
<td>773387.00</td>
<td>13</td>
<td>59491.307</td>
<td>1000.00</td>
<td>.0000</td>
</tr>
<tr>
<td>PSRTJ90.SIEVDIA</td>
<td>717916.48</td>
<td>9</td>
<td>79768.498</td>
<td>1000.00</td>
<td>.0000</td>
</tr>
<tr>
<td>PSRTJ90.VARIETIES</td>
<td>2007.35</td>
<td>3</td>
<td>669.116</td>
<td>11.886</td>
<td>.0000</td>
</tr>
<tr>
<td>PSRTJ90.PITTERS</td>
<td>1014.65</td>
<td>1</td>
<td>1014.654</td>
<td>18.025</td>
<td>.0000</td>
</tr>
</tbody>
</table>

The Residual and Total (Carr.) are as follows:

- Residual: 96034.375, df = 1706, Mean Square = 56.292131
- Total (Carr.): 869421.37, df = 1719

Zero missing values have been excluded.

##### 7.2.2 PSRTJ90R

The Multiple range analysis for PSRTJ90.UNITWT by PSRTJ90.VARIETIES is as follows:

Method: 95 Percent Confidence Intervals

<table>
<thead>
<tr>
<th>Level</th>
<th>Count</th>
<th>Average</th>
<th>Homogeneous Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>480</td>
<td>54.19375</td>
<td>*</td>
</tr>
<tr>
<td>W</td>
<td>520</td>
<td>60.38642</td>
<td>*</td>
</tr>
<tr>
<td>N</td>
<td>480</td>
<td>63.49375</td>
<td>*</td>
</tr>
<tr>
<td>K</td>
<td>240</td>
<td>68.41250</td>
<td>*</td>
</tr>
</tbody>
</table>

The Multiple range analysis for PSRTJ90.UNITWT by PSRTJ90.PITTERS is as follows:

Method: 95 Percent Confidence Intervals

<table>
<thead>
<tr>
<th>Level</th>
<th>Count</th>
<th>Average</th>
<th>Homogeneous Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>1000</td>
<td>59.45600</td>
<td>*</td>
</tr>
<tr>
<td>C</td>
<td>720</td>
<td>62.29861</td>
<td></td>
</tr>
</tbody>
</table>

##### 7.2.3 PSRTJ90T

The Table of means for PSRTJ90.UNITWT is as follows:

<table>
<thead>
<tr>
<th>Level</th>
<th>Count</th>
<th>Average (internal)</th>
<th>Average (pooled s)</th>
<th>95 Percent Confidence for mean</th>
</tr>
</thead>
</table>

**PSRTJ90.SIEVDIA**

- 41 160 33.52500 .3752305 .5931491 32.36137 34.68863
- 44 200 38.56000 .6053437 .5305287 37.51922 39.60078
- 47 280 45.13929 .3421935 .4483786 44.25966 46.01891
- 50 240 53.46250 .3388918 .4830432 52.51240 54.41260
- 52 40 48.80000 .9508431 1.1862981 46.47274 51.12726
- 54 280 62.87857 .6090294 .4483786 61.99895 63.75819
- 57 120 77.10833 .8095020 .6849095 75.76469 78.45198
- 58 160 81.40000 .7092826 .5931491 80.23637 82.56363
- 63 200 98.63000 .8217615 .5305287 97.58922 99.67078
- 65 40 105.10000 2.4077333 1.1862981 102.77274 107.42726

**PSRTJ90.VARIETIES**

<table>
<thead>
<tr>
<th>Level</th>
<th>Count</th>
<th>Average (internal)</th>
</tr>
</thead>
</table>
- K 240 68.41250 1.5173690
- N 480 63.49375 0.9820368
- O 480 54.19375 0.9462986
- W 520 60.38642 1.0027115

**PSRTJ90.PITTERS**

<table>
<thead>
<tr>
<th>Level</th>
<th>Count</th>
<th>Average</th>
</tr>
</thead>
</table>
- C 720 62.29861 0.8269281
- T 1000 59.45600 0.7159306

The Size Sorting table:

<table>
<thead>
<tr>
<th>Level</th>
<th>Count</th>
<th>Average</th>
</tr>
</thead>
</table>
- K 240 68.41250 1.5173690 0.4843042 67.66240 69.36260
- N 480 63.49375 0.9820368 0.3424548 62.82193 64.16557
- O 480 54.19375 0.9462986 0.3424548 53.52193 54.86557
- W 520 60.38642 1.0027115 0.3290199 59.74299 61.03393
- C 720 62.29861 0.8269281 0.2796132 61.75007 62.84715
- T 1000 59.45600 0.7159306 0.2372596 58.99055 59.92145

Total 1720 60.64593 0.1809088 0.1809088 60.29103 61.00083
Appendix A

8 Regression Analyses

8.1 General remarks

The regression statistics according to STSC of mass on sieve diameter for peach halves from four varieties and one mixed lot for the 1988/89 and 1989/90 seasons are detailed in this Appendix.

8.2 PSRT89MR

Regression Analysis - Exponential model: $Y = \exp(a+bX)$

Dependent variable: PSRT89MR.UNITWT  Independent variable: PSRT89MR.SIEVD1A

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>T Value</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.47008</td>
<td>0.0468049</td>
<td>31.4087</td>
<td>.00000</td>
</tr>
<tr>
<td>Slope</td>
<td>0.04753</td>
<td>9.086066E-4</td>
<td>52.3109</td>
<td>.00000</td>
</tr>
</tbody>
</table>

Analysis of Variance

Source             | Sum of Squares | Df | Mean Square | F-Ratio | Prob. Level |
-------------------|----------------|----|-------------|---------|-------------|
Model              | 33.2539        | 1  | 33.2539     | 2736.426| .00000      |
Error              | 3.37835        | 278| 0.01215     |         |             |
Total (Corr.)      | 36.63227       | 279|             |         |             |

Correlation Coefficient = 0.952773  R-squared = 90.78 percent
Std. Error of Est. = 0.110238

8.3 PSRT89KR

Regression Analysis - Exponential model: $Y = \exp(a+bX)$

Dependent variable: PSRT89KR.UNITWT  Independent variable: PSRT89KR.SIEVD1A

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>T Value</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.33081</td>
<td>0.0612667</td>
<td>21.7216</td>
<td>.00000</td>
</tr>
<tr>
<td>Slope</td>
<td>0.0525117</td>
<td>1.5461E-3</td>
<td>45.4802</td>
<td>.00000</td>
</tr>
</tbody>
</table>

Analysis of Variance

Source             | Sum of Squares | Df | Mean Square | F-Ratio | Prob. Level |
-------------------|----------------|----|-------------|---------|-------------|
Model              | 27.7218        | 1  | 27.7218     | 2068.447| .00000      |
Error              | 3.18974        | 238| 0.01340     |         |             |
Total (Corr.)      | 30.91158       | 239|             |         |             |

Correlation Coefficient = 0.947001  R-squared = 89.68 percent
Std. Error of Est. = 0.115768

8.4 PSRT900R

Regression Analysis - Exponential model: $Y = \exp(a+bX)$

Dependent variable: PSRT900R.UNITWT  Independent variable: PSRT900R.SIEVD1A

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>T Value</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.38774</td>
<td>0.0412182</td>
<td>33.6682</td>
<td>.00000</td>
</tr>
<tr>
<td>Slope</td>
<td>0.0513808</td>
<td>8.2689E-4</td>
<td>62.1373</td>
<td>.00000</td>
</tr>
</tbody>
</table>

Analysis of Variance

Source             | Sum of Squares | Df | Mean Square | F-Ratio | Prob. Level |
-------------------|----------------|----|-------------|---------|-------------|
Model              | 54.1637        | 1  | 54.1637     | 3061.049| .00000      |
Error              | 6.70549        | 478| 0.01403     |         |             |
Total (Corr.)      | 60.86915       | 479|             |         |             |

Correlation Coefficient = 0.943312  R-squared = 88.98 percent
Std. Error of Est. = 0.118441

Peach Halves
8.5 PSRT90NR

Regression Analysis - Exponential model: \( Y = \exp(a+bX) \)

Dependent variable: PSRT90NR.UNITWT  Independent variable: PSRT90NR.SIEVDI

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>T Value</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.67655</td>
<td>0.0397951</td>
<td>42.1296</td>
<td>.00000</td>
</tr>
<tr>
<td>Slope</td>
<td>0.046135</td>
<td>7.52807E-4</td>
<td>61.284</td>
<td>.00000</td>
</tr>
</tbody>
</table>

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>47.9254</td>
<td>1</td>
<td>47.9254</td>
<td>3755.725</td>
<td>.00000</td>
</tr>
<tr>
<td>Error</td>
<td>6.09957</td>
<td>478</td>
<td>.01276</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (Corr.)</td>
<td>54.02493</td>
<td>479</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correlation Coefficient = 0.941858  R-squared = 88.71 percent

Std. Error of Est. = 0.112963

8.6 PSRT90WR

Regression Analysis - Exponential model: \( Y = \exp(a+bX) \)

Dependent variable: PSRT90WR.UNITWT  Independent variable: PSRT90WR.SIEVDI

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>T Value</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.35768</td>
<td>0.0400396</td>
<td>33.9085</td>
<td>.00000</td>
</tr>
<tr>
<td>Slope</td>
<td>0.0517976</td>
<td>7.69042E-4</td>
<td>67.3534</td>
<td>.00000</td>
</tr>
</tbody>
</table>

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>64.9366</td>
<td>1</td>
<td>64.9366</td>
<td>4536.479</td>
<td>.00000</td>
</tr>
<tr>
<td>Error</td>
<td>7.41482</td>
<td>518</td>
<td>.01431</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (Corr.)</td>
<td>72.35142</td>
<td>519</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correlation Coefficient = 0.947374  R-squared = 89.75 percent

Std. Error of Est. = 0.119642

8.7 PSRT90KR

Regression Analysis - Exponential model: \( Y = \exp(a+bX) \)

Dependent variable: PSRT90KR.UNITWT  Independent variable: PSRT90KR.SIEVDI

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>T Value</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.985133</td>
<td>0.0817359</td>
<td>12.0526</td>
<td>.00000</td>
</tr>
<tr>
<td>Slope</td>
<td>0.0573384</td>
<td>1.46538E-3</td>
<td>39.1286</td>
<td>.00000</td>
</tr>
</tbody>
</table>

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>Prob. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>24.3946</td>
<td>1</td>
<td>24.3946</td>
<td>1531.046</td>
<td>.00000</td>
</tr>
<tr>
<td>Error</td>
<td>3.79213</td>
<td>238</td>
<td>.01593</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (Corr.)</td>
<td>28.18677</td>
<td>239</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correlation Coefficient = 0.930303  R-squared = 86.55 percent

Std. Error of Est. = 0.126227

Size Sorting
Variety: Kakamas; Origin: RSA, originated by O.S.H.Reinecke and A.O.Collins as a chance seedling of St Helena peach; Released: 1938; Tree: Chilling Requirements: medium; Vigour: strong; Growth Habit: spreading; Full bloom Date: mid-September; Production: good; Fruit: Harvest Date: mid-January; Mass: 140 g; Shape: round to ovate; Skin Colour: yellow; Flesh Colour: yellow; Taste: good; Texture: non-melting, fine and firm; Stone: cling; Keeping Quality: 2 weeks at -0.5 °C; General: Good canning quality. Stone residues. Suitable for national fresh market

Peach Halves
Appendix A

9.2 Prof Neethling

Variety: Neethling; Origin: RSA, bred by FFTRI as a cross between Kakamas and Early Dawn.; Released: 1961; Tree: Chilling Requirements: low; Vigour: strong; Growth Habit: spreading; Full Bloom Date: late-August; Production: good; Fruit: Harvest Date: mid-January; Mass: 130 g; Shape: round; Skin Colour: yellow; Flesh Colour: yellow; Taste: good; Texture: non-melting, fine and firm; Stone: cling; Keeping Quality: 2 weeks at -0.5 °C; General: Good canning quality. Suitable for national fresh market

Size Sorting
Variety: Oom Sarel; Origin: RSA, bred by FFTRI as a cross between Kakamas and Early Dawn; Released: 1961; Tree: Chilling Requirements: low; Vigour: strong; Growth Habit: spreading; Full Bloom Date: late-August; Production: good; Fruit: Harvest Date: mid-December; Mass: 125 g; Shape: round; Skin Colour: yellow; Flesh Colour: yellow; Taste: good; Texture: non-melting, fine and firm; Stone: cling; Keeping Quality: 2 weeks at -0.5 °C; General: Good canning quality. Suitable for national fresh market.
Variety: Woltemade; Origin: RSA, selected by Nel-Brothers from a chance seeding of Kakamas; Released: n/a; Tree: Chilling Requirements: medium; Vigour: strong; Growth Habit: spreading; Full Bloom Date: late-September; Production: good; Fruit: Harvest Date: late-January; Mass: 140 g; Shape: ovate with prominent point and suture; Skin Colour: yellow; Flesh Colour: orange-yellow; Taste: good; Texture: non-melting, fine and firm; Stone: cling; Keeping Quality: 2 weeks at -0.5 °C; General: Good canning quality. Some stone residues. Suitable for national fresh market.
Variety: Malherbe; Origin: RSA, bred by FFTRI as a cross between Kakamas and Early Dawn; Released: 1961; Tree: Chilling Requirements: medium; Vigour: strong; Growth Habit: spreading; Full Bloom Date: early-September; Production: good; Fruit: Harvest Date: late-December; Mass: 135 g; Shape: round; Skin Colour: yellow; Flesh Colour: yellow; Taste: good; Texture: non-melting, fine and firm; Stone: cling; Keeping Quality: 2 weeks at -0.5 °C; General: Good canning quality. Suitable for national fresh market.
Variety: Prof Black; Origin: RSA, bred by FFTRI as a cross between Kakamas and Early Dawn; Released: 1961; Tree: Chilling Requirements: medium; Vigour: strong; Growth Habit: spreading; Full Bloom Date: late-August; Production: moderate; Fruit: Harvest Date: early-January; Mass: 130 g; Shape: round with prominent suture; Skin Colour: yellow; Flesh Colour: yellow; Taste: fair, but little flavour; Texture: non-melting, fine and firm Stone: cling; Keeping Quality: poor; General: Good canning quality. Suitable for national fresh market.

Size Sorting
9.7 Walgant

Variety: Walgant; Origin: RSA, bred by FFTRI by self-pollinating Kakamas; Released: 1959; Tree: Chilling Requirements: medium; Vigour: strong; Growth Habit: spreading; Full Bloom Date: early-September; Production: good; Fruit: Harvest Date: late-January; Mass: 140 g; Shape: ovate with prominent point; Skin Colour: yellow; Flesh Colour: orange-yellow; Taste: good; Texture: non-melting, fine and firm; Stone: cling; Keeping Quality: 2 weeks at -0.5 °C; General: Good canning quality. Stone residues. Suitable for national fresh market.
9.8 Goudmyn

Variety: Goudmyn; Origin: RSA, Open-pollinated seed from 69-174 (Oom Sarel X 344); Released: 1989; Tree: Chilling Requirements: low; Vigour: strong; Growth Habit: semi-upright; Full Bloom Date: early-August; Production: good; Fruit: Harvest Date: early-January; Mass: 160 g; Shape: round; Skin Colour: yellow; Flesh Colour: yellow; Taste: good; Texture: non-melting; Stone: cling; Keeping Quality: not-tested; General: Very good canning quality
APPENDIX

B

2 There Is Nothing Permanent Except Change - Heraclitus

Size Sorting Peach Halves
Appendix B

Choices:

; FRED to set menu
@menu(choices); set choices menu

Choices.[1Mcan Orders & Parameters]:

; FRED to select and display/edit frame
@local(cur); set local variable cur
cur:=@setselection, ;set variable to return frame name
@setselection("Sievdiam.SEL90a.SPECT1M"), ;store selected frame in variable
@performkeys("(f9)"), ;zoom frame
@eraseprompt, ;erase
@prompt("**To Input Parameters   **Return** To Continue **,15), ;prompt
@nextkey, ;wait for any key to be pressed
@if(Or.@key=(P),@key=(p)), ;if P or p
@quitmenu, ;then quit menu
@setselection(cur); else return to origin

Choices.[A2.5can Orders & Parameters]:

; FRED to select and display/edit frame
@local(cur); set local variable cur
cur:=@setselection, ;set variable to return frame name
@setselection("Sievdiam.sel90a.SPECA2"), ;store selected frame in variable
@performkeys("(f9)"), ;zoom frame
@eraseprompt, ;erase
@prompt("**To Input Parameters   **Return** To Continue **,15), ;prompt
@nextkey, ;wait for any key to be pressed
@if(Or.@key=(P),@key=(p)), ;if P or p
@quitmenu, ;then quit menu
@setselection(cur); else return to origin

Choices.[No10can Orders & Parameters]:

; FRED to select and display/edit frame
@local(cur); set local variable cur
cur:=@setselection, ;set variable to return frame name
@setselection("Sievdiam.sel90a.SPECA10"), ;store selected frame in variable
@performkeys("(f9)"), ;zoom frame
@eraseprompt, ;erase
@prompt("**To Input Parameters   **Return** To Continue **,15), ;prompt
@nextkey, ;wait for any key to be pressed
@if(Or.@key=(P),@key=(p)), ;if P or p
@quitmenu, ;then quit menu

Size Sorting
@setselection(cur);else return origin

Choices.[Peach & Sieve Parameters]:
; FRED to select and display frame and input data
@local(cur),;set local variable cur
cur:=@setselection,;set variable to return frame name
@setselection("Siev diam.sel90a.siv"),;store selected frame in variable
@performkeys("(f9)"),;zoom frame
@performkeys("(Ctrl-Home)(Ctrl-PgDn)"),;move cursor to SS notes
@eraseprompt,;erase
@prompt("**Press Any Key To Input Parameters  **Return** To Continue **",15),;prompt
@nextkey,;wait for key to be pressed
@if(@or(@key={p},@key={P}),@key={p}),;if P or p
@quitmenu,;then quit menu
@setselection(cur);else return origin

Choices.Current Sieve Diameters:
;FRED to display current data used for sieve
;selection and recommended sieve diameters
@local(cur),;set local variable cur
cur:=@setselection,;set variable to return frame name
@setselection("Siev diam.SEL90a.DATA"),;store selected frame in variable
@performkeys("(f10)"),;zoom frame
@eraseprompt,;erase
@prompt("Press Any Key To Continue",28),;prompt instruction
@nextkey,;wait for a key
@performkeys("(f10)"),;view
@setselection(cur);return to origin

Choices.Recalculate All Frames:
; FRED to recalculate all frames
@local(cal),;set local variable cur
cal:=@setselection,;set variable to return frame name
@setselection("Siev diam.SEL90A.SPEC1M"),;call frame
@performkeys("(f9)"),;zoom frame
@performkeys("(In)(ctrl-home)(f6)(end)"),;select all dbase programs
@performkeys("(f5)(f5)(Out)"),;recalculate twice
@performkeys("(Ctrl-return)"),;save frame
@setselection("Siev diam.SEL90A.SPEC2A"),;call frame
@performkeys("(f9)"),;zoom frame
@performkeys("(In)(ctrl-home)(f6)(end)"),;select all dbase programs
@performkeys("(f5)(f5)(Out)"),;recalculate twice
@performkeys("(Ctrl-return)"),;save frame
@setselection("Siev diam.SEL90A.SPEC1A0"),;call frame
@performkeys("(f9)"),;zoom frame

Peach Halves
Appendix B

`performkeys("(In)(ctrl-home)(f6)(end)"), ;select all dbase programs`  
`performkeys("(f5)(f5)(Out)"), ;recalculate twice`  
`performkeys("(Ctrl-return)"), ;save frame`  
`setselection("Sievdiam.SEl90A.Siv"), ;call frame`  
`performkeys("(f9)"), ;zoom frame`  
`performkeys("(In)(ctrl-end)"), ;select final answer cell`  
`performkeys("(f5)(f5)(Out)"), ;recalculate twice`  
`performkeys("(Ctrl-return)"), ;save frame`  
`setselection("Sievdiam.SEl90A.Data"), ;call frame`  
`performkeys("(f9)"), ;zoom frame`  
`performkeys("(In)(f5)(f5)(Out)"), ;recalculate twice`  
`performkeys("(Ctrl-return)"), ;save frame`  
`setselection(cal) ;return to origin`  

Choices.Quit:  
; FRED to quit menu  
@quitmenu ;then quit menu
APPENDIX

3 Courage Consists In Equality To The Problem Before Us - Ralph Waldo Emerson

Size Sorting Peach Halves
SPECA2.No:
; FRED program to calculate number of rows
@fill(
  sel90a.spec1M.No, ; specify region
  1, ; start from 1
  1 ; increment = 1
) ; end

SPECA2.TNE:
; FRED program to specify tolerable negative error (TNE) in
; accordance with buyers specifications and EEC rules
@set(
  TNE, ; set tolerable negative error
  @if( ; if
    NomWt=500, ; nominal weight = 500g
    15, ; then enter 15g
  @if( ; if
    NomWt=250, ; nominal weight = 250g
    9, ; then enter 9g
  @if( ; if
    NomWt=1815, ; nominal weight = 1815g
    27, ; then enter 27g
  @if( ; if
    NomWt=510, ; nominal weight = 510g
    15, ; then enter 15g
  @if( ; if
    NomWt=1850, ; nominal weight = 1850g
    28, ; then enter 28g
  "?" ; else?
) ) ) ; end

SPECA2.Rule4:
; FRED program to calculate target weight for rule 4
@set( ; set
  Rule4, ; average of n units > nominal weight
  @ceiling( ; round upwards
    NomWt+2*s/n*.5 ; 95% confidence limit for n units
  ) ; end

SPECA2.Rule5:
; FRED program to calculate target weight rule 5
@set( ; set
  Rule5, ; unit weight > nominal weight less 3TNE
  @ceiling( ; round upwards
    (NomWt-(3*TNE)+2*s/1*.5) ; 95% confidence limit for n units rule 5
)
Appendix C

; FRED program to select largest target weight
@set DrndWt, ;nominal drained weight declared
@max( ;select highest target weight of the
Rule4,Rule5) ;two target weights
) ;end

; FRED program to calculate average count
@set CntAv, ;calculate count average
@ceiling( ;round upwards
@avg( ;calculate average
MinCnt,MaxCnt)) ;of parameters
) ;end

; FRED program to calculate count Range
@set CntR, ;calculate Range
MaxCnt-MinCnt ;obtain difference
) ;end

; FRED program to estimate
;coefficient of variation for unit count
@set( CntCV, ;count coefficient of variation
@ceiling( CntR*10^2/CntAv)) ;calculate count coefficient of variation
) ;end

; FRED program to adjust count Range downwards
RCor:= ;set
@if( CntR>siv.k32, ;adjust counts with R>2
@ABS(siv.k32-CntR), ;calculate new Range
0 ;no change
) ;end
Appendix C

SPECA2.CntCorr:
; FRED programme to narrow down unit count specifications
CntCorr:=; set count correcting factor
@floor(; round downwards
RCor/2; Range correction factor
) ;end

SPECA2.CorMinCnt:
; FRED program to adjust minimum count upwards
@set( ;set
CorMinCnt,; corrected minimum count
@ceiling( ; round upwards
MinCnt+(2*CntCorr); calculate new minimum count
) ;end

SPECA2.CorMaxCnt:
; FRED program to adjust maximum count downwards
@set( ; set
CorMaxCnt,; corrected maximum count
@ceiling( ; round upwards
MaxCnt-(CntCorr); calculate new maximum count
) ;end

SPECA2.CorCntAv:
; FRED program to calculate new average count
@set( ; set
CorCntAv, ; corrected average count
@ceiling( ; round upwards
@gavg(CorMaxCnt,CorMinCnt); calculate average
) ;end

SPECA2.CorCntR:
; FRED program to calculate corrected count Range
@set( ; set
CorCntR,; corrected count Range
CorMaxCnt-CorMinCnt; calculate
) ;end

SPECA2.CorCntCV:
; FRED program to calculate smoothed CV
@set( ; set
CorCntCV, ;
@ceiling( ; round upwards

Size Sorting
CorCntR*10^2/CorCntAv ; calculate smoothed CV
)) ;end

SPECA2.Wt1:
; FRED program to calculate largest specified half weight
Wt1:= ;set
@floor( ;round downwards
DnndWt/CorMinCnt ; calculated optimum half weight
) ;end

SPECA2.Wt2:
; FRED program to calculate optimum half weights
Wt2:= ;set
@iff( ;if
(CorMinCnt+1) ; new minimum count
<=CorMaxCnt, ; is less or equal to corrected maximum count
@floor( ; then round downwards
DnndWt/(CorMinCnt+1), ; the calculated optimum half weight
"sw" ; else print sw
) ;end

SPECA2.Wt3:
; FRED program to calculate optimum half weights
Wt3:= ;set
@iff( ; if
(CorMinCnt+2) ; new minimum count
<=CorMaxCnt, ; is less or equal to corrected maximum count
@floor( ; then round downwards
DnndWt/(CorMinCnt+2), ; the calculated optimum half weight
"sw" ; else print sw
) ;end

SPECA2.Wt4:
; FRED program to calculate optimum half weights
Wt4:= ;set
@iff( ; if
(CorMinCnt+3) ; new minimum count
<=CorMaxCnt, ; is less or equal to corrected maximum count
@floor( ; then round downwards
DnndWt/(CorMinCnt+3), ; the calculated optimum half weight
"sw" ; else print sw
) ;end

Peach Halves
Appendix C

SPECA2.Wt5:
; FRED program to calculate optimum half weights
Wt5:= ;set
@if( ;if
( CorMinCnt+4 ) ;new minimum count
<=CorMaxCnt, ;is less or equal to corrected maximum count
@floor( ;then round downwards
DrndWt/(CorMinCnt+4)), ;the calculated optimum half weight
"sw" ;else print sw
) ;end

SPECA2.Wt6:
; FRED program to calculate optimum half weights
Wt6:= ;set
@if( ;if
( CorMinCnt+5 ) ;new minimum count
<=CorMaxCnt, ;is less or equal to corrected maximum count
@floor( ;then round downwards
DrndWt/(CorMinCnt+5)), ;the calculated optimum half weight
"sw" ;else print sw
) ;end

SPECA2.No1:
; FRED program to group half weights
No1:= ;set
@if( ;if
@or( ;or
Wt1>SIV.j14, ;optimum weights are
Wt2>SIV.j14, ;heavier than
Wt3>SIV.j14, ;a specified
Wt4>SIV.j14, ;value
Wt5>SIV.j14, ;for sieve 1
Wt6>SIV.j14), ;then
@floor( ;round downwards
Tonne/Exd), ;calculated tonne
"." ;else insert "."
) ;end

SPECA2.No2:
; FRED program to group half weights
No2:= ;set
@if( ;if
@or( ;or
@and(WT1>SIV.J13,WT1<=SIV.L13), ;optimum weights
@and(WT2>SIV.J13,WT2<=SIV.L13), ;are within

Size Sorting
\@\text{\texttt{and\((WT3\geq SIV.J13, WT3\leq SIV.L13)\)}}\), \\
\@\text{\texttt{and\((WT4\geq SIV.J13, WT4\leq SIV.L13)\)}}\), \\
\@\text{\texttt{and\((WT5\geq SIV.J13, WT5\leq SIV.L13)\)}}\), \\
\@\text{\texttt{and\((WT6\geq SIV.J13, WT6\leq SIV.L13)\)}}\), \\
\@\text{\texttt{floor\((Tonne/Exd)\)}}\); calculated tonne \\
\".\" \@\text{\texttt{else print \".\"}} \\
\) ;end \\

\textbf{SPEC2.N03:} \\
\@\text{\texttt{FRED program to group half weights \texttt{No3:=}} \@\text{\texttt{set}} \\
\@\text{\texttt{\@if\(@or\(@\text{\texttt{and\((WT1\geq SIV.J12, WT1\leq SIV.L12)\)}}\), \texttt{optimum weights}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT2\geq SIV.J12, WT2\leq SIV.L12)\)}}\), \texttt{are within}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT3\geq SIV.J12, WT3\leq SIV.L12)\)}}\), \texttt{specified}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT4\geq SIV.J12, WT4\leq SIV.L12)\)}}\), \texttt{parameters}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT5\geq SIV.J12, WT5\leq SIV.L12)\)}}\), \texttt{for sieve 3}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT6\geq SIV.J12, WT6\leq SIV.L12)\)}}\), \texttt{then}} \\
\@\text{\texttt{\@floor\((Tonne/Exd)\)}}\); calculated tonne \\
\".\" \@\text{\texttt{else print \".\"}} \\
\) ;end \\

\textbf{SPEC2.N04:} \\
\@\text{\texttt{FRED program to group half weights \texttt{No4:=}} \@\text{\texttt{set}} \\
\@\text{\texttt{\@if\(@or\(@\text{\texttt{and\((WT1\geq SIV.J11, WT1\leq SIV.L11)\)}}\), \texttt{optimum weights}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT2\geq SIV.J11, WT2\leq SIV.L11)\)}}\), \texttt{are within}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT3\geq SIV.J11, WT3\leq SIV.L11)\)}}\), \texttt{specified}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT4\geq SIV.J11, WT4\leq SIV.L11)\)}}\), \texttt{parameters}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT5\geq SIV.J11, WT5\leq SIV.L11)\)}}\), \texttt{for sieve 4}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT6\geq SIV.J11, WT6\leq SIV.L11)\)}}\), \texttt{then}} \\
\@\text{\texttt{\@floor\((Tonne/Exd)\)}}\); calculated tonne \\
\".\" \@\text{\texttt{else print \".\"}} \\
\) ;end \\

\textbf{SPEC2.N05:} \\
\@\text{\texttt{FRED program to group half weights \texttt{No5:=}} \@\text{\texttt{set}} \\
\@\text{\texttt{\@if\(@or\(@\text{\texttt{and\((WT1\geq SIV.J10, WT1\leq SIV.L10)\)}}\), \texttt{FRED program to group half weights}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT2\geq SIV.J10, WT2\leq SIV.L10)\)}}\), \texttt{are within}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT3\geq SIV.J10, WT3\leq SIV.L10)\)}}\), \texttt{specified}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT4\geq SIV.J10, WT4\leq SIV.L10)\)}}\), \texttt{parameters}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT5\geq SIV.J10, WT5\leq SIV.L10)\)}}\), \texttt{for sieve 5}} \\
\@\text{\texttt{\@or\(@\text{\texttt{and\((WT6\geq SIV.J10, WT6\leq SIV.L10)\)}}\), \texttt{then}} \\
\@\text{\texttt{\@floor\((Tonne/Exd)\)}}\); calculated tonne \\
\".\" \@\text{\texttt{else print \".\"}} \\
\) ;end \\
Peach Halves
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```
@and(WT1>SIV.J10,Wt1<=SIV.L10), ; optimum weights
@and(WT2>SIV.J10,Wt2<=SIV.L10), ; are within
@and(WT3>SIV.J10,Wt3<=SIV.L10), ; specified
@and(WT4>SIV.J10,Wt4<=SIV.L10), ; parameters
@and(WT5>SIV.J10,Wt5<=SIV.L10), ; for sieve 5
@and(WT6>SIV.J10,Wt6<=SIV.L10)), ; then
@floor( ; round downwards
Tonne/Exd), ; calculated tonne
"." ; else print "."
) ; end

SPECA2.N06:
; FRED program to group half weights
N06:= ; set
@if( ; if
@or( ; or
@and(WT1>SIV.J9,Wt1<=SIV.L9), ; optimum weights
@and(WT2>SIV.J9,Wt2<=SIV.L9), ; are within
@and(WT3>SIV.J9,Wt3<=SIV.L9), ; specified
@and(WT4>SIV.J9,Wt4<=SIV.L9), ; parameters
@and(WT5>SIV.J9,Wt5<=SIV.L9), ; for sieve 6
@and(WT6>SIV.J9,Wt6<=SIV.L9)), ; then
@floor( ; round downwards
Tonne/Exd), ; calculated tonne
"." ; else print "."
) ; end

SPECA2.N07:
; FRED program to group half weights
N07:= ; set
@if( ; if
@or( ; or
@and(WT1>SIV.J8,Wt1<=SIV.L8), ; optimum weights
@and(WT2>SIV.J8,Wt2<=SIV.L8), ; are within
@and(WT3>SIV.J8,Wt3<=SIV.L8), ; specified
@and(WT4>SIV.J8,Wt4<=SIV.L8), ; parameters
@and(WT5>SIV.J8,Wt5<=SIV.L8), ; sieve 7
@and(WT6>SIV.J8,Wt6<=SIV.L8)), ; then
@floor( ; round downwards
Tonne/Exd), ; calculated tonne
"." ; else print "."
) ; end

SPECA2.N08:
; FRED program to class half weights
```
Appendix C

No8:= ;set
@if( ;if
@or( ;or
Wt1<=SIV.L7, ;optimum weight are
Wt2<=SIV.L7, ;less or equal than
Wt3<=SIV.L7, ;a specified
Wt4<=SIV.L7, ;value
Wt5<=SIV.L7, ;for siev 8
Wt6<=SIV.L7), ;then
@floor( ;round downwards
Tonne/Exd), ;calculated tonne
"." ;else print "." ) ;end

SPECA2.Opt:
; FRED program to count size options specified
Opt:= ;set
@count( ;count
Wt1:Wt6 ;range
) ;end

SPECA2.Exd:
; FRED program to count options exersized
Exd:= ;set
@count( ;count
No1:No8 ;range
) ;end

SPECA2.TonOpt:
; FRED program to calculate proportion sorted out of optimum
TonOpt:= ;set
@floor( ;round downwards
Tonne*Exd/Opt ;calculate tonne
) ;end

SPECA2.TonOvr:
; FRED program to calculate proportion sorted out of optimum
TonOvr:= ;set
@floor( ;round downwards
Tonne*(Opt-Exd)/Opt ;calculate tonne
) ;end

Peach Halves
SPECA2.Tonne:

; FRED program to calculate tonnes per size
@set(Tonne,  ; set
DrndWt  ; target ingoing weight per can, rules 4 & 5
*10^-6*24  ; calculate weight per carton of 24 cans
*Cartns  ; number of cartons to be packed
)  ; end
APPENDIX

D

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4 No Facts To Me Are Sacred; None Are Profane - Ralph Waldo Emerson

Size Sorting Peach Halves
SIV.A4:
28

SIV.B4:
; FRED to convert inches to mm
25.4*( ;constant
C4+(D4/16) ;decimalise inches
) ;end

SIV.C4:
1

SIV.D4:
2

SIV.B5:
; FRED to convert inches to mm
25.4*( ;constant
C5+(D5/16) ;decimalise inches
) ;end

SIV.C5:
1

SIV.D5:
3

SIV.A6:
32

SIV.B6:
; FRED to convert inches to mm
25.4*( ;constant
C6+(D6/16) ;decimalise inches
) ;end

SIV.C6:
1

Size Sorting
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SIV.D6:
4

SIV.A7:
33

SIV.B7:
; FRED to convert inches to mm
25.4*( ;constant
C7+(D7/16); decimalise inches
) ;end

SIV.C7:
1

SIV.D7:
5

SIV.G7:
; FRED program to calculate peach half weight(g)
; from exponential regression of weight on diameter(mm)
@floor( ;round downwards
(\text{LN}(SHS27)-SHS16)/SHS17 ;compute
) ;end

SIV.H7:
; FRED program to select sieve
@vlookup( ;look up nominal diameter
$G7, ;sieve
$S4:$S$29, ;range
0 ;offset
) ;end

SIV.L7:
; FRED to calculate peach half weight(g)
; from diameter(mm) from regression constants
@floor( ;round downwards
@exp\left(\text{SHS16}*(\text{SHS17*$H7})\right) ;solve equation
) ;end

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SIV.N7:
8

SIV.A8:
35

SIV.B8:
; FRED to convert inches to mm
25.4*(C8+(D8/16));decimalise inches
)

SIV.C8:
1

SIV.D8:
6

SIV.G8:
; FRED program to calculate peach half weight(g)
; from exponential regression of weight on diameter(mm)
@floor(@rounddownwards(@LN(SHS27+SHS31)-SHS16)/SHS17);compute
)

SIV.H8:
; FRED program to select sieve
@vlookup(@roundup nominal diameter $GB, ;sieve
$SH5:$SH29, ;range
0 ;offset
)

SIV.J8:
; FRED to calculate peach half weight(g)
; from diameter(mm) from regression constants
@floor(@rounddownwards@exp($HS16+($HS17*$H7));solve equation
)
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SIV.L8:
; FRED to calculate peach half weight (g)
; from diameter (mm) from regression constants
@floor ( ; round downwards
@exp($H$16+($H$17*$H$8)) ; solve equation
) ; end

SIV.M8:
; FRED to calculate average weight
; of screen interval
@sum ( ; sum lightest and heaviest weights
$J8,$L8)/2 ; average

SIV.N8:
7

SIV.A9:
36

SIV.B9:
FRED to convert inches to mm
25.4*( ; constant
$C9+($D9/16); ; decimalise inches
) ; end

SIV.C9:
1

SIV.D9:
7

SIV.G9:
; FRED program to calculate peach half weight (g)
; from exponential regression of weight on diameter (mm)
@floor ( ; round downwards
(GLN($H$27+2*$H$31)-$H$16)/$H$17 ; compute
) ; end

SIV.H9:
; FRED program to select sieve

Peach Halves
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@vlookup( ; look up nominal diameter
$G9, ; sieve
$S4:$S$29, ; range
0 ; offset
); end

SIV.J9:
; FRED to calculate peach half weight (g)
; from diameter (mm) from regression constants
@floor( ; round downwards
@exp($H$16+($H$17*$H8)) ; solve equation
); end

SIV.L9:
; FRED to calculate peach half weight (g)
; from diameter (mm) from regression constants
@floor( ; round downwards
@exp($H$16+($H$17*$H9)) ; solve equation
); end

SIV.M9:
; FRED to calculate average weight
; of screen interval
@sum( ; sum lightest and heaviest weights
J9, L9)/2 ; average

SIV.N9:
6

SIV.A10:
38

SIV.B10:
; FRED to convert inches to mm
25.4*( ; constant
C10+(D10/16) ; decimalise inches
); end

SIV.C10:
1

Size Sorting
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SIV.D10:
  8

SIV.G10:
  ; FRED program to calculate peach half weight (g)
  ; from exponential regression of weight on diameter (mm)
  @floor( ; round downwards
  (GLN($H$27+3*$H$31]-$H$16)/$H$17 ; compute
  ) ; end

SIV.H10:
  ; FRED program to select sieve
  @vlookup( ; look up nominal diameter
  $G10, ; sieve
  $B4:$B29, ; range
  0 ; offset
  ) ; end

SIV.J10:
  ; FRED to calculate peach half weight (g)
  ; from diameter (mm) from regression constants
  @floor( ; round downwards
  @exp($H$16+($H$17*$H9)) ; solve equation
  ) ; end

SIV.L10:
  ; FRED to calculate peach half weight (g)
  ; from diameter (mm) from regression constants
  @floor( ; round downwards
  @exp($H$16+($H$17*$H10)) ; solve equation
  ) ; end

SIV.M10:
  ; FRED to calculate average weight
  ; of screen interval
  @sum( ; sum lightest and heaviest weights
  J10, L10)/2 ; average

SIV.N10:
  5

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SIV.A11:  
39

SIV.B11:  
; FRED to convert inches to mm
25.4*(;constant
C11+(D11/16);decimalise inches
) ;end

SIV.C11:  
1

SIV.D11:  
9

SIV.G11:  
; FRED program to calculate peach half weight(g)
; from exponential regression of weight on diameter(mm)
@floor( ;round downwards
@LN($H$27+4*$H$31)-$HS16)/$HS17 ;compute
) ;end

SIV.H11:  
; FRED program to select sieve
@vlookup( ;look up nominal diameter
$G11, ;sieve
$B4:$B29, ;range
0 ;offset
) ;end

SIV.J11:  
; FRED to calculate peach half weight(g)
; from diameter(mm) from regression constants
@floor( ;round downwards
@exp($H$16+($H$17*$H10)) ;solve equation
) ;end

SIV.L11:  
; FRED to calculate peach half weight(g)
; from diameter(mm) from regression constants
@floor( ;round downwards
Size Sorting
\begin{verbatim}
#exp($H$16+($H$17*$H11)) ; solve equation

SIV.M11:
; FRED to calculate average weight
; of screen interval
@sum( ; sum lightest and heaviest weights
J11,L11)/2 ; average

SIV.N11:
4

SIV.A12:
41

SIV.B12:
; FRED to convert inches to mm
25.4*( ; constant
C12+(D12/16) ; decimalise inches
) ; end

SIV.C12:
1

SIV.D12:
10

SIV.G12:
; FRED program to calculate peach half weight (g)
; from exponential regression of weight on diameter (mm)
@floor( ; round downwards
(GLN($H$27+5*$H$31)-$H$16)/$H$17 ; compute
) ; end

SIV.H12:
; FRED program to select sieve
@vlookup( ; look up nominal diameter
$G12, ; sieve
$B$4:$B$29, ; range
0 ; offset

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\end{verbatim}
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SIV.J12:
; FRED to calculate peach half weight (g)
; from diameter (mm) from regression constants
\text{Qfloor( } \text{round downwards}\n\text{exp(}$H$16+($H$17*$H$11))\text{);solve equation}

SIV.L12:
; FRED to calculate peach half weight (g)
; from diameter (mm) from regression constants
\text{Qfloor( } \text{round downwards}\n\text{exp(}$H$16+($H$17*$H$12))\text{);solve equation}

SIV.M12:
; FRED to calculate average weight
; of screen interval
\text{Qsum( } \text{sum lightest and heaviest weights}\n\text{J12,L12)/2 ;average}

SIV.N12:
3

SIV.B13:
; FRED to convert inches to mm
25.4*($C$13+(D13/16)) ;decimalise inches

SIV.C13:
1

SIV.D13:
11

SIV.G13:
; FRED program to calculate peach half weight (g)
; from exponential regression of weight on diameter (mm)
Appendix D

@floor( ;round downwards
( @LN($H$27+6*SHS31)-SHS16)/SHS17 ;compute
) ;end

SIV.H13:
; FRED program to select sieve
@vlookup( ;look up nominal diameter
$G13, ;sieve $8$4:$8$29, ;range 0 ;offset ) ;end

SIV.J13:
; FRED to calculate peach half weight(g)
;from diameter(mm) from regression constants
@floor( ;round downwards
@exp($H$16+($H$17*$H$12)) ;solve equation
) ;end

SIV.L13:
; FRED to calculate peach half weight(g)
;from diameter(mm) from regression constants
@floor( ;round downwards
@exp($H$16+($H$17*$H$13)) ;solve equation
) ;end

SIV.M13:
; FRED to calculate average weight
;of screen interval
@sum( ;sum lightest and heaviest weights $J13,L13)/2 ;average

SIV.N13:
2

SIV.A14:
44

SIV.B14:
; FRED to convert inches to mm
25.4*;constant

Peach Halves
C14+(D14/16) ;decimalise inches
) ;end

SIV.C14:
1

SIV.D14:
12

SIV.J14:
; FRED to calculate peach half weight(g)
; from diameter(mm) from regression constants
@floor( ;round downwards
@exp($HS16+($HS17*$H13)) ;solve equation
) ;end

SIV.N14:
1

SIV.B15:
; FRED to convert inches to mm
25.4*( ;constant
C15+(D15/16) ;decimalise inches
) ;end

SIV.C15:
1

SIV.D15:
13

SIV.A16:
47

SIV.B16:
; FRED to convert inches to mm
25.4*( ;constant
C16+(D16/16) ;decimalise inches
) ;end

Size Sorting
SIV.C16: 1

SIV.D16: 14

SIV.H16: .9

SIV.B17:
; FRED to convert inches to mm
25.4*( ;constant
C17+(D17/16) ;decimalise inches
) ;end

SIV.C17: 1

SIV.D17: 15

SIV.H17: .0461

SIV.J17: 8

SIV.K17:
; FRED to sum tonne sorted by sieve 8
;against requirement for 1M can size
@sum(SPEC1M.No8) ;summate tonne for sieve No8

SIV.L17:
; FRED to sum tonne sorted by sieve 8
;against requirement for 1M can size
@sum(SPECa2.No8) ;summate tonne for sieve No8

Peach Halves
SIV.M17:
; FRED to sum tonne sorted by sieve 8
; against requirement for A10 can size
@sum(SPECA10.No8) ;summate tonne for sieve No8

SIV.N17:
; FRED to obtain tonne /sieve
@sum(K17:M17) ;sum

SIV.A18:
50

SIV.B18:
; FRED to convert inches to mm
25.4*( ;constant
C18+(D18/16) ;decimalise inches
) ;end

SIV.C18:
2

SIV.D18:
0

SIV.J18:
7

SIV.K18:
; FRED to sum tonne sorted by sieve 7
; against requirement for 1M can size
@sum(SPEC1M.No7) ;summate tonne for sieve No7

SIV.L18:
; FRED to sum tonne sorted by sieve 7
; against requirement for A2.5 can size
@sum(SPECA2.No7) ;summate tonne for sieve No7

Size Sorting
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SIV.M18:
; FRED to sum tonne sorted by sieve 7
;against requirement for A10 can size
@sum(SPECA10.No7); summate tonne for sieve No7

SIV.N18:
; FRED to obtain tonne /sieve
@sum(K18:M18); sum

SIV.A19:
52

SIV.B19:
; FRED to convert inches to mm
25.4*(; constant
C19+(D19/16); decimalise inches
) ; end

SIV.C19:
2

SIV.D19:
1

SIV.J19:
6

SIV.K19:
; FRED to sum tonne sorted by sieve 6
;against requirement for 1M can size
@sum(SPEC1M.No6); summate tonne for sieve No6

SIV.L19:
; FRED to sum tonne sorted by sieve 6
; against requirement for A2.5 can size
@sum(SPECA2.No6); summate tonne for sieve No6

SIV.M19:
; FRED to sum tonne sorted by sieve 6

Peach Halves
; against requirement for A10 can size
@sum(SPEC:A10:No6) ; summate tonne for sieve No6

SIV.N19:
; FRED to obtain tonne / sieve
@sum(K19:M19) ; sum

SIV.A20:
54

SIV.B20:
; FRED to convert inches to mm
25.4 *( ; constant C20 + (D20/16) ; decimalise inches
) ; end

SIV.C20:
2

SIV.D20:
2

SIV.H20:
; FRED program to calculate minimum peach half
; diameter (mm) from lightest weight (g) entered
@floor( ; round downwards
(SLN($H$27)-$H$16)/$H$17 ; solve regression equation
) ; end

SIV.J20:
5

SIV.K20:
; FRED to sum tonne sorted by sieve 5
; against requirement for 1M can size
@sum(SPEC1M:No5) ; summate tonne for sieve No5

SIV.L20:
; FRED to sum tonne sorted by sieve 6

Size Sorting
; against requirement for A2.5 can size
@sum(SPECA2.N06); summate tonne for sieve No6

SIV.M20:
; FRED to sum tonne sorted by sieve 5
; against requirement for A10 can size
@sum(SPECA10.N05); summate tonne for sieve No5

SIV.N20:
; FRED to obtain tonne/sieve
@sum(K20:M20); sum

SIV.B21:
; FRED to convert inches to mm
25.4*(; constant
C21+(D21/16); decimalise inches)
; end

SIV.C21:
2

SIV.D21:
3

SIV.H21:
; FRED program to calculate peach half weight(g)
; from exponential regression of weight on diameter(mm)
@floor( ; round downwards
(LN($H$28)-$H$16)/$H$17 ;)
; end

SIV.J21:
4

SIV.K21:
; FRED to sum tonne sorted by sieve 4
; against requirement for 1M can size
@sum(SPECM.N04); summate tonne for sieve No4

Peach Halves
SIV.L21:
; FRED to sum tonne sorted by sieve 4
; against requirement for A2.5 can size
@sum(SPECA2.N04); summate tonne for sieve No4

SIV.M21:
; - FRED to sum tonne sorted by sieve 4
; against requirement for A10 can size
@sum(SPECA10.N04); summate tonne for sieve No4

SIV.N21:
; FRED to obtain tonne /sieve
@sum(K21:M21); sum

SIV.A22:
57

SIV.B22:
; FRED to convert inches to mm
25.4*(C22+(D22/16)); decimalise inches
); end

SIV.C22:
2

SIV.D22:
4

SIV.J22:
3

SIV.K22:
; FRED to sum tonne sorted by sieve 3
; against requirement for 1M can size
@sum(SPEC1M.No3); summate tonne for sieve No3

SIV.L22:
; FRED to sum tonne sorted by sieve 3

Size Sorting
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; against requirement for A2.5 can size
@sum(SPEC.A2.No3) ; summate tonne for sieve No3

SIV.M22:
; FRED to sum tonne sorted by sieve 3
; against requirement for A10 can size
@sum(SPEC.A10.No3) ; summate tonne for sieve No3

SIV.N22:
; FRED to obtain tonne / sieve
@sum(K22:M22) ; sum

SIV.A23:
58

SIV.B23:
; FRED to convert inches to mm
25.4*(;constant
C23+(D23/16); decimalise inches)
; end

SIV.C23:
2

SIV.D23:
5

SIV.H23:
7

SIV.J23:
2

SIV.K23:
; FRED to sum tonne sorted by sieve 2
; against requirement for 1M can size
@sum(SPEC1M.No2) ; summate tonne for sieve No2

Peach Halves
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SIV.L23:
; FRED to sum tonne sorted by sieve 2
; against requirement for A2.5 can size
@sum(SPECA2.No2) ; summate tonne for sieve No2

SIV.M23:
; FRED to sum tonne sorted by sieve 2
; against requirement for A10 can size
@sum(SPECA10.No2) ; summate tonne for sieve No2

SIV.N23:
; FRED to obtain tonne / sieve
@sum(K23:M23) ; sum

SIV.A24:
60

SIV.B24:
; FRED to convert inches to mm
25.4*(; constant
C24+(D24/16) ; decimalise inches
) ; end

SIV.C24:
2

SIV.D24:
6

SIV.J24:
1

SIV.K24:
; FRED to sum tonne sorted by sieve 1
; against requirement for 1M can size
@sum(SPEC1M.No1) ; summate tonne for sieve No1

SIV.L24:
; FRED to sum tonne sorted by sieve 1

Size Sorting
;against requirement for A2.5 can size
@sum(SPECA2.No1) ;summate tonne for sieve No1

SIV.M24:
;FRED to sum tonne sorted by sieve 1
;against requirement for A10 can size
@sum(SPECA10.No1) ;summate tonne for sieve No1

SIV.N24:
; FRED to obtain tonne /sieve
@sum(K24:M24) ;sum

SIV.B25:
; FRED to convert inches to mm
25.4*( ;constant
C25+(D25/16) ;decimalise inches
) ;end

SIV.C25:
2

SIV.D25:
7

SIV.H25:
; FRED to calculate average weight
; for selected sieve stack configuration
@floor( ;round downwards
@avg(M8:M13) ) ;calculate mean for sieve stack

SIV.K25:
; FRED to sum tonne/can size
@sum(SPECM.TonOpt) ;sum

SIV.L25:
; FRED to sum tonne/can size
@sum(SPECA2.TonOpt) ;sum

Peach Halves
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SIV.M25:
; FRED to sum tonne/can size
@sum(SPECA10.TonOpt) ;sum

SIV.N25:
; FRED to obtain tonne /sieve
@sum(K25:M25) ;sum

SIV.A26:
63

SIV.B26:
; FRED to convert inches to mm
25.4*( ;constant
C26+(D26/16) ;decimalise inches ) ;end

SIV.C26:
2

SIV.D26:
8

SIV.K26:
; FRED to sum required tonne
@sum(SPEC1M.Tonne) ;sum

SIV.L26:
; FRED to sum required tonne
@sum(SPECA2.Tonne) ;sum

SIV.M26:
; FRED to sum required tonne
@sum(SPECA10.Tonne) ;sum

SIV.N26:
; FRED to sum TOTAL required packing tonne
@sum(SPEC1M.Tonne,SPECA2.Tonne,SPECA10.Tonne) ;sum

Size Sorting
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SIV.A27:
67

SIV.B27:
; FRED to convert inches to mm
25.4*( ;constant
C27*(D27/16) ;decimalise inches
) ;end

SIV.C27:
2

SIV.D27:
10

SIV.G27:
34

SIV.H27:
28

SIV.K27:
; FRED to select lightest specified half
@min(SPEC1M.Wt1:SPEC1M.Wt6) ;minimum weight adjusted

SIV.L27:
; FRED to select lightest specified half
@min(SPECA2.Wt1:SPECA2.Wt6) ;minimum weight adjusted

SIV.M27:
; FRED to select lightest specified half
@min(SPECA10.Wt1:SPECA10.Wt6) ;minimum weight adjusted

SIV.B28:
; FRED to convert inches to mm
25.4*( ;constant
C28*(D28/16) ;decimalise inches
) ;end

Peach Halves
SIV.C28:
2

SIV.D28:
12

SIV.H28:
75

SIV.K28:
; FRED to select heaviest specified half
@max(SPEC1M.Wt1:SPEC1M.Wt6) ;maximum weight adjusted

SIV.L28:
; FRED to select heaviest specified half
@max(SPECA2.Wt1:SPECA2.Wt6) ;maximum weight adjusted

SIV.M28:
; FRED to select heaviest specified half
@max(SPECA10.Wt1:SPECA10.Wt6) ;maximum weight adjusted

SIV.A29:
74

SIV.B29:
; FRED to convert inches to mm
25.4*( ;constant
C29*(D29/16) ;decimalise inches
) ;end

SIV.C29:
2

SIV.D29:
14

SIV.H29:
; FRED to calculate mean weight of specifications

Size Sorting
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\@floor\( \); round downwards
\@avg(SPEC1M.Wt1:SPEC1M.Wt6, \); calculate mean
SPEC2A2.Wt1:SPEC2A2.Wt6, \); from specifications
SPEC1A10.Wt1:SPEC1A10.Wt6) \); in database
) \); end

SIV.K29:
; FRED to calculate mean specified weight
\@floor\( \);
\@avg(SPEC1M.Wt1:SPEC1M.Wt6) \); maximum weight adjusted
) \); end

SIV.L29:
; FRED to calculate mean specified weight
\@floor\( \); round downwards
\@avg(SPEC2A2.Wt1:SPEC2A2.Wt6) \); mean weight adjusted
) \); end

SIV.M29:
; FRED to select mean specified weight
\@floor\( \);
\@avg(SPEC1A10.Wt1:SPEC1A10.Wt6) \); maximum weight adjusted
) \); end

SIV.H30:
; FRED to calculate
\@ceiling\( \); round upwards
($SH$28-$SH$27) \); Range
*10^-2/$SH$25) \); CV

SIV.K30:
; FRED find max CV
\@ceiling(@avg(SPEC1M.CntCV)) \); mean count

SIV.L30:
; FRED find max CV
\@ceiling(@avg(SPEC2A.CntCV));

SIV.M30:
; FRED find max CV
\@ceiling(@avg(SPEC1A10.CntCV)) ;

Peach Halves
SIV.H31:  
  ; FRED to calculate sieve stack weight interval  
  @ceiling((SH$28-$HS27)/(SH$23-1)) ;compute and round upwards

SIV.K31:  
  ; FRED to calculate weight interval  
  @ceiling((K28-K27)/(SHS23-1)) ;compute

SIV.L31:  
  ; FRED to calculate weight interval  
  @ceiling((L28-L27)/(SHS23-1)) ;compute

SIV.M31:  
  ; FRED to calculate weight interval  
  @ceiling((M28-M27)/(SHS23-1)) ;compute

SIV.K32:  
  2

SIV.L32:  
  4

SIV.M32:  
  10

SIV.K33:  
  ; FRED to select maximum Range for count  
  @max(SPEC1M.CntR) ;select

SIV.L33:  
  ; FRED to select maximum Range for count  
  @max(SPEC2A.CntR) ;select

SIV.M33:  
  ; FRED to select maximum Range for count  
  @max(SPEC1A0.CntR) ;select

Size Sorting
SIV.K34:
; FRED to select minimum Range for count
@min(SPECT1M.CntR) ;select

SIV.L34:
; FRED to select minimum Range for count
@min(SPECA2.CntR) ;select

SIV.M34:
; FRED to select minimum Range for count
@min(SPECA10.CntR) ;select

SIV.K35:
; FRED to calculate percentage Sorting Efficiency (SE)
@beep, ;beep
K25/K26*100 ;% SE 1M weights

SIV.L35:
; FRED to calculate percentage Sorting Efficiency (SE)
@beep, ;beep
L25/L26*100 ;% SE A2.5 weights

SIV.M35:
; FRED to calculate percentage Sorting Efficiency (SE)
@beep, ;beep
M25/M26*100 ;% SE A10 weights

SIV.N35:
; FRED to calculate percentage Sorting Efficiency (SE)
@beep(600,50), ;beep
N25*10^2/N26 ;% SE overall

Peach Halves