

**Maximizing deliveries of freshly-lifted beet throughout an
extended harvesting campaign**

by

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BBRO 06:06. Maximizing deliveries of freshly-lifted beet throughout an extended harvesting campaign

Summary

1. To remain competitive, the UK sugar-beet industry needs to improve the cost-effectiveness of its sugar production and exploit the unique advantages of its long harvesting campaign. Apart from changes to the way the crop is grown this could include changes to patterns in which the crop is lifted and stored prior to delivery to the factories.
2. The yield and quality of this beet are maximal when freshly lifted and deteriorate during storage. Maximising the proportion of freshly-lifted beet, especially in the 40% of the tonnage delivered after Christmas, should improve the economics of sugar production in the UK.
3. To quantify the practicality and economic benefits of such a strategy requires, among other things, better information on the proportion of the crop that is currently stored on-farm, the length and conditions of storage, whether the practices differ for crops grown on light and heavy soils, and the reasons for the lifting and storage practices that growers adopt.
4. British Sugar plc conducted initial surveys to collect the required information during the 2006-07 and 2007-08 processing campaigns, the results of which are summarised below.
5. 50% of the UK sugar-beet tonnage is delivered to the factories within a week of lifting (*i.e.* 'just in time'), 25% after storage for 1-2 weeks, and the remaining 25% after periods of medium to long-term storage lasting from 2-3 to more than 4 weeks.
6. The majority of medium to long-term stored beet is delivered from late November onwards during which time it constitutes approximately one-third of the total deliveries. This is the tonnage that needs to be targeted to maximise deliveries of freshly-harvested beet.
7. The need to maximise the returns from both the beet and the following crops is a major consideration in deciding when beet is to be lifted and for how long it is stored. It was found that:
 - (a) Growers on 60% of the fields – predominantly on the heavier-textured soils - intended to follow the sugar beet with a winter cereal. Almost two-thirds of their tonnage was delivered 'just in time' or from a short-term store, mostly during the first half of the campaign. A quarter of the tonnage was delivered from medium to long-term stores during the latter half of the campaign.
 - (b) Growers on a quarter of the fields intended to grow a spring cereal after their sugar beet. These growers were on both light and heavy-textured soils, and the majority of their beet was delivered within 2 weeks of lifting mainly during the later stages of the campaign.

8. 5% of the growers aimed to follow their sugar beet with potatoes and 4% of them with vegetables or maize. Their entire beet was delivered late in the campaign, much of it within 2 weeks of lifting. A proportion was, however, stored for long periods even though there was no great pressure to cultivate for the following crop. The choices of spring cereals, potatoes or vegetables are likely to be determined primarily by contract delivery dates.
9. It is calculated that approximately 10% of the total tonnage of beet delivered during the second half of the processing campaign comes from medium to long-term stores. The rescheduling of these deliveries on a national scale would greatly increase deliveries of freshly-lifted beet.
10. Timely access to harvesting machinery can influence when growers lift their beet and how long they store it prior to delivery. Two-thirds of the surveyed fields were lifted by contractors, a quarter by growers owning their own machines, and the balance by group-owned machines. 75% of the beet tonnage of growers owning their own machines was delivered 'just in time' or after a short period of storage and 25% after medium to long-term storage, compared to 60% and 40%, respectively, for beet lifted with group-owned machines or by contractors.
11. Around 4.23 million adjusted tonnes of beet was delivered to British Sugar factories between late November and the end of January the 2006-07 and 2007-08 campaigns. It is estimated that 14% was stored for an average of 18 days, 8% for 25 days, and 15% for 43 days. The overall loss of yield resulting from these periods of storage was estimated to be about 82,000 tonnes of adjusted beet - equivalent to almost 2% of the national delivered yield.

It is concluded that scope exists within the national pattern of beet lifting and storage for significant gains to be made from maximising the deliveries of freshly-harvested beet. This will, however, entail closer study of the logistics of beet production and delivery.

Maximizing deliveries of freshly-lifted beet throughout an extended harvesting campaign

Introduction

The UK sugar-beet industry needs to improve the cost-effectiveness of sugar production if it is to remain competitive within the new EU Sugar Regime. This may require radical changes to the way the crop is grown, harvested and delivered - especially changes that help the UK sugar industry to exploit its unique advantage of a long harvesting campaign which, providing there are no breakdowns, typically lasts for 160-170 days from mid September through to the end of February or early March.

The yield and quality of beet are maximal when they are lifted from the ground, and deteriorate rapidly if the beet is stored^{1,2}. About 40% of the national beet tonnage is currently delivered after Christmas, so maximising the proportion of this that is freshly lifted would considerably improve the economics of sugar production and processing in the UK. In recent mild winters, an increasing proportion of UK sugar beet grown on light soils and scheduled for late delivery has been left in the ground rather than lifted and stored on-farm and hence delivered fresh with little loss of yield or quality.

At present, we have very little quantitative information on UK sugar-beet storage practices. To allow the practicality and economic benefits of maximising the deliveries of freshly-lifted beet to be quantified requires: (a) more information on the proportion of the crop that is currently stored on-farm and the length of storage on the different soil types; (b) some idea of the potential acreages of beet suited to in-field storage in the different factory areas and how well they would fit with factory requirements for late delivery; and (c) predictions of the likelihood of January and February frosts to identify the regions of least risk for beet left in the ground. The primary aim of the project was to produce a cohesive database on UK beet storage practices from which strategies to maximise deliveries of freshly-lifted beet could be devised and implemented. Ultimately, we would need to ascertain how acceptable changes in delivery strategies would be to growers and fit into their farm operations and rotations.

British Sugar plc's requirements were to undertake a survey of current UK on-farm beet storage practices and the agronomic factors that determine them, to estimate the current scale of national sugar losses through storage, and to undertake an initial analysis of the benefits of increasing the proportion of freshly-lifted beet in late-campaign deliveries. The Arable Crops Research Centre, Broom's Barn was contracted to produce a frost-risk, land suitability map to indicate the most suitable areas for the in-field storage of late-delivered beet. In the event, Broom's Barn considered this latter objective unattainable so this report relates only to the British Sugar component of the work.

¹ Jaggard KW, Clark CJA, May MJ, McCullagh S & Draycott AP (1997). Changes in the weight and quality of sugar-beet (*Beta vulgaris*) roots in storage clamps on farms. *Journal of Agricultural Science, Cambridge* **129**, 287-301.

² Armstrong MJ & Houghton BJ (1996). Sugar beet storage trials: the results. *British Sugar Beet Review* **64** (3), 4-7.

Survey data

As an addition to the ongoing annual British Sugar field survey questionnaire, growers were questioned in 2006-07 and 2007-08 on the ownership of their harvesting machinery and the dates the fields were lifted and the beet delivered to the factory. Further information was requested in 2007-08 on the crop that growers intended to put in after the sugar beet and its projected date of sowing.

A total of 482 fields representing 4670 ha and an estimated 2.44 million tonnes of beet were surveyed in 2006-07, and 485 fields representing 5640 ha and 3.18 million tonnes of beet in 2007-08. These fields were selected as being statistically representative of the national crop and came from six factory areas in 2006-07 (Allscott, Bury, Cantley, Newark, Wisington and York) but only from four in 2007-08 following the closure of the Allscott and York factories.

About 85% of the surveyed fields were lifted in a single contiguous operation lasting between 1-5 days, 13% were lifted on two separate occasions, and 1% required three operations. A total of approximately 520 discrete deliveries from the surveyed fields were therefore analysed each year. Mean harvest and delivery dates were calculated for each delivery - the number of days between the two representing the length of storage. Beet delivered within a week of lifting were considered as 'just in time', and those delivered within 1-2 weeks, 2-3 weeks, or more than 3 weeks after lifting to have undergone short, medium and long-term storage, respectively. The proportion of delivered beet in each of these categories was calculated for successive fortnightly periods from mid September to the end of January.

Data was collected on the number of fields involved and their drilled area, but the following analysis primarily focuses on the tonnages of beet involved. These were estimated by multiplying the contracted tonnage by the ratio of the drilled area of the field to the declared total contract area. When fields were lifted on two or three discrete occasions, it was assumed that equal proportions of the field were harvested each time. The resulting data on the length of storage of the beet from the surveyed fields was analysed in conjunction with other survey data relating to contract size, field area, soil type *etc.*. It is assumed throughout that this analysis of the 900 or so surveyed fields over the two years realistically reflects what happens in the national crop.

Patterns of beet storage

Full details of length of storage of delivered beet are given for the 2006-07 and 2007-08 campaigns in Appendix Tables I and II. Table 1 summarises the overall storage patterns for each campaign. There was little evidence that the reduction of factories from six in 2006-07 to four in 2007-08 greatly affected the patterns of beet storage. Approximately one-half of the estimated beet tonnage from the surveyed fields was delivered 'just-in-time' and a further quarter within a fortnight of lifting, with the final quarter coming out of medium to long stores of between 2-4 weeks or more.

Table 1. *Patterns of beet storage in the 2006-07 and 2007-08 processing campaigns.*

| | Estimated tonnage delivered from surveyed fields | Mean length of storage | | | | |
|---------|--|--|---------|---------|---------|---------|
| | | < 1 wk | 1-2 wks | 2-3 wks | 3-4 wks | > 4 wks |
| | | <i>Percentage of total delivered tonnage</i> | | | | |
| 2006-06 | 243692 | 48.1 | 24.7 | 10.5 | 5.2 | 11.6 |
| 2007-08 | 300794 | 51.8 | 25.4 | 9.9 | 5.1 | 8.6 |
| Mean | | 49.9 | 25.0 | 10.1 | 5.1 | 9.9 |

Fig. 1 summarises the deliveries of 'just in time' deliveries or stored beet at successive stages of the processing campaign. 80% of the beet was delivered 'just-in-time' during the first few weeks of the campaign, decreasing to around 60% by mid November. During this time, a further 20% of the beet was delivered from short-term stores of 1-2 weeks with very little (< 10%) being delivered beet from stores lasting longer than 2 weeks. From late November onwards, the pattern of beet storage became more stable with approximately one-third of the beet being delivered 'just in time', one-third after a period of short-term storage of 1-2 weeks, and the remaining third from medium to long-term stores. It is this latter tonnage of medium to long-term stored beet delivered from late November onwards that should be targeted to maximise deliveries of freshly-harvested beet. The reasons for this beet being lifted early and stored for so long are considered later.

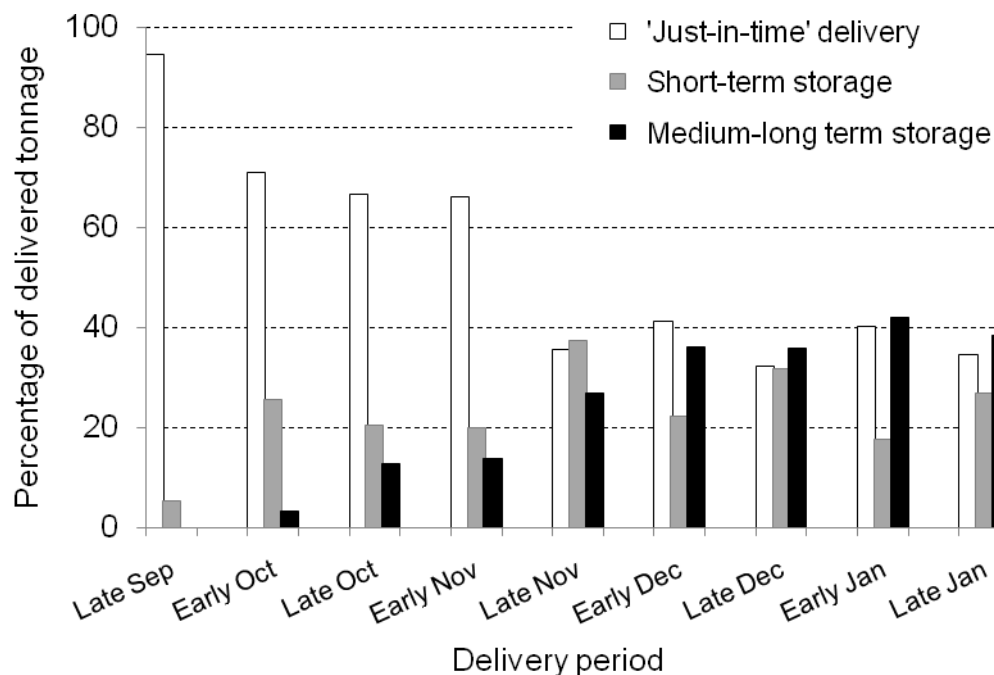


Fig. 1. *The mean length of storage of beet delivered from surveyed fields during successive fortnightly intervals in the 2006-07 and 2007-08 processing campaigns.*

The effects of soil type and following crop on storage practices

The need to maximise the returns from both the beet and the following crops is a major consideration in deciding when beet is to be lifted and for how long it is stored with the lifting of beet being timed to optimise the sowing of the following crop to maximise yield, taking into account soil type. Very little quantitative data exist on the beet harvesting and storage practices for UK sugar beet. One aim of this project was to obtain such information. Questions were therefore asked in British Sugar's 2007-08 survey on the crops that growers' intended to grow after their sugar beet and when these were to be sown.

Full details of beet deliveries during successive fortnightly periods of the 2006-07 and 2007-08 processing campaigns categorised by length of storage are given in Appendix Tables I – II. They are further categorised according to soil type in Appendix Tables III – IV, and by soil type and the interval between the lifting of the sugar beet and the sowing of the following crop for 2007-08 in Appendix Table Va - Vd.

Table 2 presents a condensed breakdown from the 2007-08 survey of the estimated tonnages of beet delivered during the early and later stages of the processing campaign from fields on heavy and light-textured soils following different lengths of storage.

Table 2. *Estimated proportions of short and medium-long term stored beet delivered during the early and late stages of the 2007-08 processing campaign from light and heavy soil textured fields upon which growers intended to sow various winter or spring-sown crops.*

| | Soil texture | % of the total estimated delivered beet tonnage | % total tonnage of beet delivered | | | |
|---|--------------|---|---|-----------------------------|---------------------------------------|-----------------------------|
| | | | Mid September- mid Nov | Mid November - late January | Mid September- mid Nov | Mid November - late January |
| | | | <i>Just in time or from short term stores</i> | | <i>From medium - long term stores</i> | |
| Winter cereal | Heavy | 51.0 | 45.6 | 3.6 | - | 9.3 |
| | Light | 9.2 | 13.3 | 14.0 | 1.3 | 12.8 |
| Spring cereal | Heavy | 16.3 | 0.1 | 22.6 | - | 8.0 |
| | Light | 14.5 | 7.6 | 57.3 | 2.5 | 10.1 |
| Potatoes | Heavy | 1.5 | - | 25.5 | - | 8.4 |
| | Light | 3.9 | - | 32.5 | - | 20.4 |
| Vegetables or maize | Heavy | 2.3 | - | 37.8 | - | 10.5 |
| | Light | 1.4 | 1.5 | 23.5 | - | 19.0 |
| Total beet tonnage from surveyed fields | | 282174 | | | | |

Growers farming 60% of the fields intended following their sugar beet with a winter cereal (primarily wheat) - a large majority of them on the heavier soils (clay loam, silts and peat/organic soils). Almost two-thirds of the beet tonnage from these fields was delivered 'just in time' or from short-term stores, mostly during the first half of the campaign. A further quarter of the beet tonnage was delivered from medium to long-term stores during the latter half of the campaign.

Growers farming about a quarter of the fields - both on light and heavy-textured soils - intended to grow a spring cereal (primarily barley) after their sugar beet. The majority of this beet was delivered during the later stages of the campaign within 2 weeks of lifting.

Growers farming the remaining fields aimed to follow their sugar beet with either potatoes (5%) or vegetables or maize (4%). Virtually all this beet was delivered during the latter half of the campaign, much of it within 2 weeks of lifting. A proportion was, however, stored for long periods even though there was no great pressure to cultivate for the following crop.

The data in the Appendix Tables I-IV can be re-categorised in a number of ways. Table 3, for instance, provides more detail on the effects of soil texture on lifting and storage practices. It contains a condensed breakdown of the deliveries of stored beet during the early and latter halves of the campaign from the light (sand, loamy sand and sandy loam) and heavier-textured (clay loam, silt and peat/organic) soils.

Table 3. *Deliveries of minimal and medium-long term stored beet during the early and late stages of the processing campaign.*

| Period in campaign | 'Just in time' & short term storage | | Medium - long term storage | |
|---|-------------------------------------|---------------|----------------------------|---------------|
| | Light soils | Heavier soils | Light soils | Heavier soils |
| <i>Percentage of the total tonnage for the soil</i> | | | | |
| Late Sep - late Nov | 41.8 | 52.1 | 5.0 | 8.5 |
| Early Dec - late Jan | 36.1 | 21.0 | 16.5 | 18.4 |
| Total tonnage (million tonnes) | 0.274 | 0.290 | | |

* Values are the totals and averages for the two campaigns (2006-07 and 2007-08).

In the two years of the surveys, a similar total tonnage of beet was delivered from fields with light and heavy-textured soils (*i.e.* 0.274 and 0.290 million tonnes). The pattern that emerges from Tables 2 and 3 support the commonly-held view that growers on the heavier soils tend to lift their sugar beet early for delivery with minimal storage presumably to optimise the sowing and maximise the returns from their following winter cereals. Growers who lift and deliver late generally have to grow a spring cereal, potatoes or vegetables. A large proportion of the beet grown on the heavier-textured soils was delivered during the first half of the campaign following minimal storage. During the later stages of the campaign, the majority of the minimally-stored beet came from the lighter-textured soils.

Calculations based on Table 2 show that approximately 28,550 tonnes of beet - representing 10% of the total tonnage from the surveyed fields - was delivered from medium to long-term stores during the latter half of the processing campaign. The rescheduling of these deliveries on a national scale would greatly increase the deliveries of freshly-lifted beet.

Influence of harvester ownership

Timely access to harvesting machinery will strongly influence when growers lift their beet and how long they might have to store it prior to delivery. Growers owning their own machines or in group ownerships might be expected to be able to time their harvests to deliver more beet 'just in time' or after a short period of

storage than growers that have to rely on contractors to lift their beet. The proportion of beet tonnage delivered during the later stages of both processing campaigns has been categorised by the ownership of harvesting machinery and the length of storage in Appendix Table VI. A condensed summary is given in Table 4.

The survey suggests that beet storage practices are influenced by timely access to harvesting machinery. Almost two-thirds of the surveyed tonnage was lifted by contractors, about a quarter by growers owning their own machines, and the balance by group-owned machines. 75% of the beet tonnage delivered by growers owning their own machines arrived 'just in time' or after a short period of storage and 25% after medium to long-term storage. This compares to 60% and 40%, respectively, for beet lifted with group-owned machines or by contractors.

Table 4. *Estimated tonnages of beet delivered during the later stages of the processing campaign (late Nov - end Jan) categorised by length of storage and harvester ownership*
(Values are means of 2006-07 and 2007-08 campaigns)

| Beet storage | Harvester ownership | | | Total tonnage |
|--|------------------------------------|-------|------------|---------------|
| | Grower | Group | Contractor | |
| | <i>Percentage of total tonnage</i> | | | |
| Just in time' delivery or short-term storage | 75.0 | 59.6 | 60.1 | |
| Medium to long-term storage | 24.9 | 40.4 | 39.8 | |
| Total tonnage | 39213 | 19739 | 105359 | 164311 |
| % total | 23.9 | 12.0 | 64.1 | |

What are the implications of medium-long term beet storage?

Accepting that the field survey data reflect the behaviour of the national crop, the data in Appendix Tables I-IV can be used in conjunction with factory tarehouse data to estimate the potential commercial losses of sugar arising from the medium to long term storage of beet. This was done by calculating the percentage of the total delivered tonnage of beet that had come from medium-long term stores (lasting 2-3 to more than 4 weeks) and the mean length of storage for each fortnightly period between late November and the end of January (Appendix Table VII) – this being the period during which the majority of medium-long term stored beet is delivered (Fig. 1). These percentages were then used to adjust the factory tarehouse returns for the same periods to estimate the proportion of the national crop likely to have undergone medium to long-term storage. The potential yield losses during these periods of storage were then calculated on an adjusted beet basis using the average rate of yield-loss of 0.18% of adjusted yield/day of storage quoted by Jaggard & Hopkinson (1998)³.

³ Jaggard KW & Hopkinson I (1998). *British Sugar Beet Review*

Table 5. *Estimated yield losses arising from the medium-long term storage of beet during the later stages of the processing campaign from late November to the end of January.*
(Values are means for the 2006-07 and 2007-08 campaigns)

| | Length of storage (weeks) | Proportion of beet tonnage stored (%) | Mean length of storage (days) | Beet stored (adj t) | Yield loss (adj t) | Yield loss as percentage of beet delivered |
|---|---------------------------|---------------------------------------|-------------------------------|---------------------|--------------------|--|
| | 2-3 | 13.6 | 18 | 574520 | 18116 | 0.43 |
| | 3-4 | 7.6 | 25 | 328893 | 14665 | 0.35 |
| | >4 | 15.1 | 43 | 634013 | 49079 | 1.16 |
| Total UK delivered tonnage (adjusted t) | 4234694 | | | | 81860 | 1.93 |

On average, just over 4.23 million adjusted tonnes of beet was delivered to British Sugar factories between late November and the end of January the 2007-07 and 2007-08 campaigns (Table 5) of which, it is estimated, 14% was stored for an average of 18 days, 8% for 25 days, and 15% for 43 days. This, overall, results in a total yield loss of about 82,000 tonnes of adjusted beet as a consequence of the storage, which is equivalent to around 2% of the national delivered yield.

Concluding remarks

The recent article by Ashfield (2008)⁴ summarises the changes that have occurred in beet harvesting and delivery practices in recent years. It emphasises the increase in 'just in time' deliveries driven by yield gains from the more prolonged growth of the crop in autumn resulting from milder weather and improved fungicides to maintain a healthy and functional leaf canopy. The greater use of 6-row harvesting machine makes it possible to lift more of this beet for 'just in time' delivery. Improvements in the logistics of haulier activity could further increase 'just in time' deliveries.

The main driver for beet harvest and storage schedules should be to maximise the returns from both the beet and the following crops which requires the lifting of beet to be timed to optimise the sowing and maximise the returns from the following crop, taking into account soil type.

Accurate monitoring and assessment of the benefits of such changes in growers' beet harvesting and storage practices has been hampered by a lack of detailed knowledge of these practices, and the factors that drive them. This project represents a first – somewhat limited – attempt to obtain some quantitative information from British Sugar's 2006-07 and 2007-08 field surveys. From this it is estimated that:

1. 50% of the UK sugar-beet tonnage is delivered to the factories within a week of lifting (*i.e.* 'just in time'), 25% after storage for 1-2 weeks, and the remaining 25% after periods of medium to long-term storage lasting from 2-3 to more than 4 weeks.
2. The majority of the medium to long-term stored beet is delivered from late November onwards during which time it constitutes approximately one-third of the total deliveries. It is the tonnage that needs to be targeted to maximise deliveries of freshly-harvested beet.

⁴ **Ashfield S (2008).** Harvesting, storage and the possible way forward. *British Sugar Beet Review* **76** (2), 39-40.

3. The need to maximise the returns from both the beet and the following crops is a major consideration in deciding when beet is to be lifted and for how long it is stored. Consequently:
 - (i) Growers on 60% of the fields – predominantly on the heavier-textured soils - intended to follow the sugar beet with a winter cereal. Almost two-thirds of their tonnage was delivered 'just in time' or from a short-term store, mostly during the first half of the campaign. A quarter of the tonnage was delivered from medium to long-term stores during the latter half of the campaign.
 - (ii) Growers on a quarter of the fields intended to grow a spring cereal (primarily barley) after their sugar beet. These growers were on both light and heavy-textured soils, and the majority of their beet was delivered within 2 weeks of lifting mainly during the later stages of the campaign.
 - (iii) 5% of the growers aimed to follow their sugar beet with potatoes and 4% of them with vegetables or maize. Their entire beet was delivered late in the campaign, much of it within 2 weeks of lifting. A proportion was, however, stored for long periods even though there was no great pressure to cultivate for the following crop. The choices of spring cereals, potatoes or vegetables are likely to be determined primarily by contract delivery dates.
4. It is calculated that approximately 10% of the total tonnage of beet delivered during the latter half of the processing campaign comes from medium to long-term stores. The rescheduling of these deliveries on a national scale would greatly increase deliveries of freshly-lifted beet.
5. Timely access to harvesting machinery can influence when growers lift their beet and how long they store it prior to delivery. Two-thirds of the surveyed fields were lifted by contractors, a quarter by growers owning their own machines, and the balance by group-owned machines. 75% of the beet tonnage of growers owning their own machines was delivered 'just in time' or after a short period of storage and 25% after medium to long-term storage, compared to 60% and 40%, respectively, for beet lifted with group-owned machines or by contractors.
6. Around 4.23 million adjusted tonnes of beet was delivered to British Sugar factories between late November and the end of January the 2007-07 and 2007-08 campaigns. It is estimated that 14% was stored for an average of 18 days, 8% for 25 days, and 15% for 43 days. The overall, loss of yield resulting from these periods of storage was estimated to be about 82,000 tonnes of adjusted beet - equivalent to almost 2% of the national delivered yield.

It is concluded that scope exists within the national pattern of beet lifting and storage for significant gains to be made from maximising the deliveries of freshly-harvested beet. This will, however, entail closer study of the logistics of beet production and delivery.

Addendum

An ancillary objective of the project was to produce a frost-risk, land suitability map to indicate the most suitable areas for the in-field storage of late-delivered beet with minimal risk for delivery fresh in January and February. This was to be done by the Arable Crops Research Centre at Broom's Barn. The following explanation is given for why this was not achieved:

"Post-Christmas, deliveries of freshly lifted beet can be maximized if we can schedule 'just-in-time harvest' for those areas that are:

- (a) capable of carrying harvest traffic when the soil is wet (i.e. sandy soils), and
- (b) the least likely to suffer freeze damage.

We can identify simply the areas of sand, because each grower records his surface soil texture when he/she declares their beet area. However, to delineate areas of sandy soil where the freeze risk is low is more complex. The extension of the 'In-Field Frost Protection' project determined that freeze risks were associated closely with times or places when the daily minimum air temperature fell below -5°C for two consecutive nights. We have tried to make maps to delineate the areas where this is most likely to happen, but the density of weather recording stations is not sufficient to allow this to be done except in a form that is too crude for practical use.

As a result of this, we wrote a proposal for BBRO to use high-resolution interpolation techniques making use of topographical, urban and coastal features in order to make the necessary maps. This proposal was not supported. As a consequence, we have not been able to make useful maps of the best areas for post-Christmas in-field storage for use with moderate confidence by advisors wishing to assemble groups of growers with zoned harvest dates."

Appendix Table I. Summary of the length of storage of beet delivered during successive fortnightly periods during the 2006-07 processing campaign.

| Delivery period | | Mean length of storage | | | | | Total |
|-----------------|--------------------------|------------------------|---------|---------|---------|---------|--------|
| | | < 1 wk | 1-2 wks | 2-3 wks | 3-4 wks | > 4 wks | |
| Late Sep | No. fields | 24 | 3 | | | | 27 |
| | Mean N ^o days | 4 | 9 | | | | |
| | Tonnage | 12386 | 907 | | | | 13293 |
| | % tonnage in period | 93.2 | 6.8 | | | | |
| Early Oct | No. fields | 37 | 11 | 2 | | | 50 |
| | Mean N ^o days | 4 | 10 | 20 | | | |
| | Tonnage | 16664 | 7922 | 1713 | | | 26299 |
| | % tonnage in period | 63.4 | 30.1 | 6.5 | | | |
| Late Oct | No. fields | 45 | 15 | 5 | 1 | 3 | 69 |
| | Mean N ^o days | 4 | 10 | 18 | 28 | 24 | |
| | Tonnage | 15326 | 5988 | 2506 | 2118 | 2712 | 28650 |
| | % tonnage in period | 53.5 | 20.9 | 8.7 | 7.4 | 9.5 | |
| Early Nov | No. fields | 36 | 16 | 9 | 1 | 2 | 64 |
| | Mean N ^o days | 4 | 10 | 18 | 25 | 38 | |
| | Tonnage | 19298 | 6835 | 3958 | 536 | 1391 | 32018 |
| | % tonnage in period | 60.3 | 21.3 | 12.4 | 1.7 | 4.3 | |
| Late Nov | No. fields | 26 | 28 | 4 | 1 | 7 | 66 |
| | Mean N ^o days | 5 | 10 | 16 | 27 | 41 | |
| | Tonnage | 9253 | 10308 | 1982 | 251 | 3412 | 25206 |
| | % tonnage in period | 36.7 | 40.9 | 7.9 | 1.0 | 13.5 | |
| Early Dec | No. fields | 24 | 13 | 12 | 7 | 5 | 61 |
| | Mean N ^o days | 5 | 10 | 17 | 25 | 48 | |
| | Tonnage | 13007 | 6196 | 4882 | 2673 | 4415 | 31173 |
| | % tonnage in period | 41.7 | 19.9 | 15.7 | 8.6 | 14.2 | |
| Late Dec | No. fields | 29 | 20 | 10 | 5 | 6 | 70 |
| | Mean N ^o days | 5 | 11 | 18 | 24 | 41 | |
| | Tonnage | 12074 | 8000 | 3898 | 1284 | 2373 | 27629 |
| | % tonnage in period | 43.7 | 29.0 | 14.1 | 4.6 | 8.6 | |
| Early Jan | No. fields | 18 | 9 | 7 | 13 | 15 | 62 |
| | Mean N ^o days | 4 | 11 | 20 | 25 | 51 | |
| | Tonnage | 12125 | 5075 | 3851 | 2012 | 7304 | 30367 |
| | % tonnage in period | 39.9 | 16.7 | 12.7 | 6.6 | 24.1 | |
| Late Jan | No. fields | 16 | 12 | 5 | 1 | 15 | 49 |
| | Mean N ^o days | 4 | 11 | 17 | 25 | 45 | |
| | Tonnage | 7963 | 7651 | 3122 | 201 | 6709 | 25646 |
| | % tonnage in period | 31.0 | 29.8 | 12.2 | 0.8 | 26.2 | |
| Total | No. fields | 255 | 127 | 54 | 29 | 53 | 518 |
| | Tonnage | 118096 | 58882 | 25912 | 9075 | 28316 | 240281 |
| | % tonnage in period | 49.1 | 24.5 | 10.8 | 3.8 | 11.8 | |

Appendix Table II. *Summary of the length of storage of beet delivered during successive fortnightly periods during the 2007-08 processing campaign.*

| Delivery period | | Mean length of storage | | | | | Total |
|-----------------|--------------------------|------------------------|---------------|--------------|--------------|--------------|--------|
| | | < 1 wk | 1-2 wks | 2-3 wks | 3-4 wks | > 4 wks | |
| Late Sep | No. fields | 47 | 2 | | | | 49 |
| | Mean N ^o days | 3 | 10 | | | | |
| | Tonnage | 32184 | 1334 | | | | 33518 |
| | % tonnage in period | 96.0 | 4.0 | | | | |
| Early Oct | No. fields | 42 | 10 | | | | 52 |
| | Mean N ^o days | 4 | 9 | | | | |
| | Tonnage | 23491 | 6283 | | | | 29774 |
| | % tonnage in period | 78.9 | 21.1 | | | | |
| Late Oct | No. fields | 43 | 13 | | | | 56 |
| | Mean N ^o days | 4 | 9 | | | | |
| | Tonnage | 28583 | 7297 | | | | 35880 |
| | % tonnage in period | 79.7 | 20.3 | | | | |
| Early Nov | No. fields | 33 | 14 | 5 | 2 | | 54 |
| | Mean N ^o days | 4 | 9 | 18 | 30 | | |
| | Tonnage | 24119 | 6291 | 2920 | 146 | | 33476 |
| | % tonnage in period | 72.0 | 18.8 | 8.7 | 0.4 | | |
| Late Nov | No. fields | 27 | 27 | 13 | 3 | 4 | 74 |
| | Mean N ^o days | 4 | 10 | 17 | 24 | 35 | |
| | Tonnage | 14797 | 14663 | 7787 | 1867 | 3932 | 43046 |
| | % tonnage in period | 34.4 | 34.1 | 18.1 | 4.3 | 9.1 | |
| Early Dec | No. fields | 25 | 16 | 10 | 7 | 4 | 62 |
| | Mean N ^o days | 4 | 10 | 18 | 26 | 36 | |
| | Tonnage | 15021 | 9171 | 3369 | 2206 | 6941 | 36708 |
| | % tonnage in period | 40.9 | 25.0 | 9.2 | 6.0 | 18.9 | |
| Late Dec | No. fields | 15 | 19 | 9 | 8 | 8 | 59 |
| | Mean N ^o days | 4 | 11 | 17 | 24 | 41 | |
| | Tonnage | 6752 | 11235 | 5283 | 4884 | 4209 | 32363 |
| | % tonnage in period | 20.9 | 34.7 | 16.3 | 15.1 | 13.0 | |
| Early Jan | No. fields | 13 | 10 | 5 | 8 | 6 | 42 |
| | Mean N ^o days | 4 | 11 | 18 | 24 | 40 | |
| | Tonnage | 10453 | 4863 | 2743 | 3486 | 4229 | 25774 |
| | % tonnage in period | 40.6 | 18.9 | 10.6 | 13.5 | 16.4 | |
| Late Jan | No. fields | 27 | 18 | 11 | 4 | 10 | 70 |
| | Mean N ^o days | 4 | 10 | 17 | 24 | 46 | |
| | Tonnage | 18217 | 11354 | 8574 | 3105 | 6221 | 47471 |
| | % tonnage in period | 38.4 | 23.9 | 18.1 | 6.5 | 13.1 | |
| Total | Tonnage | 272 | 129 | 53 | 32 | 32 | 518 |
| | % tonnage in period | 173617 54.6 | 72491 22.8 | 30676 9.6 | 15694 4.9 | 25532 8.0 | 318479 |

Appendix Table III. *Estimated tonnages of beet delivered from surveyed fields in 2006-07*

| | Delivery period | Mean length of storage | | | | | Period total |
|---------------------|-----------------|------------------------|---------|---------|---------|---------|--------------|
| | | < 1 wk | 1-2 wks | 2-3 wks | 3-4 wks | > 4 wks | |
| Sands & loamy sands | Late Sept | 347 | 0 | 0 | 0 | 0 | 347 |
| | Early Oct | 683 | 0 | 0 | 0 | 0 | 683 |
| | Late Oct | 1325 | 969 | 181 | 0 | 0 | 2475 |
| | Early Nov | 1472 | 199 | 451 | 0 | 0 | 2122 |
| | Late Nov | 1093 | 1527 | 0 | 0 | 0 | 2620 |
| | Early Dec | 566 | 508 | 1237 | 1345 | 0 | 3656 |
| | Late Dec | 2475 | 368 | 0 | 0 | 0 | 2843 |
| | Early Jan | 2653 | 1970 | 611 | 1184 | 209 | 6627 |
| | Late Jan | 946 | 1847 | 324 | | | 3117 |
| | Soil total | 11560 | 7388 | 2804 | 2529 | 209 | 24490 |
| % | 47.2 | 30.2 | 11.4 | 10.3 | 0.9 | | |
| Sandy loams | Late Sept | 2288 | 455 | 0 | 0 | 0 | 2743 |
| | Early Oct | 7232 | 2455 | 0 | 0 | 0 | 9687 |
| | Late Oct | 3520 | 1664 | 483 | 0 | 1095 | 6762 |
| | Early Nov | 9025 | 3950 | 1324 | 536 | 0 | 14835 |
| | Late Nov | 4472 | 3983 | 522 | 0 | 1679 | 10656 |
| | Early Dec | 5895 | 1013 | 950 | 0 | 395 | 8253 |
| | Late Dec | 3245 | 6133 | 2454 | 525 | 1335 | 13692 |
| | Early Jan | 5346 | 3106 | 1920 | 1679 | 1682 | 13733 |
| | Late Jan | 3403 | 1750 | 2397 | 201 | 3327 | 11078 |
| | Soil total | 44426 | 24509 | 10050 | 2941 | 9513 | 91439 |
| % | 48.6 | 26.8 | 11.0 | 3.2 | 10.4 | | |
| Clay loams | Late Sept | 1991 | 452 | 0 | 0 | 0 | 2443 |
| | Early Oct | 5676 | 1136 | 152 | 0 | 0 | 6964 |
| | Late Oct | 4407 | 1864 | 1032 | 2118 | 56 | 9477 |
| | Early Nov | 6127 | 2522 | 1666 | 0 | 586 | 10901 |
| | Late Nov | 2510 | 3657 | 0 | 251 | 1209 | 7627 |
| | Early Dec | 2463 | 4110 | 2388 | 493 | 4020 | 13474 |
| | Late Dec | 3446 | 1538 | 0 | 267 | 240 | 5491 |
| | Early Jan | 3519 | 0 | 787 | 1385 | 2947 | 8638 |
| | Late Jan | 2552 | 1527 | 401 | 0 | 1216 | 5696 |
| | Soil total | 32691 | 16806 | 6426 | 4514 | 10274 | 70711 |
| % | 46.2 | 23.8 | 9.1 | 6.4 | 14.5 | | |
| Silts | Late Sept | 5748 | 0 | 0 | 0 | 0 | 5748 |
| | Early Oct | 3073 | 4332 | 1561 | 0 | 0 | 8966 |
| | Late Oct | 4416 | 1101 | 0 | 0 | 2159 | 7676 |
| | Early Nov | 2509 | 164 | 516 | 0 | 805 | 3994 |
| | Late Nov | 1046 | 1141 | 1030 | 0 | 0 | 3217 |
| | Early Dec | 3607 | 0 | 306 | 835 | 0 | 4748 |
| | Late Dec | 2256 | 787 | 1355 | 101 | 274 | 4773 |
| | Early Jan | 247 | 0 | 533 | 631 | 621 | 2032 |
| | Late Jan | 1009 | 2088 | 0 | 0 | 507 | 3604 |
| | Soil total | 23911 | 9613 | 5301 | 1567 | 4366 | 44758 |
| % | 53.4 | 21.5 | 11.8 | 3.5 | 9.8 | | |
| Peat & organic | Late Sept | 2359 | 0 | 0 | 0 | 0 | 2359 |
| | Early Oct | 0 | 0 | 0 | 0 | 0 | |
| | Late Oct | 1208 | 489 | 810 | 0 | 0 | 2507 |
| | Early Nov | 165 | 0 | 0 | 0 | 0 | 165 |
| | Late Nov | 132 | 0 | 0 | 524 | 0 | 656 |
| | Early Dec | 236 | 804 | 0 | 0 | 0 | 1040 |
| | Late Dec | 0 | 74 | 90 | 391 | 524 | 1079 |
| | Early Jan | 360 | 0 | 0 | 132 | 1845 | 2337 |
| | Late Jan | 54 | 438 | 0 | 0 | 1659 | 2151 |
| | Soil total | 4514 | 1805 | 900 | 1047 | 4028 | 12294 |
| % | 36.7 | 14.7 | 7.3 | 8.5 | 32.8 | | |
| Campaign total | | | | | | 243692 | |

Appendix Table IV. *Estimated tonnages of beet delivered from surveyed fields in 2007-08*

| | Delivery period | Mean length of storage | | | | | Period total |
|---------------------|-----------------|------------------------|---------|---------|---------|---------|--------------|
| | | < 1 wk | 1-2 wks | 2-3 wks | 3-4 wks | > 4 wks | |
| Sands & loamy sands | Late Sept | 1807 | 0 | 0 | 0 | 0 | 1807 |
| | Early Oct | 1530 | 0 | 0 | 0 | 0 | 1530 |
| | Late Oct | 88 | 0 | 0 | 0 | 0 | 88 |
| | Early Nov | 1330 | 0 | 817 | 0 | 0 | 2147 |
| | Late Nov | 3090 | 1311 | 1207 | 0 | 0 | 5608 |
| | Early Dec | 2022 | 1016 | 319 | 0 | 0 | 3357 |
| | Late Dec | 110 | 640 | 2140 | 0 | 0 | 2890 |
| | Early Jan | 4931 | 0 | 0 | 737 | 0 | 5668 |
| | Late Jan | 792 | 1700 | 1526 | 0 | 0 | 4018 |
| | Soil total | 15700 | 4667 | 6009 | 737 | 0 | 27113 |
| % | 57.9 | 17.2 | 22.2 | 2.7 | 0.0 | | |
| Sandy loams | Late Sept | 8496 | 583 | 0 | 0 | 0 | 9079 |
| | Early Oct | 4476 | 4467 | 0 | 0 | 0 | 8943 |
| | Late Oct | 18738 | 2281 | 0 | 0 | 0 | 21019 |
| | Early Nov | 7578 | 3217 | 0 | 0 | 0 | 10795 |
| | Late Nov | 7502 | 1878 | 4560 | 289 | 676 | 14905 |
| | Early Dec | 9094 | 5290 | 0 | 378 | 1411 | 16173 |
| | Late Dec | 4424 | 5816 | 1647 | 0 | 1550 | 13437 |
| | Early Jan | 4780 | 2771 | 710 | 1467 | 1169 | 10897 |
| | Late Jan | 9882 | 4807 | 4154 | 2784 | 4689 | 26316 |
| | Soil total | 74970 | 31110 | 11071 | 4918 | 9495 | 131564 |
| % | 57.0 | 23.6 | 8.4 | 3.7 | 7.2 | | |
| Clay loams | Late Sept | 16085 | 1516 | 0 | 0 | 0 | 17601 |
| | Early Oct | 12286 | 1813 | 0 | 0 | 0 | 14099 |
| | Late Oct | 4921 | 4901 | 0 | 0 | 0 | 9822 |
| | Early Nov | 6951 | 2445 | 992 | 0 | 146 | 10534 |
| | Late Nov | 3472 | 4873 | 2021 | 0 | 3256 | 13622 |
| | Early Dec | 1338 | 2365 | 0 | 990 | 702 | 5395 |
| | Late Dec | 1547 | 3951 | 446 | 2004 | 1225 | 9173 |
| | Early Jan | 280 | 1589 | 1285 | 1282 | 1552 | 5988 |
| | Late Jan | 2307 | 3226 | | 321 | 809 | 6663 |
| | Soil total | 49187 | 26679 | 4744 | 4597 | 7690 | 92897 |
| % | 52.9 | 28.7 | 5.1 | 4.9 | 8.3 | | |
| Silts | Late Sept | 3610 | 0 | 0 | 0 | 0 | 3610 |
| | Early Oct | 2171 | 543 | 0 | 0 | 0 | 2714 |
| | Late Oct | 3532 | 115 | 0 | 0 | 0 | 3647 |
| | Early Nov | 2653 | 629 | 1111 | 0 | 0 | 4393 |
| | Late Nov | 734 | 5705 | 0 | 649 | 0 | 7088 |
| | Early Dec | 1425 | 0 | 1005 | 439 | 0 | 2869 |
| | Late Dec | 671 | 828 | 1151 | 917 | 1434 | 5001 |
| | Early Jan | 462 | 504 | 403 | 0 | 662 | 2031 |
| | Late Jan | 5507 | 0 | 2363 | 0 | 402 | 8272 |
| | Soil total | 20765 | 8324 | 6033 | 2005 | 2498 | 39625 |
| % | 52.4 | 21.0 | 15.2 | 5.1 | 6.3 | | |
| Peat & organic | Late Sept | 368 | 0 | 0 | 0 | 0 | 368 |
| | Early Oct | 3027 | 0 | 0 | 0 | 0 | 3027 |
| | Late Oct | 1304 | 0 | 0 | 0 | 0 | 1304 |
| | Early Nov | 5607 | 0 | 0 | 0 | 0 | 5607 |
| | Late Nov | 0 | 5705 | 0 | 929 | 0 | 6634 |
| | Early Dec | 1143 | 0 | 1286 | 399 | 4828 | 7656 |
| | Late Dec | 0 | 0 | 0 | 1963 | 0 | 1963 |
| | Early Jan | 0 | 0 | 346 | 0 | 877 | 1223 |
| | Late Jan | 0 | 1620 | 0 | 0 | 322 | 1942 |
| | Soil total | 11449 | 7325 | 1632 | 3291 | 6027 | 29724 |
| % | 38.5 | 24.6 | 5.5 | 11.1 | 20.3 | | |
| Campaign total | | | | | | 320923 | |

Appendix Table VI. *Estimated tonnages of beet delivered during the later half of the processing campaign (late Nov - end Jan) categorised by length of storage and harvester ownership*

| Campaign | Beet storage | | Harvester ownership | | | Total |
|-------------------------------|--|------------|---------------------|-------|------------|--------|
| | | | Grower | Group | Contractor | |
| <i>Estimated beet tonnage</i> | | | | | | |
| 2006-07 | Just in time' delivery or short-term storage | Tonnage | 25261 | 7645 | 59646 | 92552 |
| | | % of total | (75) | (55) | (62) | |
| | Medium to long-term storage | Tonnage | 8432 | 6315 | 36191 | 50938 |
| | | % of total | (25) | (45) | (38) | |
| | Total | Tonnage | 33720 | 13968 | 95901 | 143590 |
| | | % of total | | | | |
| 2007-08 | Just in time' delivery or short-term storage | Tonnage | 33581 | 15866 | 67078 | 116525 |
| | | % of total | (75) | (62) | (58) | |
| | Medium to long-term storage | Tonnage | 11096 | 9629 | 47682 | 68407 |
| | | % of total | (25) | (38) | (42) | |
| | Total | Tonnage | 44706 | 25509 | 114818 | 185032 |
| | | % of total | | | | |

Appendix Table VII. *Estimated yield losses arising from beet storage during the 2006-07 and 2007-08 processing campaigns*

| Campaign | Delivery period | Mean length of beet storage (days) | Mean date of lifting ² | Tonnage ² | Stored as % of total delivered ² | National adjusted beet tonnage delivered during period ³ | Estimated tonnage of stored beet | Percentage yield loss ⁴ | Yield loss adjusted tonnes ⁴ | Total yield loss during period |
|----------|--------------------------------|------------------------------------|-----------------------------------|----------------------|---|---|----------------------------------|------------------------------------|---|--------------------------------|
| 2006-07 | Late Nov | 17 | 05-Nov | 1552 | 6.26 | 937604 | 58735 | 3.06 | 1797 | 11788 |
| | | 27 | 02-Nov | 251 | 1.01 | | 9499 | 4.86 | 462 | |
| | | 41 | 10-Oct | 3412 | 13.77 | | 129126 | 7.38 | 9530 | |
| | | Delivered tonnage ¹ | | | 24775 | | | | | |
| | Early Dec | 17 | 22-Nov | 4882 | 15.66 | 956661 | 149823 | 3.06 | 4585 | 19982 |
| | | 25 | 15-Nov | 2673 | 8.57 | | 82031 | 4.50 | 3691 | |
| | | 48 | 21-Oct | 4415 | 14.16 | | 135491 | 8.64 | 11706 | |
| | | Delivered tonnage ¹ | | | 31173 | | | | | |
| | Late Dec | 18 | 02-Dec | 3898 | 13.66 | 1002925 | 137033 | 3.24 | 4440 | 12405 |
| | | 25 | 27-Nov | 1143 | 4.01 | | 40182 | 4.50 | 1808 | |
| | | 41 | 13-Nov | 2373 | 8.32 | | 83422 | 7.38 | 6157 | |
| | | Delivered tonnage ¹ | | | 28529 | | | | | |
| | Early Jan | 20 | 17-Dec | 3851 | 11.54 | 849478 | 98038 | 3.60 | 3529 | 26341 |
| | | 25 | 14-Dec | 5012 | 15.02 | | 127595 | 4.50 | 5742 | |
| | | 51 | 18-Nov | 7304 | 21.89 | | 185944 | 9.18 | 17070 | |
| | | Delivered tonnage ¹ | | | 33368 | | | | | |
| | Late Jan | 17 | 05-Jan | 3122 | 12.17 | 769143 | 93631 | 3.06 | 2865 | 19434 |
| | | 25 | 29-Dec | 201 | 0.78 | | 6028 | 4.50 | 271 | |
| 45 | | 12-Dec | 6709 | 26.16 | 201208 | | 8.10 | 16298 | | |
| | Delivered tonnage ¹ | | | 25646 | | | | | | |
| | Campaign total | | | | | 4515811 | | | | 89950 |
| 2007-08 | Late Nov | 17 | 06-Nov | 7787 | 18.09 | 795420 | 143891 | 3.06 | 4403 | 10471 |
| | | 24 | 28-Oct | 1867 | 4.34 | | 34499 | 4.32 | 1490 | |
| | | 35 | 22-Oct | 3932 | 9.13 | | 72657 | 6.30 | 4577 | |
| | | Delivered tonnage ¹ | | | 43046 | | | | | |
| | Early Dec | 18 | 20-Nov | 3369 | 9.18 | 783722 | 71929 | 3.24 | 2330 | 14138 |
| | | 26 | 12-Nov | 2206 | 6.01 | | 47098 | 4.68 | 2204 | |
| | | 36 | 04-Nov | 6941 | 18.91 | | 148192 | 6.48 | 9603 | |
| | | Delivered tonnage ¹ | | | 36708 | | | | | |
| | Late Dec | 17 | 04-Dec | 5383 | 16.58 | 809799 | 134276 | 3.06 | 4109 | 17120 |
| | | 24 | 29-Nov | 4884 | 15.04 | | 121829 | 4.32 | 5263 | |
| | | 41 | 11-Nov | 4209 | 12.97 | | 104991 | 7.38 | 7748 | |
| | | Delivered tonnage ¹ | | | 32464 | | | | | |
| | Early Jan | 18 | 18-Dec | 2743 | 10.64 | 724455 | 77097 | 3.24 | 2498 | 15289 |
| | | 24 | 14-Dec | 3486 | 13.52 | | 97981 | 4.32 | 4233 | |
| | | 40 | 29-Nov | 4229 | 16.41 | | 118864 | 7.20 | 8558 | |
| | | Delivered tonnage ¹ | | | 25775 | | | | | |
| | Late Jan | 17 | 07-Jan | 8043 | 17.13 | 840181 | 143962 | 3.06 | 4405 | 16226 |
| | | 24 | 08-Jan | 3105 | 6.61 | | 55577 | 4.32 | 2401 | |
| 47 | | 13-Dec | 6221 | 13.25 | 111350 | | 8.46 | 9420 | | |
| | Delivered tonnage ¹ | | | 46940 | | | | | | |
| | Campaign total | | | | | 3953577 | | | | 73244 |

¹ For delivery period ² From British Sugar field survey data ³ From factory tarehouse records
⁴ Sugar loss during storage = 0.18% adjusted beet/day (Jaggard & Hopkinson 1998)