HGCA

PROJECT REPORT No. 66

EVALUATION OF THE MALTING, BREWING AND DISTILLING QUALITIES OF NEW BARLEY VARIETIES IN SCOTLAND - 1991

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EVALUATION OF THE MALTING, BREWING AND DISTILLING QUALITIES OF NEW BARLEY VARIETIES IN SCOTLAND – 1991

by

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Final report of a two year project at the Scottish Agricultural College – Edinburgh. The work commenced in August 1989 and was funded by a grant of £18,524 from the Home-Grown Cereals Authority (Project No. 0050/2/88).

SUMMARY

1. This project continues as part of the recommended list project for evaluating the quality of new barley varieties.

2. This report covers the 1991 harvest results in detail and summarises the three year results and achievements

3. The technical results have led to published statements in the Cereal Recommended List for Scotland governing malting quality, approval for malting and comment in the thumbnail sketches. This includes comment on recently recommended varieties Bronze, Chariot, Derkado and Sprite.

4. The technical results have enabled limited and expensive micro-malting resources to be targeted on those varieties in recommended list trials that are likely to provide growers with a malting premium.

5. The availability of sound micro-malting data from NL1 has enabled SAC staff to be more selective in the choice of varieties for subsequent recommended list testing.

6. The germination energy results have led to the exclusion of unsuitable varieties from further testing in Scotland. In the past this information became available after growers had sown commercial seed eg Doublet.

7. This project has facilitated a number of important indirect objectives.

a. The open exchange of results by the malting laboratories on common samples and the accompanying statistical consistency ratios have highlighted some of the variation that currently aggravates the malting barley market. Laboratories with outlying averages or poor consistency ratios are examining their techniques to improve the uniformity of analysis; this will indirectly remove some of the strange analyses that affect premium offers and rejection at harvest.

b. Of particular note was the between lab variation in screenings. There was some evidence evidence that worn screens and incorrectly stamped or sized new screens were partly responsible.

c. For some years delays in gaining IOB approval for malting have meant that farmers were denied an early message on the commercial potential of new varieties. Based on NL1 and NL2 micro-malting results, bulks of Chariot and Derkado were booked for commercial scale malting during the first year of recommended list trials. These first commercial results have supported the micro-malting indicators and allowed the IOB to grant provisional approval in the first season following recommendation. Likewise Moray Firth Malting's experience with Dallas was sufficient for it to feature on their buying list at a very early stage.

d. The allocation by McCreath, Simpson & Prentice and JP Simpson, of commercial bulks of Sprite at an early stage to their competitors allowed the industry to gain a year in its acceptance of this winter barley. The spirit of co-operation engendered by this project together with the micro-malting results contributed to this useful outcome.

e. The various laboratories include those with the primary interests of distilling, brewing and sale maltsters. In addition to core micro-malting tests, the laboratories include their own tests to check whether new varieties are especially suited or not suited to their requirements. Work done by United Distillers as part of this project is being used by breeders as well as maltsters to ensure that new varieties meet the future market requirements for distilling.

Objectives

1. To provide a uniform drying and conditioning treatment for samples from Scottish variety trials so as to improve the comparability of data on those aspecty of germination that affect malting and export.

2. To provide data on the barley analysis, covering the main criteria affecting acceptance for malting.

3. To select approriate sites based on barley analysis for the production of bulks for distribution to the co-operating micro-malting labs who carry out a malt analysis and establish value forbrewing and distilling.

Materials & Methods

The following NLT/BSPB sites were used for winter barley:

Type	Site		Micro-malted by
SAC NL	Treaton, Fife		United Distillers Menstrie
SAC NL	Udny		Robert Kilgour, Kirkcaldy
ICI BSPB	Kelso	NL1	Robert Kilgour, Kirkcaldy
		NL2	JP Simpson & Co, Berwick

The following NLT/BSPB sites were used for spring barley:

Type	Site		Micro-malted by
SAC NL	Wolfstar, East Lothian		United Distillers
		NL1	Elgin
		NL2	Menstrie
SAC NL	Dumfries	NL1	Pauls Malt, Ipswich
		NL2	Robert Kilgour, Kirkcaldy
SAC NL	Insch	NL1	Moray Firth Maltings, Arbroath
	Inverurie	NL2	Bass Maltings Ltd., Alloa
ICI BSPB	Kelso	NL1	Hugh Baird &Sons Ltd, Pencaitland
		NL2	JP Simpson & Co, Berwick
NSL BSPB	Turriff	NL1	Portgordon Maltings
		NL2	Highland Distillers, Aberlour

The recommended list trial varieties submitted for malting tests were the spring barley varieties:

Camargue
Chariot
Dallas
Decor
Derkado
Teal

and the winter barley varieties:

Halcyon
Bronze

Because dormancy is so important, extra varieties were tested for germination energy: they were the spring varieties:

Alexis
Blenhieim
Chad
Nomad
Prisma
Sherpa
Triumph
Tyne
Volga

and the winter varieties:

Clarine
Puffin
Sprite

The spring barley bulks were made up from 11 sites; the Stirling site was omitted because of high nitrogen and the Ayr site because of water sensitivity. The winter barley bulks were made up from six sites; Udny was omitted because of high nitrogen and both Inverness and Huntly were omitted as they were still dormant on the date bulks had to be submitted for malting analysis.

The following procedures for barley analysis were decided by the micro-malting group convened by the Scottish Working Party of the Barley Committee of the Institute of Brewing:

1. Samples were dried to between 10 and 12% moisture using an air temperature not exceeding 45 C.

2. Samples were stored at 20 C to speed recovery from dormancy.

3. Germination capacity was assessed on 200 grains screened over a 2.2mm sieve after three days in a covered flask with 200ml of freshly made-up H_2O_2. Unchitted grains (no plumule or radicle) were peeled and replaced for one more day.

4. Size distribution was assessed by screening over 2.2, 2.5 and 3.0mm sieves.

5. Thousand corn weight was assessed on a sub-sample screened over 2.2mm and then dried to zero moisture.

6. Nitrogen % was assessed on a dried, milled sample using Kjeldahl's method.

7. Germination energy was assessed at weekly intervals on Halcyon and Camargue using grain screened over 2.2mm. The test consisted of placing 100 grains in two 9cm petri dishes on black Whatman No 1 filter paper; 5ml water was added to one petri dish and 8ml to the other. After 72 hours, unchitted grains were counted. A low figure for germination in both tests indicated dormancy. A high figure for both tests indicated complete recovery from dormancy and a high 5ml, low 8ml result indicated that the sample was still water-sensitive. At the first date that Halcyon or Camague exceeded 90% on the 5ml test, all the other varieties were tested for that site.

8. Warm storage continued until December for the winter barley varieties and January for the spring barley varieties. By these dates two winter barley sites had not broken dormancy so they were excluded from the bulks. The spring variety Teal had been shown to be dormant during the site analyses; by January it had broken dormancy but was still very water sensitive.

9. Suitable sites were then bulked with careful mixing through dividers and the bulks split such that each co-operating laboratory received sufficient grain to carry out their own malt analysis. The following laboratories assessed the spring barley varieties - Moray Firth Maltings, Pauls Malt, Portgordon, Robert Kilgour, Highland Distillers, JP Simpson. Hugh Baird, United Distillers (Elgin & Menstrie). Winter barley varieties were assessed by Moray Firth Maltings, JP Simpson, Hugh Baird and both United Distiller labs.

10. The individual results were checked by Mr Page of Robert Kilgour and processed by SASS who applied consistency ratios to the data to assist laboratories review their techniques.

Results

The results of barley and malt analyses on spring and winter varieties in recommended list trials are reported in appendices 1 to 4. The analyses of national list material has given provisional indicators of malting potential, the more promising varieties have subsequently been tested over a wider range of sites at the recommended list stage. The results enabled the Institute of Brewing to target their future work and ensure that promising malting varieties are fully tested at an early stage in their commercial life.

Appendix 1	Barley Analysis Spring Barley Sites
Appendix 2	Barley Analysis Winter Barley Sites
Appendix 3	Mean barley and malt analysis on spring barley bulks
Appendix 4	Mean barley and malt analysis on winter barley bulks
Appendix 5	Germination energies by years

Discussion

Screenings were a significant contributor to deductions in 1991. Maltsters reported that losses were low in the Borders but particularly high in Tayside and Fife. The new spring barley varieties Chariot and Derkado both performed well over 2.2 and 2.5mm sieves being 10 and 7% better than Camargue respectively in the SVT bulk (Appendix 1). Decor and Teal had higher losses than Camargue. Of the winter barley varieties Bronze had much lower screening losses than Halcyon but the maltsters were concerned that Bronze with such a high 1000 grain weight might result in under-modification when malted in a short germination regime without gibberellic acid (Appendix 2).

Among the spring barley varieties the grain nitrogen figures were inversely related to yield (Appendix 1). By contrast Bronze was higher yielding than Halcyon in the winter barley trials and its grain nitrogen in the SVT bulk was 0.17% higher (Appendix 2). As high grain nitrogen is a major limitation to the production of malting winter barley in Scotland, the future of Bronze is far from assured.

The individual germination capacities in 1991 were highly satisfactory, this provided evidence that the trials had been harvested, dried and stored properly (Appendices 1 & 2). The commercial significance is that maltsters supplying the brewing market normally have to meet a specification of less than 5% unmalted grains in the malt.

In 1991, only Triumph and Teal were dormant relative to Camargue (Appendix 5). In 1990 there was no differential dormancy; in 1989 both Nomad and Triumph were significantly more dormant than Camargue. The 1991 water-sensitivity tests provided considerable varietal discrimination with Blenheim showing marked sensitivity; non-dormant varieties were close to or better than Camargue. Of particularly note were the high 5 and 8ml tests for Dallas, indicating a possible use as a barley likely to be ready for malting before other varieties; this may be reflected in the commercial interest expressed by Moray Firth Maltings in this high extract variety.

Relative to Halcyon the only dormancy indicators were Fighter in 1990 and Clarine in 1989 (Appendix 5). But in both 1990 and 1991 Clarine was water-sensitive although to a lesser extent than Puffin indicating that neither variety is likely to be ready for malting early in the new season. Despite conditioning, the most northerly sites at Huntly and Inverness were so dormant that Halcyon was far from ready for testing by early December so these sites were omitted from the bulk sent for malt analysis (appendix 4). This considerably reduces the malting appeal of winter barley as maltsters in Scotland are likely to prefer the higher quality spring crop if winter barley is not ready to malt before spring barley.

Teal's dormancy was so profound that its micro-malting results were suspect; its dormancy is such a potential problem that the variety should not be considered for malting in Scotland.

Teal apart, the other spring varieties produced respectable malt extracts with Chariot, Dallas and Derkado showing real potential for improvements in spirit yield above the level achieved with Camargue (Appendix 3). There were reservations over Dallas in that it appeared to over-modify very easily but its high germination energy may mean that it requires a faster malting regime; it also had a very high soluble nitrogen ratio at 45% compared with the normal specification of 30-40%. None of the varieties were sufficiently high in diastatic power for use as an enzyme starter in grain whisky production.

The winter barley malt analysis is confused by the wide difference in grain nitrogen (Appendix 4). If both varieties are corrected to 1.5% nitrogen then Bronze has the higher malt extract but as it appears that Bronze takes up nitrogen more readily this correction must be used with caution. As Clarine, Puffin and Sprite had been micro-malted in previous years and were due for tests on commercial bulks, no comparable micro-malting data were presented.

The national list results were much less detailed; their provisional nature inhibits publication but they have been useful as a early warning on dormancy and in the selection of varieties for recommended list trials and they provide some useful additional indicators on distilling potential. They do also provide a check on the official NIAB-based system in that a few varieties have behaved significantly differently in the two systems.

As the SVT bulks were divided between several malting laboratories who analyse both the barley and malt according to a co-ordinated protocol, the project provided a useful ring-check on analytical accuracy. For each character the co-operating laboratories were able to compare their mean with the overall mean and check how consistently their individual results deviated from the mean. A reduction in the range of means reported for nitrogen and screenings would be a benefit to the malting market, so too would be any improvement in consistency. Anxiety over the screenings results has encouraged some of the laboratories to look at their methods and equipment. It will be interesting to check whether future years produce a reduction in range of means and consistency ratios; if the improvements are achieved it will be a major gain to the malting market inadvertently brought about by this H-GCA funded project.

This work will continue as part of the H-GCA project on varietal evaluation for the recommended list. The conclusions are effectively of two types; there are the malting references to varieties in the recommended lists but there are also the decisions by purchasers of malting barley in Scotland and the readiness shown to revise buying lists to take into account the results of this project.

Acknowledgements

Thanks are due to Dr Peter Freeman, formerly of Moray Firth Maltings and to Mr Ronnie Page of Robert Kilgour Ltd for their considerable input and leadership in getting so many competing companies to cooperate and share their results such that a more confident and clearer message on malting potential is presented to the industry. The following companies shared out the malting analyses:

Bass Maltings
Highland Distillers
Hugh Baird & Sons
JP Simpson
Moray Firth Maltings
Pauls Malt
Portgordon Maltings
Pure Malt Products
Robert Kilgour
United Distillers (Menstrie & Elgin)

Thanks are also due to Dr Mike Talbot of the Scottish Agricultural Statistics Service for putting together the results from so many disparate companies.

Thanks are due to members of BSPB for agreeing to provide samples from their trials to supplement the national list sites.

Finally might I acknowledge the role of The Institute of Brewing's Scottish Working Party in initiating this project, supporting and delivering the enthusiastic support of their malting laboratories.

Without the willingness of HGCA to act as a catalyst it is unlikely that the improvements in industry co-operation and knowledge of malting quality and dormancy would have been possible.

APPENDIX 1 **SPRING BARLEY SITES - RESULTS 1991**

Site Variety	Screenings				TCW	N%	Germ
	>3.0	2.5-3.0	2.2-2.5	<2.2	(g)	dm	Cap
SVT Bulk							
Camargue	4.7	75.0	14.8	5.5	47.8	1.75	99.0
Chariot	29.2	60.6	8.2	2.0	48.5	1.64	99.0
Dallas	9.2	69.1	16.6	5.1	49.0	1.61	99.0
Decor	5.9	71.3	16.6	6.2	46.5	1.63	98.5
Derkado	14.9	71.6	10.5	3.0	49.4	1.59	98.0
Teal	6.0	69.2	18.7	6.1	42.6	1.61	52.0
Whitehouse							
Camargue	8.0	74.5	12.7	4.8	49.9	1.74	99.5
Chariot	25.3	59.2	11.4	4.1	46.4	1.72	98.0
Dallas	5.4	68.4	18.8	7.4	46.7	1.70	99.0
Decor	8.9	65.1	19.3	6.7	46.7	1.77	98.0
Derkado	30.7	61.9	4.9	2.5	51.9	1.76	98.5
Teal	10.5	60.4	17.8	11.3	42.4	1.70	97.0
Wolfstar							
Camargue	4.8	78.0	13.3	3.9	48.6	1.61	97.5
Chariot	27.0	59.0	10.3	3.7	46.6	1.54	97.0
Dallas	11.1	71.9	12.0	5.0	48.2	1.52	99.5
Decor	6.5	69.0	17.0	7.5	40.9	1.61	99.0
Derkado	13.2	74.6	10.0	2.2	48.3	1.62	98.5
Teal	7.8	69.1	16.6	6.5	42.9	1.45	98.0
Bush							
Camargue	5.7	78.9	12.0	3.4	49.2	1.75	98.0
Chariot	28.4	61.0	7.2	3.4	47.4	1.81	99.5
Dallas	12.0	70.9	11.6	5.5	48.5	1.72	99.5
Decor	9.5	71.0	13.8	5.7	47.2	1.68	98.0
Derkado	16.7	68.6	10.6	4.1	46.9	1.78	97.0
Teal	5.9	62.5	20.9	10.7	42.9	1.83	96.0
Treaton							
Camargue	1.4	66.7	21.2	10.7	46.1	1.78	100
Chariot	16.0	63.1	14.4	6.5	43.6	1.73	99.0
Dallas	4.9	66.6	20.7	7.8	44.9	1.65	99.5
Decor	5.4	61.6	20.7	12.3	44.3	1.64	100
Derkado	7.8	70.7	15.9	5.6	46.4	1.81	97.5
Teal	2.2	58.2	25.2	14.4	40.5	1.63	100
Star Inn							
Camargue	2.5	68.7	19.6	9.2	45.2	1.72	98.5
Chariot	27.7	58.8	8.9	4.6	44.9	1.74	98.5
Dallas	7.1	70.5	14.8	7.6	45.7	1.64	100.
Decor	1.2	64.0	23.3	11.5	42.5	1.58	98.5
Derkado	17.9	68.5	10.0	3.6	46.1	1.77	97.5
Teal	3.2	62.0	21.4	13.4	41.7	1.58	97.5

Craibstone							
Camargue	8.4	77.2	10.2	4.2	51.9	1.61	98.0
Chariot	32.7	57.7	6.5	3.1	49.5	1.58	96.5
Dallas	13.7	69.5	11.5	5.3	50.2	1.51	95.5
Decor	4.2	71.1	15.3	9.4	51.4	1.54	96.5
Derkado	23.2	66.4	6.3	4.1	46.0	1.64	98.0
Teal	4.9	72.0	16.9	6.2	44.2	1.57	96.0
Inverurie							
Camargue	9.9	69.5	11.8	8.8	50.4	1.58	95.0
Chariot	45.0	45.9	6.0	3.1	50.7	1.57	88.0
Dallas	22.7	65.5	7.7	4.1	51.8	1.41	94.0
Decor	23.4	63.5	7.9	5.2	50.9	1.51	92.5
Derkado	29.3	64.0	5.6	1.1	53.5	1.57	97.0
Teal	13.9	72.2	11.1	2.8	46.1	1.49	96.0
Evanton							
Camargue	3.7	77.1	14.9	4.3	47.8	1.59	98.0
Chariot	23.2	63.8	9.8	3.2	45.5	1.54	98.5
Dallas	8.3	70.2	16.5	5.0	46.8	1.54	98.0
Decor	4.6	69.5	18.0	7.9	43.6	1.48	100
Derkado	12.1	69.8	12.6	5.5	46.8	1.59	99.5
Teal	1.7	65.0	22.2	11.1	40.7	1.55	98.0
Elgin							
Camargue	6.7	85.2	6.5	1.6	50.4	1.47	99.0
Chariot	32.8	61.4	4.5	1.3	46.1	1.48	98.0
Dallas	11.5	79.1	6.9	2.5	49.7	1.51	97.5
Decor	5.1	81.2	10.4	3.3	45.0	1.41	97.5
Derkado	11.3	80.9	6.5	1.3	44.9	1.48	99.0
Teal	3.7	73.6	18.3	4.4	42.3	1.31	97.5
Stirling							
Camargue	1.2	44.1	30.4	24.3	41.0	1.97	100
Chariot	10.0	57.2	20.2	12.6	43.6	1.93	100
Dallas	4.5	48.6	28.8	18.1	41.3	1.92	98.0
Decor	4.3	46.7	24.6	24.4	44.9	1.98	96.0
Derkado	5.6	56.3	23.4	14.7	43.3	2.01	97.0
Teal	2.7	41.2	31.4	24.7	38.8	2.14	96.5
Ayr							
Camargue	11.6	78.4	7.2	2.8	51.6	1.60	94.5
Chariot	43.7	50.1	4.6	1.6	50.2	1.60	100
Dallas	19.4	70.7	7.0	2.9	51.4	1.54	97.5
Decor	17.2	70.8	8.9	3.1	49.9	1.56	97.0
Derkado	35.3	55.8	5.4	3.5	54.1	1.71	95.0
Teal	16.2	70.0	10.0	3.8	47.3	1.46	97.0
Dumfries							
Camargue	18.9	69.4	8.0	3.7	51.3	1.40	99.0
Chariot	35.4	54,6	7.5	2.5	47.6	1.30	99.5
Dallas	24.2	64.4	7.9	3.5	50.0	1.33	99.0
Decor	14.6	66.7	12.2	6.5	46.6	1.24	99.5
Derkado	21.2	67.0	8.5	3.3	48.1	1.36	99.0
Teal	14.7	65.3	13.6	6.4	45.7	1.33	99.0

	Germination Energy					
	5ml			8ml		
	24hr	48hr	72hr	24hr	48hr	72hr
SVT Bulk						
Camargue	54	91	96	49	81	84
Chariot	65	90	96	64	92	96
Dallas	73	93	97	87	96	98
Decor	67	88	95	74	95	99
Derkado	62	94	96	71	98	99
Teal	32	71	91	24	43	52
Whitehouse						
Camargue	39	88	96	27	55	63
Chariot	35	88	94	33	75	85
Dallas	65	97	99	79	94	98
Decor	39	84	96	54	74	80
Derkado	43	84	94	47	83	89
Teal	9	24	43	11	25	37
Alexis	37	79	93	25	53	69
Blenheim	34	70	96	21	42	47
Chad	26	58	82	25	41	45
Nomad	20	65	88	28	50	61
Prisma	41	84	98	42	58	66
Sherpa	53	84	91	42	77	84
Triumph	24	59	72	23	34	42
Tyne	51	87	94	57	80	82
Volga	36	79	93	37	75	85
Wolfstar						
Camargue	22	85	98	26	74	82
Chariot	30	89	94	25	65	73
Dallas	39	94	99	67	91	95
Decor	29	94	98	41	87	91
Derkado	32	88	98	40	87	93
Teal	8	43	74	8	17	25
Alexis	20	68	96	31	72	82
Blenheim	22	70	95	13	51	68
Chad	37	68	92	35	59	71
Nomad	17	53	85	19	41	57
Prisma	36	80	98	28	50	57
Sherpa	33	85	91	47	83	88
Triumph	16	42	75	19	35	41
Tyne	35	82	90	44	78	85
Volga	26	86	97	40	77	83

	5ml			8ml		
	24hr	48hr	72hr	24hr	48hr	72hr
Bush						
Camargue	35	89	97	27	68	81
Chariot	46	87	98	33	69	79
Dallas	53	89	95	53	86	88
Decor	57	95	98	43	89	95
Derkado	51	83	93	45	79	85
Teal	21	43	79	13	23	26
Alexis	41	53	97	27	61	76
Blenheim	29	86	98	14	34	44
Chad	39	82	94	39	72	77
Nomad	42	93	99	25	56	67
Prisma	39	94	96	33	59	68
Sherpa	47	87	95	31	55	64
Triumph	31	54	82	18	27	39
Tyne	45	91	95	48	85	92
Volga	33	75	93	26	51	57
Treaton						
Camargue	21	57	79	21	40	57
Chariot	28	71	91	31	55	73
Dallas	55	91	97	59	90	97
Decor	24	80	90	41	82	93
Derkado	40	78	93	52	80	93
Teal	10	40	64	10	17	28
Alexis	31	68	92	22	48	59
Blenheim	16	37	68	9	27	46
Chad	37	70	91	39	53	67
Nomad	24	54	83	23	50	70
Prisma	24	75	98	31	47	60
Sherpa	29	70	96	27	57	67
Triumph	19	54	79	13	33	53
Tyne	29	82	94	34	66	83
Volga	28	82	96	21	53	68
Star Inn						
Camargue	29	74	98	29	67	80
Chariot	33	79	92	24	63	79
Dallas	47	91	97	38	84	90
Decor	27	86	92	40	91	93
Derkado	39	89	93	45	80	89
Teal	12	42	77	9	28	40
Alexis	28	76	94	16	48	65
Blenheim	20	61	93	17	45	62
Chad	37	67	91	23	46	65
Nomad	16	68	92	28	58	78
Prisma	25	72	98	29	56	65
Sherpa	26	79	90	30	69	80
Triumph	15	55	73	15	52	60
Tyne	32	88	97	31	82	88
Volga	19	84	95	27	66	81

	5ml			8ml		
	24hr	48hr	72hr	24hr	48hr	72hr
Craibstone						
Camargue	28	84	93	10	61	68
Chariot	40	87	97	19	66	72
Dallas	49	84	92	47	77	83
Decor	37	95	98	28	81	85
Derkado	34	70	88	29	67	71
Teal	2	35	56	8	23	28
Alexis	41	72	89	37	59	65
Blenheim	32	82	91	27	36	44
Chad	32	76	95	28	65	70
Nomad	20	83	97	15	41	50
Prisma	43	77	92	30	62	68
Sherpa	41	82	92	28	63	66
Triumph	20	61	76	13	34	37
Tyne	60	92	98	47	68	76
Volga	31	81	93	45	70	78
Evanton						
Camargue	20	78	92	20	73	81
Chariot	37	82	89	24	70	82
Dallas	64	96	97	60	91	98
Decor	58	90	93	46	86	93
Derkado	51	91	94	42	90	92
Teal	21	58	82	15	26	30
Alexis	35	89	96	33	84	89
Blenheim	25	74	96	14	55	71
Chad	46	88	96	33	73	85
Nomad	27	63	94	19	63	79
Prisma	32	80	98	36	60	72
Sherpa	55	93	95	45	94	96
Triumph	44	75	84	17	44	65
Tyne	32	82	94	32	78	88
Volga	45	79	98	34	66	77
Elgin						
Camargue	56	95	97	48	84	93
Chariot	48	87	94	51	88	92
Dallas	82	96	97	68	99	100
Decor	63	94	94	58	84	91
Derkado	72	92	98	74	88	94
Teal	27	48	68	20	30	43
Alexis	34	72	94	32	74	79
Blenheim	40	79	94	24	72	84
Chad	44	78	96	32	59	71
Nomad	41	93	98	37	81	91
Prisma	49	92	99	33	63	73
Sherpa	76	93	100	67	92	99
Triumph	34	69	89	17	32	41
Tyne	56	90	96	49	81	95
Volga	60	87	98	28	74	82

	5ml			8ml		
	24hr	48hr	72hr	24hr	48hr	72hr
Inverness						
Camargue	19	70	93	17	53	58
Chariot	28	79	91	28	58	64
Dallas	50	89	90	60	83	86
Decor	14	76	83	32	66	70
Derkado	43	93	98	53	88	95
Teal	11	50	68	16	41	45
Alexis	41	76	83	33	51	56
Blenheim	30	73	89	28	47	52
Chad	38	77	92	29	53	58
Nomad	20	85	99	39	58	64
Prisma	37	88	94	34	61	66
Sherpa	33	79	90	51	77	80
Triumph	19	70	92	20	36	43
Tyne	44	80	88	49	70	75
Volga	37	92	99	43	76	79
Stirling						
Camargue	32	64	83	42	61	65
Chariot	41	77	85	54	74	82
Dallas	74	88	93	61	75	83
Decor	40	75	88	52	68	73
Derkado	50	76	87	51	77	81
Teal	12	42	48	21	30	36
Alexis	43	71	89	34	45	52
Blenheim	38	62	86	31	47	54
Chad	41	78	93	45	60	73
Nomad	40	81	93	42	62	81
Prisma	43	74	95	48	69	81
Sherpa	46	73	85	49	81	84
Triumph	42	72	77	39	58	67
Tyne	61	82	89	72	87	90
Volga	52	73	83	58	72	81
Ayr						
Camargue	26	62	93	25	46	58
Chariot	32	66	90	32	63	71
Dallas	53	81	89	56	74	82
Decor	29	66	92	22	51	57
Derkado	42	77	94	42	62	71
Teal	15	44	51	8	15	20
Alexis	28	57	83	22	29	37
Blenheim	21	46	88	17	29	43
Chad	23	54	93	25	52	61
Nomad	29	69	93	26	36	56
Prisma	42	81	98	25	38	46
Sherpa	30	70	89	25	42	54
Triumph	24	62	79	17	25	30
Tyne	33	63	83	35	62	72
Volga	22	65	91	32	57	65

	5ml			8ml		
	24hr	48hr	72hr	24hr	48hr	72hr
Dumfries						
Camargue	33	86	92	24	72	80
Chariot	44	87	92	37	82	86
Dallas	84	95	97	82	97	99
Decor	78	95	98	54	82	93
Derkado	58	88	93	47	80	88
Teal	13	35	53	7	19	24
Alexis	50	81	84	44	82	89
Blenheim	36	73	84	28	53	68
Chad	44	83	94	20	82	85
Nomad	38	75	91	21	58	73
Prisma	56	84	95	34	60	71
Sherpa	72	91	93	56	88	97
Triumph	44	73	89	30	56	69
Tyne	62	90	94	41	80	87
Volga	55	83	90	31	67	86

APPENDIX 2 **WINTER BARLEY SITES - RESULTS 1991**

Site Variety	Screenings				TCW	N%	Germ
	>3.0	2.5-3.0	2.2-2.5	<2.2	(g)	dm	Cap
SVT Bulk							
Halcyon	12.4	79.5	8.0	0.1	47.3	1.64	99.0
Bronze	71.4	27.0	1.5	0.1	57.7	1.81	99.0
Whitehouse							
Halcyon	26.4	68.2	4.3	1.1	48.7	1.59	97.5
Bronze	84.5	14.3	0.6	0.6	58.6	1.78	96.5
Bush							
Halcyon	19.6	69.8	8.4	2.2	46.8	1.66	99.0
Bronze	71.4	27.0	1.0	0.6	56.2	1.72	99.5
Treaton							
Halcyon	15.0	73.0	8.5	3.5	44.6	1.76	97.5
Bronze	72.9	23.3	2.1	1.7	54.3	1.86	98.0
Udny							
Halcyon	7.6	68.8	16.3	7.3	43.5	1.92	99.0
Bronze	42.4	52.0	4.2	1.4	52.5	2.06	99.0
Huntly							
Halcyon	7.4	58.6	19.5	14.5	45.0	2.03	96.5
Bronze	52.4	43.2	2.9	1.5	55.1	2.29	98.0
Inverness							
Halcyon	2.2	73.0	18.9	5.9	42.9	1.93	98.0
Bronze	71.2	26.2	1.6	1.0	56.7	2.18	99.5
Ayr							
Halcyon	8.9	83.5	5.9	1.7	50.7	1.53	
Bronze	70.7	27.8	1.1	0.4	58.8	1.62	
Dumfries							
Halcyon	9.6	52.8	22.5	15.1	42.4	1.61	
Bronze	65.5	31.6	1.9	1.0	55.0	1.51	

	Germination Energy					
	5ml			8ml		
	24hr	48hr	72hr	24hr	48hr	72hr
SVT Bulk						
Halcyon	35	89	97	36	86	94
Bronze	46	90	98	49	85	93
Whitehouse						
Halcyon	15	82	97	15	67	85
Bronze	44	96	98	29	74	84
Clarine	26	74	92	19	62	80
Puffin	10	64	88	12	36	40
Sprite	32	78	92	28	67	84
Bush						
Halcyon	14	74	96	23	78	85
Bronze	50	96	100	45	80	86
Clarine	17	77	96	16	53	60
Magie	38	85	96	43	74	79
Puffin	35	77	95	17	32	35
Sprite	31	74	97	26	69	76
Treaton						
Halcyon	42	71	89	27	51	62
Bronze	33	82	97	32	67	81
Clarine	35	58	89	25	46	56
Magie	30	73	85	27	64	75
Puffin	17	46	86	10	40	51
Sprite	42	71	92	48	80	86
Udny						
Halcyon	26	65	86	19	57	85
Bronze	50	89	99	42	91	93
Ayr						
Halcyon	11	73	92	10	62	75
Bronze	14	75	96	18	62	80
Clarine	11	43	89	11	34	49
Magie	27	76	94	15	63	78
Puffin	12	58	91	10	45	61
Sprite	17	71	89	14	55	70
Dumfries						
Halcyon	31	71	87	22	57	73
Bronze	55	93	98	67	91	94
Clarine	31	72	87	20	54	65
Magie	48	81	92	55	92	94
Puffin	32	70	96	16	55	63
Sprite	49	88	97	48	69	81

APPENDIX 3 MEAN BARLEY AND MALT ANALYSIS ON SPRING BARLEY BULKS 1991

Barley Analysis

Variety	Screenings < 2.5mm	TCW g	Nitrogen %	Germination 5ml	Energy % 8ml
CAMARGUE	18.5	38.5	1.78	95.8	76.1
CHARIOT	12.2	37.8	1.76	94.9	79.7
DALLAS	18.0	38.2	1.74	96.3	81.0
DECOR	23.8	36.6	1.71	96.7	77.7
DERKADO	17.4	39.0	1.80	95.4	79.4
TEAL	27.3	35.3	1.71	92.0	48.1

Malt Analysis

Variety	Malt Extract Fine	Coarse	Soluble N Ratio	Fermentability	Predicted Spirit Yield	Diastatic Power	Viscosity
	l degrees/kg		%	%	l alcohol/t malt mashed	Degrees IOB	centipoises
CAMARGUE	309	304	37.8	86.5	413	95	1.51
CHARIOT	313	310	37.9	87.3	426	113	1.46
DALLAS	313	310	45.1	86.6	422	108	1.49
DECOR	309	305	37.3	86.9	417	101	1.49
DERKADO	314	309	40.2	86.8	422	80	1.48
TEAL	306	302	32.1	87.4	416	101	1.50

APPENDIX 4 MEAN BARLEY AND MALT ANALYSIS ON WINTER BARLEY BULKS 1991

Barley Analysis

Variety	Screenings < 2.5mm	TCW g	Nitrogen %	Germination 5ml	Energy 8ml
HALCYON	11.7	37.0	1.80	96.4	67.0
BRONZE	3.5	44.3	1.91	96.0	72.5

Malt Analysis

Variety	Malt Extract Fine	Coarse	Soluble N Ratio	Fermentability %	Predicted Spirit Yield	Diastatic Power	Viscosity
HALCYON	308	305	38.7	86.8	417	99	1.54
BRONZE	305	303	36.4	86.6	413	101	1.52

APPENDIX 5 **GERMINATION ENERGY**

	5ml			8ml		
	1991	1990	1989	1991	1990	1989
Camargue	93	96	90	72	91	74
Chariot	92	-	-	78	-	-
Dallas	95	-	-	92	-	-
Decor	93	93	-	85	86	-
Derkado	94	-	-	87	-	-
Teal	**64**	-	-	**32**	-	-
Alexis	91	95	90	68	87	63
Blenheim	**90**	95	-	**57**	82	-
Chad	92	96	-	69	88	-
Nomad	93	96	**82**	69	85	65
Prisma	97	-	-	66	-	-
Sherpa	92	-	-	80	-	-
Triumph	**81**	94	**81**	**49**	84	**58**
Tyne	93	97	-	84	84	-
Volga	94	95	88	77	83	69
G Promise	-	97	95	-	91	90
Forester	-	96	-	-	89	-
Heritage	-	97	-	-	**89**	-
Grit	-	-	91	-	-	73
Sed		1.7	3.2		3.8	3.6
Halcyon	92	91	90	76	70	81
Fighter	-	**85**	-	-	64	-
Sprite	93	93	-	79	78	-
Clarine	91	91	**68**	**62**	**59**	**67**
Magie	-	91	-	-	71	-
Puffin	91	90	-	**50**	**52**	-
Paris	-	96	-	-	83	-
Sed		3.9	5.0		8.2	7.0