British Beet Research Organisation

---------- FINAL REPORT ----------

06/25 – Benchmarking grower's production to the potential yield set by the environment

Executive Summary

- The benchmarking model that we developed should be a powerful and useful tool for growers to improve their performance in terms of yields and profits.
- Meetings were held with grower groups from each factory area to explain the project and to gather detailed information about production practices that could impact how well they achieve their benchmark.
- The Benchmarking Tool is currently running as a web-based system on a Broom's Barn server, incorporating the Broom's Barn Growth Model and capable of uploading anonomysed contract information to create a projected yield for the current growing season for each contract.
- The program also creates graphs showing past performance so the grower can instantly see how performance has ranked against the benchmark, and how the gap between actual and potential yields changes over the years the benchmark is run.
- Information technology advances at a fast pace. Translation of the PC-based program to a web-based version running on the UK sugar beet portal has turned out to be a more time-consuming and costly process than originally planned when the proposal was written in 2005, which is now an outdated approach. With a further small investment, this final stage can be accomplished, making this valuable decision support tool available to all growers.

Background

The most effective way to produce low cost beet is to grow the contract tonnage on the minimum area and to deliver as much of the potential production as possible. This also means avoiding the use of expensive inputs on excess crop when contract tonnage is assured. However, not all growers are successful at consistently achieving the target contract tonnage. Some of this year-to-year variation is due to weather that is beyond their control. But some of the variation in yields and profitability is also due to practices that can be improved. The aim of this project was to provide growers with a tool to analyse their past performance so that they can separate the effects of differences between seasons from the changes in their ability to harness the latest technology to produce big yields.

An important way for farmers to improve the match between the contract and their production is to assess their performance by benchmarking it against the potential set by the season. If this is consistent they can then forecast what their production is likely to be in an average season. However, if their production relative to the

potential is inconsistent then, with their advisors, growers can examine the reasons for this inconsistency: this process should provide clues about how to improve.

Benchmarking has the potential to greatly reduce the amount of overproduction of beet which, under the current sugar regime and current practice, costs UK farmers *c.* £11M per year.

This benchmarking tool should keep costs down by helping growers to

- plan the area to plant

- analyse performance in relation to the potential of their site and season, thus identifying and hopefully correcting weaknesses.

- enable them to predict yield during the growing season (assuming the subsequent weather is average) to aid decisions on whether or not to apply another input, e.g. a fungicide or irrigation.

At the moment it is difficult for growers to analyse their performance. The yardstick is usually 'How do I compare with others?' and the explanation for a difference is usually (often wrongly) ascribed to differences in soil. This tool will enable growers to compare their performance against their own potential instead of their neighbours' declared performance. This 'benchmark' provides a fair and useful indication of what a grower should be able to achieve, given certain soil and weather conditions. Some growers deliver >90% of their potential production, whereas the average is only 70%.

Using data supplied by growers as source material to run the Broom's Barn growth model, potential crop performance in all the beet fields in the country were simulated, which was then compared with actual delivered yields. See Figures in the Appendix for the outcome of this exercise. The Benchmarking Tool was designed as a decision support tool to both analyse past production and forecast this seasons' production for individual farmers, via the internet. The information provided by the tool will provide a basis for making rational decisions on steps to improve performance. We initially used farmers' discussion groups to determine how best to do this.

Objectives

1. To develop user-friendly, web-based systems to enable growers to benchmark their performance relative to their potential, as an aid to identifying management problems and raising yields.

2. To develop a grower-friendly web based system to deliver decision support about how much area to plant with sugar beet, based on historical performance and weather.

3. To develop a user-friendly interface for the Broom's Barn crop model so that growers can forecast their expected performance and then make decisions about use of in-season inputs.

4. To establish and maintain a small network of weather stations to provide data for BBRO research projects.

5. To produce a report for BBRO and articles describing the systems for British Sugar Beet Review.

Achievements and progress

The benchmarking model that we developed should be a powerful and useful tool for growers to improve their performance in terms of yields and profits. However, the steps to move the benchmarking from the 'core' user groups to the wider community have been hampered by delays. Implementation of this project as a tool that all growers can access is close to realisation, but still requires addtional input of time and resource.

For each of the growers in the 'core' group in each factory area, calculations of potential yields for 2006 and 2007 were made. These were compared with the delivered yields for each contract (Figs. 1-4). It is interesting to see that the performance (percentage of the benchmark achieved) of individual growers varied significantly between years. However, it is important to remember that 2007 was an extremely unusual year, characterised by anaerobic soil conditions in many areas. In some cases these challenging conditions were not a good reflection of how the grower manages to grow the crop, and in fairness the 2007 data should be discarded for growers affected by flooded soil that year.

Meetings were held with grower groups from each factory area to explain the project and to initiate a dialog between researchers at Broom's Barn, British Sugar and growers. By the end of the 2007 campaign, growers (11 out of 22) submitted information sheets that supplemented management information that was available as part of the contract data on the UK sugar beet portal. The 2008 campaign was drawn out, and it proved difficult to organise follow-up meetings to discuss the outcomes of the benchmarking exercise with growers.

The benchmarking program also allowed the performance of the entire set of 4700 (in 2007) growers to be judged against their own benchmarks. However, in this case, a fixed harvest date of 31 October was used for the calculation. This would over- or under-estimate the potential yield for the contract, depending on the actual harvest date. Nevertheless, it is clear that there was a normal distribution of performance, with the majority of growers delivering approximately 80% of the potential (see Appendix). The median performance shifted, as expected, to a much smaller value in 2007, for the reasons stated above. The proportions of growers in the highest and lowest classes were similar in 2005 and 2006, but many growers failed to deliver a decent crop in 2007. The histograms can be used in each season to track the general ability of growers. A shift towards greater median performance in one year could be due to generally kinder growing conditions that permit best practice and buffer poor decision making. Over the course of several years, steady progression of the median performance upwards might also indicate success in technology and knowledge transfer. Conversely, a declining median, particularly in seasons with favourable growing conditions, would suggest that outreach to growers was slipping.

Conclusions

The Benchmarking Tool is running as a web-based system on a Broom's Barn server, incorporating the Broom's Barn Growth Model and capable of uploading anonymysed contract information to create a projected yield for the current growing season for each contract. The grower can input farm-specific rainfall data to supplement the weather data supplied by the in-built database. The program also creates graphs showing past performance so the grower can instantly see how performance has ranked against the benchmark, and how the gap between actual and potential yields changes over the years the benchmark is run.

Future directions

Broom's Barn has been working with the British Sugar team and the programmers at SilverBear Ltd to migrate the web-based Benchmarking Tool to the UK sugar beet portal website where other decision support tools are located. However, this requires translation from one programming language to another, and was beyond the resources allocated to this project. An alternative approach is to keep the program on the Broom's Barn server, but to add an api layer to provide access to growers. This would make secure remote access possible to the system hosted on the Broom's Barn server from within the sugar beet portal, thus keeping all confidential contract information resident on the portal server and not visible or accessible at Broom's Barn. Hence the Benchmarking Tool would appear to the grower as a native tool on the portal. Hosting the program itself at Broom's Barn also makes access to current and long-term weather data sets by the program more straightforward. The ideas in the original proposal in 2005 about how an internet-based model would work are already outdated, indicating the speed at which informational technology moves. We had hoped that with an extension to this project that we could find a way to make this happen, but it was not a trivial cost in time and resources. Therefore, this final stage of the work is stalled until this can be resolved.

When growers can begin to use the Benchmarking Tool, it will be useful to re-convene the growers groups to discuss the utility of the tool. As a result of these discussions, it is anticipated that further information sheets will be distributed to garner more detail about the previous seasons. This is crucial, because it is the exploration of why benchmarks were better achieved in one year than another, that real on-farm improvements can be made. Also, within groups, comparisons amongst growers (with delicate diplomacy) can highlight where some growers might be getting things wrong.

An additional aim of the project was to create and maintain an integrated climate and weather network to support in-season sugar beet crop management and yield forecasting operations, which could support many weather data-dependent research projects. Broom's Barn does now run an automatic weather station in the northern part of the beet-growing area. Current methods of collating rainfall data gathered by selected individuals and scattered Met Office sites are nearly adequate, but the process is cumbersome, and data are often fraught with gaps and errors. However, funds requested for this project to support dedicated automatic recording rainfall weather stations ultimately were not allocated, but the need is still urgent.

Staff who have contributed

Broom's Barn: Keith Jaggard
                        Aiming Qi
                        Ian Pettit
                        Chris Clark
                        Eric Ober

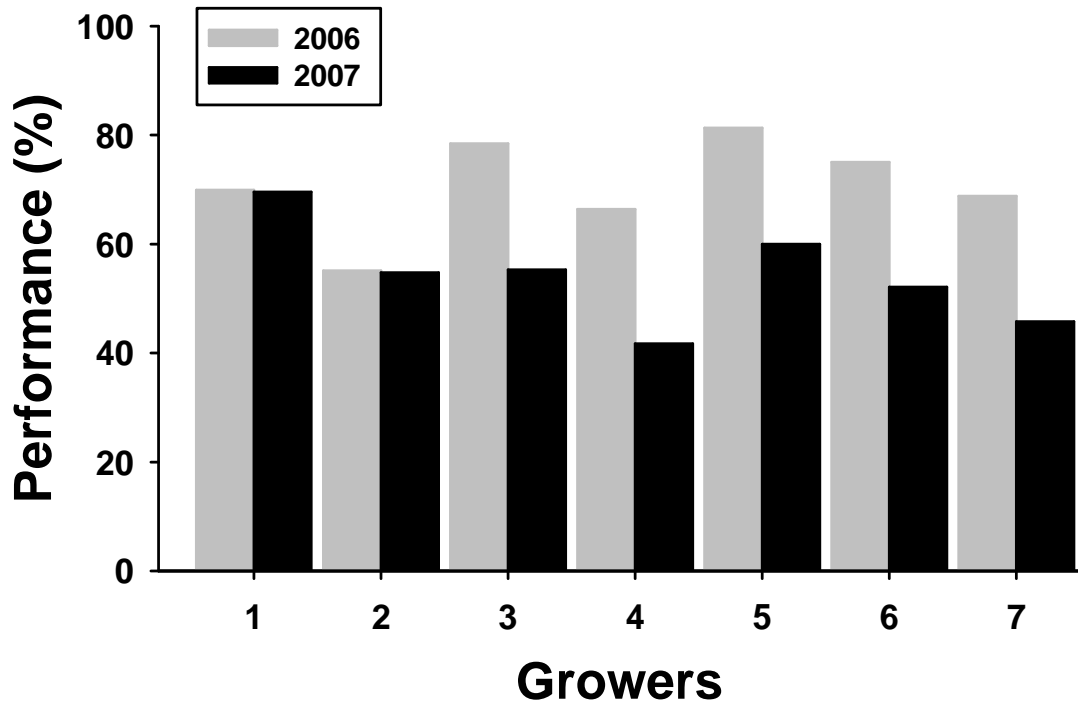British Sugar: John Prince
                        Patrick Jarvis
                        Paul Bee

Fig. 1. Performance relative to the potential set by the environment for seven selected growers in the Wissington factory area. The benchmark potential is specific to each grower.
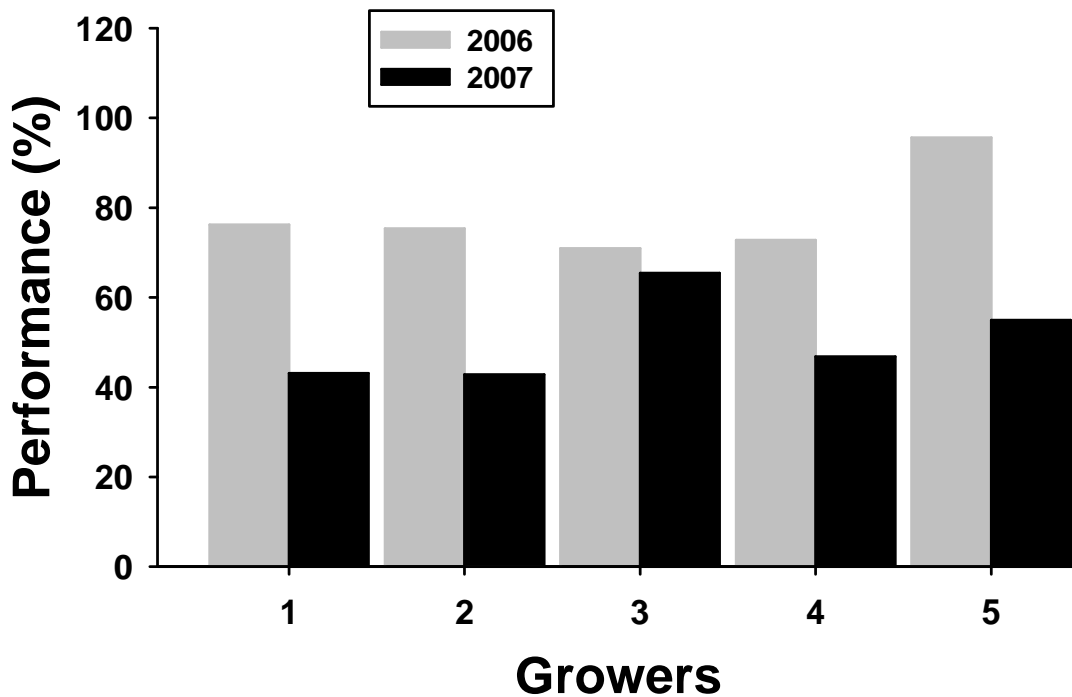

Fig. 2. Performance relative to the potential set by the environment for five selected growers in the Cantley factory area.
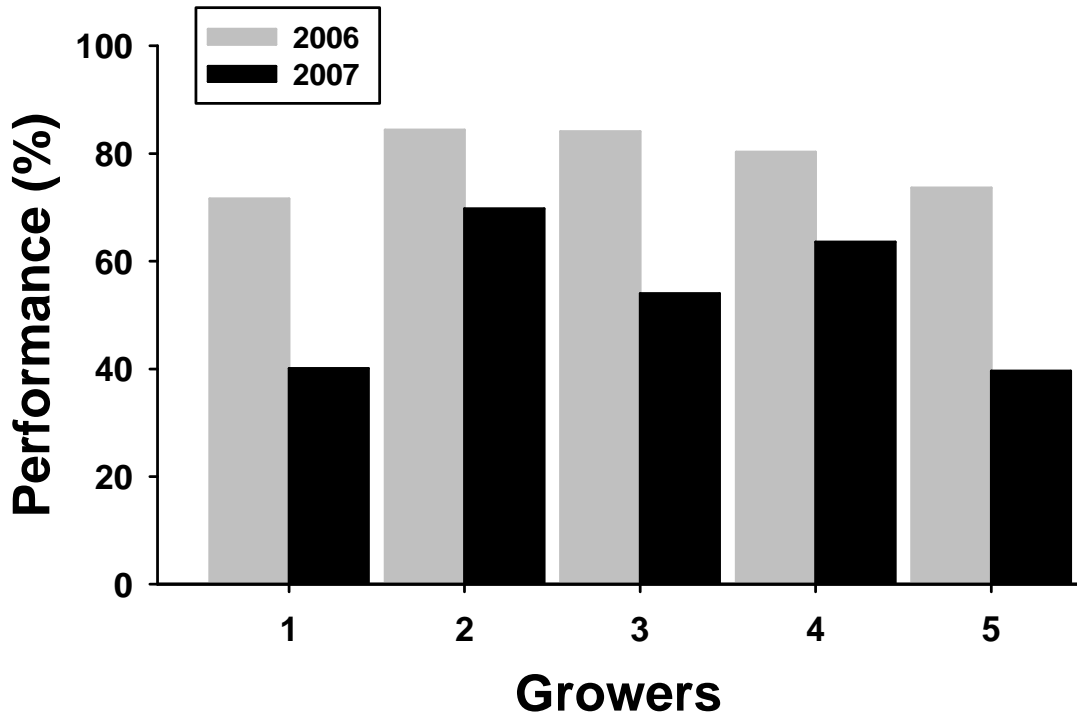
Fig. 3. Performance relative to the potential set by the environment for five selected growers in the Newark factory area.
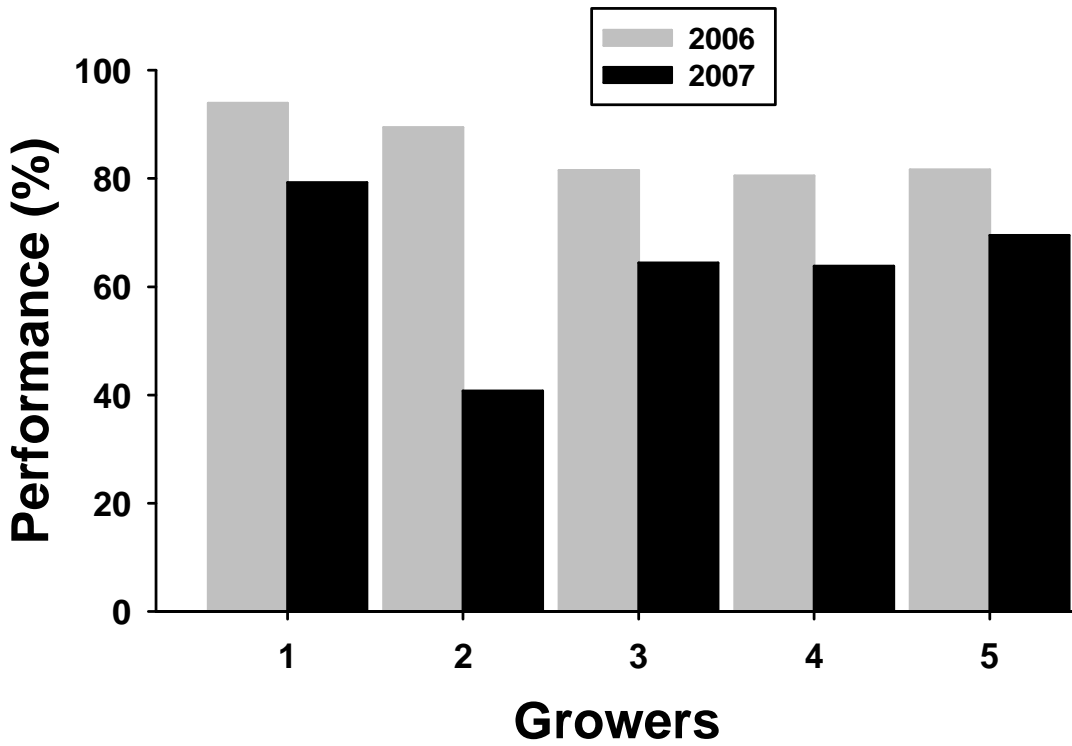

Fig. 4. Performance relative to the potential set by the environment for five selected growers in the Bury factory area.
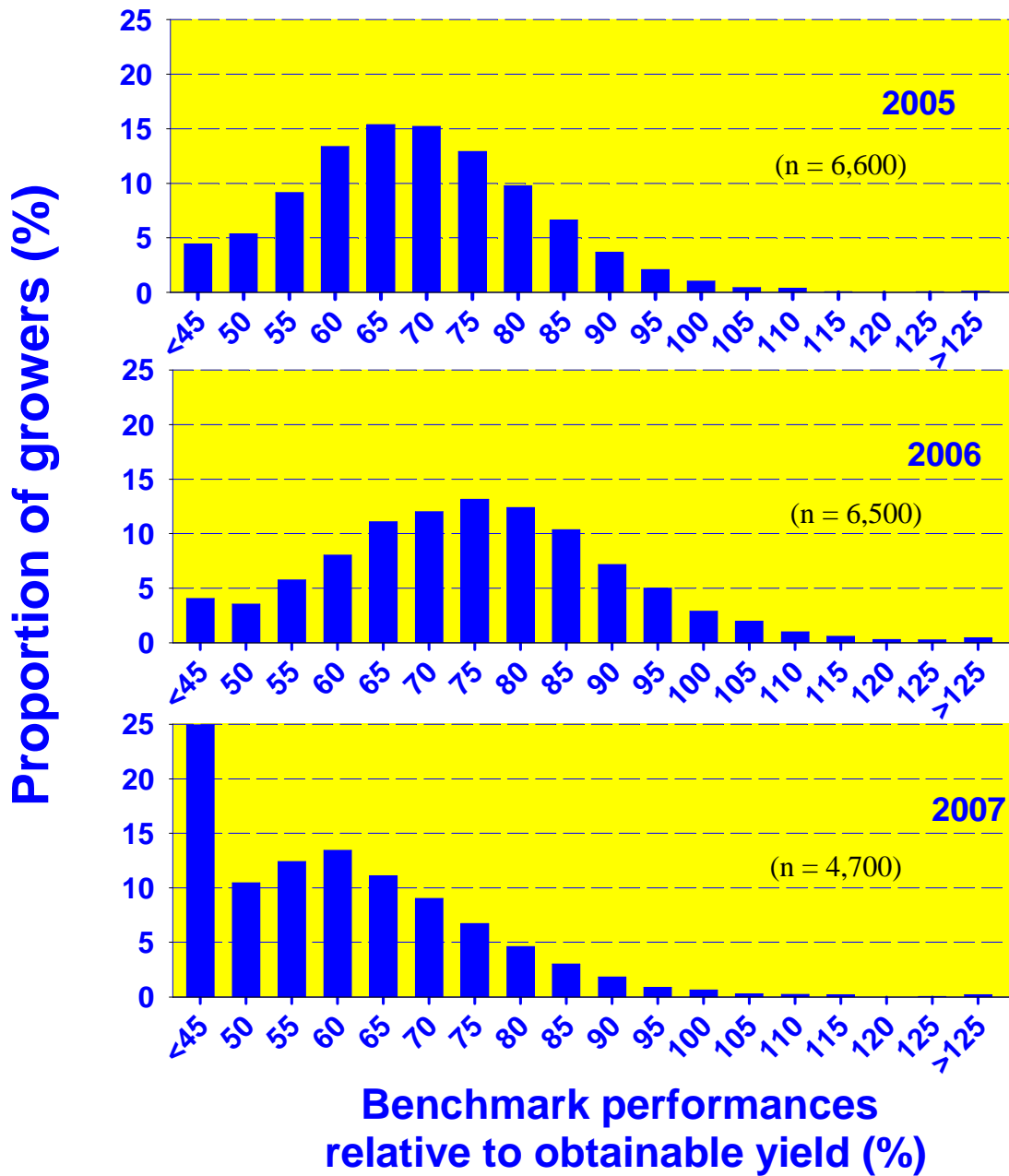
Fig. 5. Distribution of benchmark performances, 2005 to 2007. The number of growers in each data set are indicated in brackets. This is just an indicator of how delivered sugar yield varied from the modelled sugar yield as of 31 October each year. Actual benchmark performance needs both the actual sowing and harvest date for a given field. Actual harvest dates for fields are not entered into contract details.

Table. 1. National benchmark performance since 2000.

Factory	Year							
	2000	2001	2002	2003	2004	2005	2006	2007
Bury	73.1	71.5	68.7	73.0	73.3	69.3	73.2	61.5
Cantley	85.6	73.1	72.8	79.7	75.8	72.9	79.1	56.6
Newark	67.1	69.6	67.3	67.5	66.8	65.3	71.5	53.8
Wissington	71.6	67.6	64.1	68.6	67.2	64.2	71.4	53.0
UK National	72.2	71.6	67.9	71.0	70.1	66.3	72.4	56.0

Table 2. Discussions and participation of 'core' grower groups in 2008.

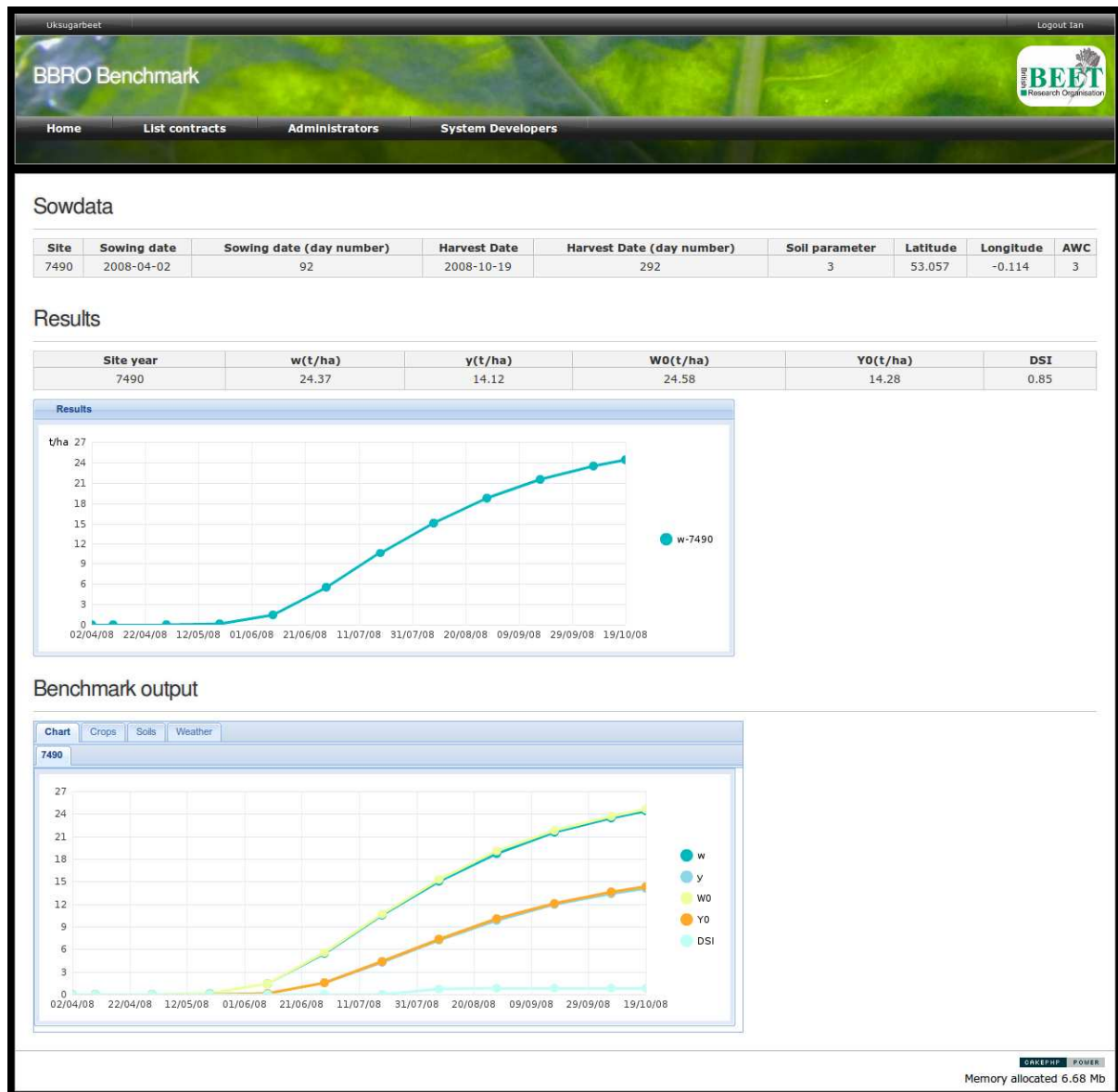| Factory area	Meeting date	Attendance
Bury	30-4-08	3 out of 5 core growers
Cantley	1-5-08	3 out of 5 core growers
Wissington	1-5-08	7 out of 7 core growers
Newark	2-5-08	4 out of 5 core growers

Fig. 6. A screenshot from the Benchmark program showing basic contract information in the top window under 'Sowdata'. A graph showing the projected dry matter production potential for the current year based on the modelled output under rainfed conditions is shown in the Results window. In the Benchmark Output, the simulated yields are shown together. Abbreviations: w: total dry matter yield under actual rainfed conditions; y: sugar yield under rainfed conditions; w0: total dry matter yield with no stress; y0: sugar yield with no stress; DSI: the drought stress index for the fields considered in this contract. The difference between y and y0 indicates the potential benefit of irrigation.
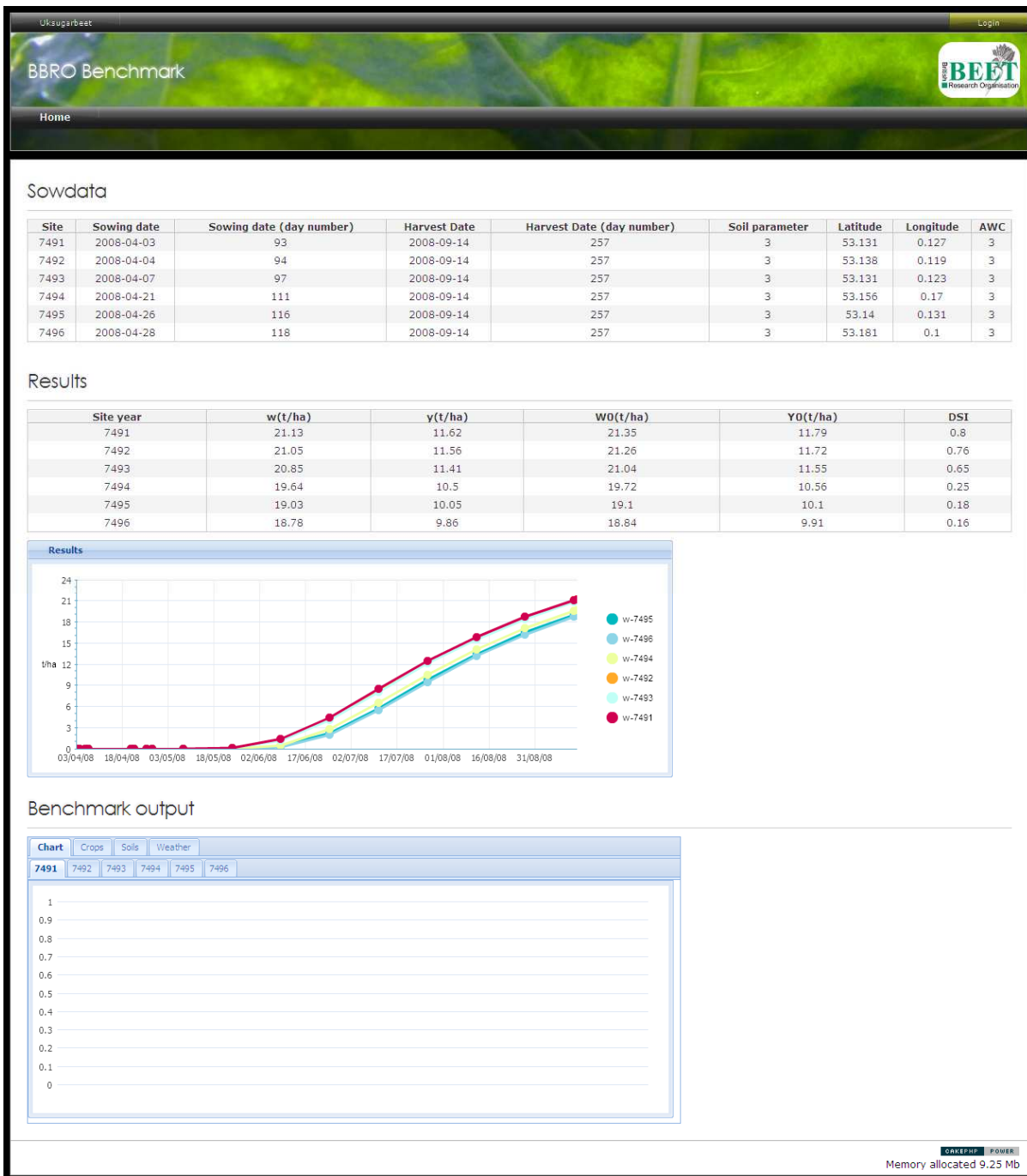
BBRO Benchmark

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Sowdata

Site	Sowing date	Sowing date (day number)	Harvest Date	Harvest Date (day number)	Soil parameter	Latitude	Longitude	AWC
7491	2008-04-03	93	2008-09-14	257	3	53.131	0.127	3
7492	2008-04-04	94	2008-09-14	257	3	53.138	0.119	3
7493	2008-04-07	97	2008-09-14	257	3	53.131	0.123	3
7494	2008-04-21	111	2008-09-14	257	3	53.156	0.17	3
7495	2008-04-26	116	2008-09-14	257	3	53.14	0.131	3
7496	2008-04-28	118	2008-09-14	257	3	53.181	0.1	3

Results

Site year	w(t/ha)	y(t/ha)	W0(t/ha)	Y0(t/ha)	DSI
7491	21.13	11.62	21.35	11.79	0.8
7492	21.05	11.56	21.26	11.72	0.76
7493	20.85	11.41	21.04	11.55	0.65
7494	19.64	10.5	19.72	10.56	0.25
7495	19.03	10.05	19.1	10.1	0.18
7496	18.78	9.86	18.84	9.91	0.16

Results

(Chart legend: w-7495, w-7496, w-7494, w-7492, w-7493, w-7491; x-axis 03/04/08 18/04/08 03/05/08 18/05/08 02/06/08 17/06/08 02/07/08 17/07/08 01/08/08 16/08/08 31/08/08; y-axis t/ha 0–24)

Benchmark output

Chart | Crops | Soils | Weather

7491 | 7492 | 7493 | 7494 | 7495 | 7496

(Chart y-axis 0 to 1)

CAKEPHP POWER
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Fig. 7. A screenshot from the Benchmark program similar to Fig. 6, except showing the yield development in different fields described in the contract. See Fig. 6 for abbreviations.

Fig. 8. A screenshot from the Benchmark program showing fields within a contract and the information associated with that contract that is incorporated into the calculations of the model.