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Assessment of three commercial automatic grain samplers fitted to front loader buckets

by

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Contents

1. Abstract

The objective of the work was to test and compare samples collected with three currently-available bucket-mounted samplers during grain loading with samples collected by manual and automated spear sampling of the loaded lorry.

Six batches of wheat and four batches of barley samples were collected at ten sites: over a six month period. The procedure for sampling was to load a lorry with the bucket fitted with a sampler, collect the sample from the sampler, then to sample the loaded lorry either at the farm with a manual spear or at the recipient's site using their normal methodology. At least four lorry-loads were sampled on each occasion.

Both the front-loader and lorry samples were tested by the recipient or by an independent laboratory or, in some cases, by both. All samples were tested for moisture, screenings and specific weight whilst barley was tested for nitrogen and wheat for protein and hardness. Results from each set of experiments were analysed to test for any differences between the bucket sampling and the alternative method being used.

All three of the automatic bucket samplers tested worked well and appeared to provide a consistent way of taking out-loading grain samples. None of them caused any delay in the loading process. The automatic bucket sampler provided samples of grain that were comparable with samples collected from lorries following current best practice recommendations. However, the sample collected was not always of sufficient size to allow it to be divided into two parts, one of which could be retained by the seller and the other sent with the load to the buyer.

It is concluded that the adoption of automatic bucket samplers could save time and money for buyers and sellers, as well as offering a standard sample that has a high probability of being representative.

2. Introduction

Automatic samplers attached to front loaders offer an effective method of collecting representative samples of lorry-loads of grain. Earlier work on this topic attracted much interest and appears to have wide application (HGCA Project Reports 310, 325, 339). These initial trials showed that the Claydon sampler consistently collected a representative sample of wheat or barley during loading of a lorry and was safe and easy to use. The sample collected fully satisfied assurance schemes that require samples of out-going grain to be collected and retained.

The results of the initial trials were presented to the Cereal Liaison Group in April 2005 who concluded that this approach to sampling had potential to provide a sample that could be used by end users and that this concept should be further investigated. The need for additional work gained added impetus as two additional samplers were marketed.

3. Materials and methods

3.1. Constraints on the project

Due to the nature of the work it was not possible to take the same number of samples at each location or to test equipment "back to back" because fitting more than one sampler to a single bucket was, in most cases, impractical. However, by appropriate statistical analysis the unbalanced design of the experiment has been accounted for.

3.2. Samplers

3.2.1. Claydon black box sampler

Figure 1. Claydon sampler

This sampler fits on the back of a front-loader bucket and has a sample-collection pipe that projects though the bucket into the grain. It has an internal cup arrangement that collects a small sample of grain each time the bucket is filled and emptied. This is collected in the box at the back of the sampler.

3.2.2. Fletcher sampler

Figure 2. Fletcher sampler

This sampler fits inside the bucket and is retained by 2 bolts through the side. It has an intake chamber that fills when the bucket is filled and then empties into the sample holder as the bucket is tipped. When loading is completed the sample holder is detached by unscrewing the wing nut under the unit.

3.2.3. Metcalf sampler

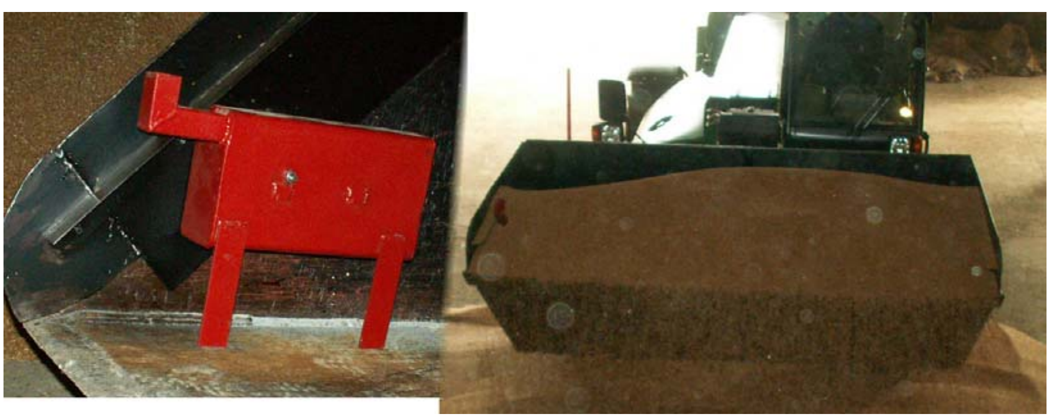

Figure 3. Metcalf sampler

The Metcalf sampler is attached to the inside of the bucket with two bolts through the side. The two legs on the sampler in the photo were added by the farmer and are not standard. The machine uses a simple tube with a right-angle bend to collect a small sample of grain each time the bucket is filled and empties. When loading is completed, the sampler is emptied by unscrewing a wing nut at the back, removing a plate and collecting the sample. This process requires the bucket to be tipped back to some degree.

3.3.Approaches

In general methods used followed those set out in HGCA Project Report 339 so that results from this current and the earlier work are comparable. A sampler was installed on a front loader bucket at a farm or commercial store and samples collected during loading of several lorry-loads of grain. These loads were then sampled, either using the normal commercial practice of the end user or manually by spearing at eight points with a multi-compartmented spear. Both samples were analysed, either by the end user or by an independent laboratory and sometimes by both for moisture content, specific weight, fine material, nitrogen (barley), protein and hardness (wheat).

3.3.1. End user assessments

It proved extremely difficult to obtain advance notice about grain movements, particularly where sufficient notice was needed to install a sampler before loading started. Therefore, the assessments spread over a period of six months. Fortunately, a number of grain merchants, millers, maltsters and farmers made great efforts to set up grain movements for the benefit of the project.

Batches of malting barley, milling and feed wheat were included in this assessment and the samples were often tested by the laboratories at maltings and flour mills or by cargo superintendents. On occasions, samples were tested by an independent laboratory in addition to or instead of the tests done by end users. Results from these assessments were compiled so that a direct comparison could be made between samples collected by front-loader sampler and those collected from the lorry after loading.

Work was done on several sites for both wheat and barley and involved a range of end users. At least four lorry-loads of grain were assessed from each batch of grain. When sufficient grain was collected, the sample from the front-loader was mixed, divided by coning and quartering and, when appropriate half the sample was sent with the lorry to its destination. In the case of smaller samples all the grain was sent with the lorry. These samples were then tested alongside the sample collected from the lorry.

In most cases, the loaded lorries were sampled at their destination by the end user or cargo superintendent following their own sampling schedule. In some case this was observed and seen mostly to follow the recommendations for lorry sampling of eight probes/load to give a composite sample for testing. However, in two cases, grain was sampled by scooping from the surface of the load with a bucket. With some batches of feed wheat the lorry was sampled at the farm by spear and this sample was used to compare with the one collected by the front loader sampler. In these cases, analysis was always done by an independent laboratory.

3.3.2. Assessment of new samplers

The two new samplers were assessed in the same way that the Claydon sampler was tested in previous work. Two examples of each sampler were tested and used to collect samples of wheat or barley as grain was loaded onto lorries. The lorry-loads were then either sampled by end users or by manually spearing the load at eight points with a multi-compartmented spear and producing a single sample for the load. These samples, together with those collect with the front-loader sampler were tested either by the end users of the grain or by an independent laboratory and the two methods of sampling were compared.

In most cases the new samplers were tested singly but in one case both were fitted to the same bucket so that two front loader samples were collected and analysed, together with the end user sample. At this site, exceptionally, some loads were also speared manually before despatch to the end user.

3.4. Assessment of samples

End user assessments of both front-loader and lorry samples were done on the day of collection. Samples that had to be transported to the independent testing laboratory incurred some additional delay between the collection and assessment. However, samples that could not be analysed within 48 hours were stored in a freezer at -16^{o}C to minimise changes in the properties of the grain. These samples were allowed to return to ambient temperature before testing.
When testing was done at an independent laboratory, the properties of each sample were assessed using a Foss Infratec Grain Analyser 1241 GA-TWM. The machine used official calibrations as provided by the NIR network and measured moisture content, specific weight, protein in the case of wheat, or nitrogen in the case of barley and made an assessment of hardness of wheat.

3.5. Statistical analysis of data

Analysis of the data was done using the R Project for Statistical Computing software (The R Foundation for Statistical Computing (2002), ISBN 3-900051-07-0). The results were analysed to test for significant differences between the farm, trailer and the sampling method.

4. Results

4.1 Practical aspects of using the samplers

4.1.1 Claydon black box sampler

This sampler requires the cutting of a relatively large hole in the back of the bucket and, in most cases this hole must be elliptical. The manufacturer provides a mounting template to ease this task. It is relatively easy by flame cutting but more difficult by drilling. However, none of farmers using these samplers during this work complained about difficulty in fitting. In one case a farmer found that with his loading equipment the sampler fouled the front wheels of the loader but in all other case with this and previous trials, fitting was not considered a problem.

In every case, the sampler worked faultlessly and collected relatively large composite samples (about 2kg) from various sizes of lorry and using a range of sizes of bucket. It would collect at least 30 sub-samples before the box was full. It was easy and safe to empty.

4.1.2 Fletcher sampler

The cradle that holds the sampler box is fitted to the inside of the bucket via 2x13mm bolts. The manufacturer provides instructions showing the angle at which the sampler should be mounted. The sampler box is retained on the cradle by a single wing nut.

One of the samplers tested worked correctly when used with barley. However, the second unit required some modification to the entry spout before it worked correctly with wheat. The size of sample box limits the size of sample collected. As a result, these samples were generally too small (about 700 -1000g) to divide so that half could be sent with the lorry and half retained by the farmer. Tests showed that it would collect at least 20 sub-samples before the sample box was full.

The sampler was easy to use and the sample box could be removed by leaning over the side of the bucket.

4.1.3 Metcalf sampler

This is fitted to the side of the bucket by 2x13mm bolts. However, in one case the farmer used only one bolt and welded legs on the sampler as shown in the figure. The manufacturer provides simple fitting instructions.

Both units tested worked correctly. The sample was removed from the sampler via a plate at the rear which was retained by a wing nut. In order to collect the sample, it was necessary to get in the bucket and to have it tip back so the grain would flow out of the sampler. The sample collected was smaller than that collected by the Claydon at about 1 – 1.5kg. It would collect at least 25 sub-samples before it was full.

The Metcalf sampler was the most difficult of the three to empty.

4.2 Sample results

The samples collected by front-loader samplers did not exhibit any consistent differences from the samples collected from the loaded lorries. Hence none of the quality parameters were consistently higher or lower between sampling methods either within a single farm or store of across all the results.

There was one exception to the above. Grain was loaded onto the lorry using both a front loader and an auger discharging from a trailer (see Figure 4). The trailer had been filled from the same batch of grain but had come from the edges of the store and its moisture content was higher. Some of the eight spear samples taken from the lorry came from the front of the load where the grain from the trailer had been loaded so that the lorry sample had consistently higher moisture content. Other quality parameters were unaffected.

Figure 4. Lorry loaded by auger and front loader

4.3 Statistical analysis

Residual maximum likelihood estimation (REML) using The R Foundation for Statistical Computing (2002), ISBN 3-900051-07-0 was used to analyse the results to account for the unbalanced incomplete nature of the data. All the data collected for samples of wheat were combined to detect differences between farms, trailers, and sampling methods. The REML was used to detect which of the random elements of the model (farm, trailer, sampler type and sample number) best described the variance that was seen in the fixed factor (moisture, protein or nitrogen, specific weight or fines). The REML analysis was run with all random effects and then had effects deleted one by one. The model (i.e. random effects structure) that gave the lowest value for the Akaike's Information Criterion (AIC) indicating the best fit, was selected. Symmetry of the residuals was checked to ensure that data were normally distributed.

Sampling wheat. The analysis showed that for Moisture Content and Protein the variables *farms* and *trailers* accounted for the significant variance in the model but there was no variation accounted for by *samples within trailers* or *sampling methods*. For Specific weight, significant variance in the model was accounted for only by *farms.* There was therefore no significant variation between the samples taken by the different bucket samplers and the use of automatic samplers.

Sampling barley. The analysis showed that for Moisture Content and Nitrogen the variable *farms* accounted for the significant variance in the model but there was no variation accounted for by *trailer*, *samples within trailers* or *sampling methods*. For Screenings, significant variance in the model was accounted for by *farms* and *trailers.* There was therefore no significant variation between the samples taken by the different bucket samplers and the use of automatic samplers.

Although there were no statistical differences between the different samplers and with the “standard” Samplex sampler there was some variation in the results although this did not appear to be in any way systematic. However, it is possible, as when sampling any heterogeneous material, that through chance alone samples taken from the same batch could provide different answers. The variability exhibited by these samplers is no worse (or better) than the other sampling method used here or reported in earlier reports (HGCA Project Reports 301, 325, 339). The results of the sampling at the different locations for the two different grains are shown in Figures 5 and 6.

All the raw data generated during the work are attached as Appendix I.

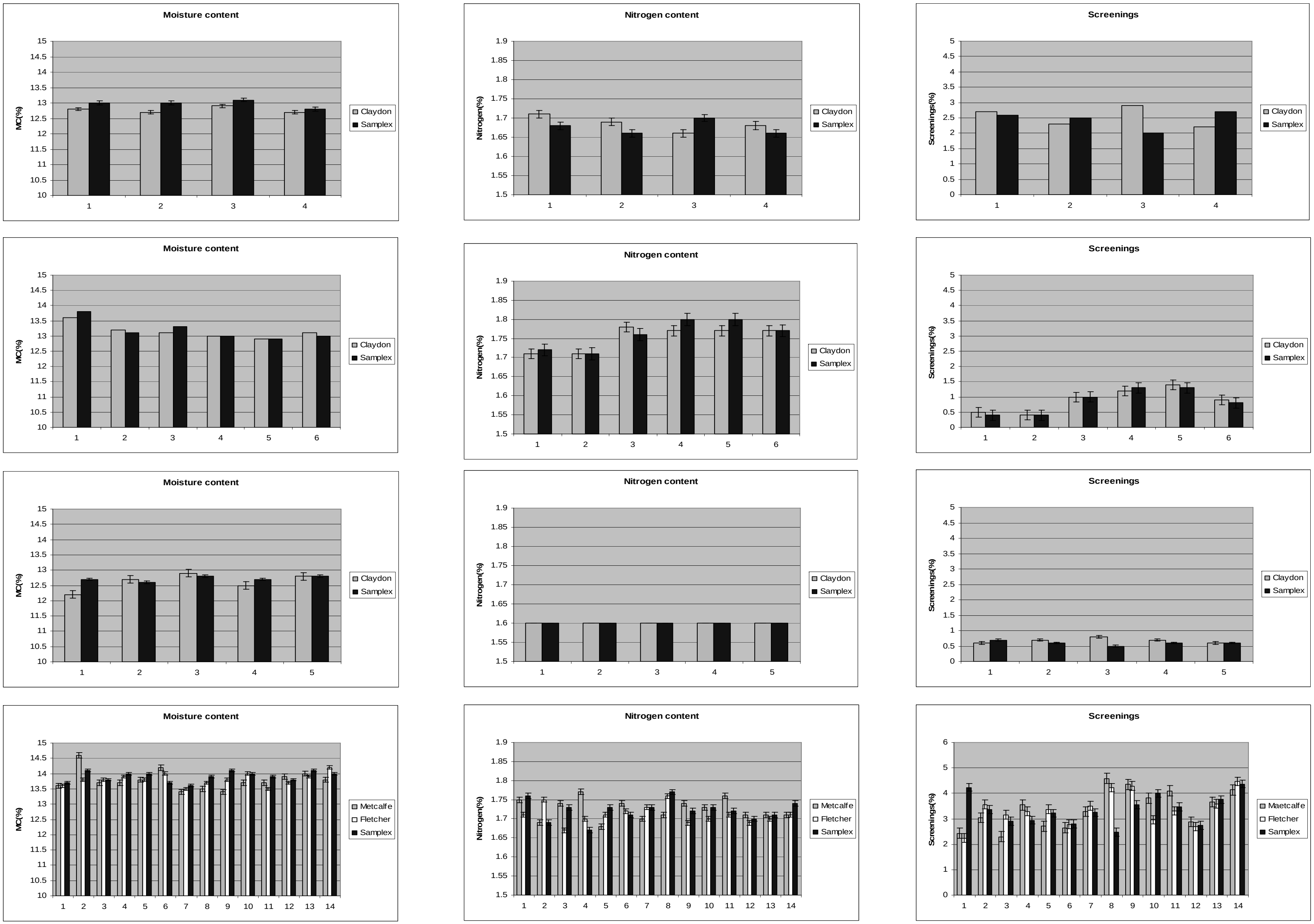

Figure 5 Variation in samples of Barley for Moisture content, Nitrogen and Specific weight

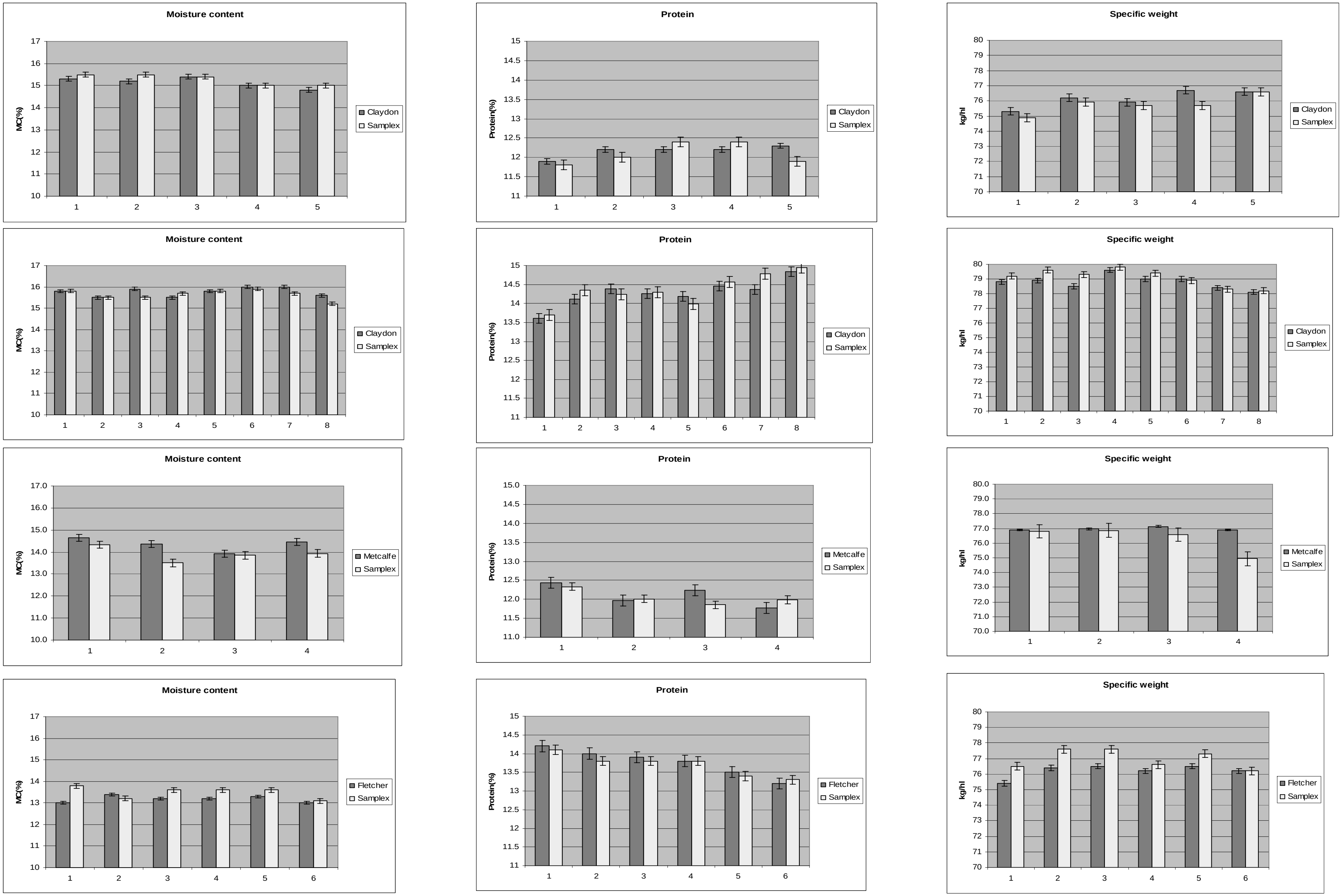

Figure 6 Variation in samples of Wheat for Moisture content, Protein and Specific weight

5. Discussion

Earlier reports have indicated that quality parameters of grain are inherently variable which implies that good sampling design and practice is vital to ensure that as representative a sample as possible is obtained so that reliable estimates of quality can be made. If a material is naturally variable then the only way to get a statistically reliable estimate of its qualities is to use a substantial number of samples which in itself raises problems of where to sample, with what and how frequently. This work has examined the use of three grain-bucket mounted automatic samplers that are intended to simplify the sampling process during out-loading of grain and provide a reliable sample of grain to determine the quality of the load of in question. The results demonstrate that the all three samplers are effective at producing a reliable sample but that there are slight differences in ease of fitting and use. The quality of the sample collected was, in all cases, comparable to those collected by end users sampling the loaded lorry.

The quantity of grain that each sampler can contain may be an important factor in deciding the purchase; the smaller samplers will become full before a large lorry is filled if fitted to a small bucket. However, this should not present a problem if fitted to a two tonne bucket. The quantity of grain retained may also be an issue with the smaller capacity samplers if fitted to a large bucket since there may be insufficient grain to split into two sub-samples.

The key question is now not whether the sampling technology works but how best to use it to improve the speed and performance of sampling within the industry. This is an issue that needs to be agreed amongst the various stakeholders within the industry.

6. Acknowledgements

The authors of this report wish to acknowledge the valuable assistance given by the farmers and companies who allowed us to work on the farms or in their stores and were happy to have holes cut in their grain buckets! In particular, thanks go to Mark Charlton (ATS), Mike Porter (Porter Grain), Dennis Allsopp (Coors Malt), Chilton Grain, Kate McDonald (Bairds Malt), Jo Cauvain and Tim Wakely (Muntons). Special thanks to Bob Dixon for tolerating the disruption.

7. References

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The R Foundation for Statistical Computing (2002), ISBN 3-900051-07-0

Appendix 1

Raw data from sampling activities.

Malting barley (var. Cocktail) sampled on farm with Claydon Black Box sampler compared with samples from Samplex CS90 used at intake at maltings

Results using test equipment at maltings						
		Moisture content (%)	Nitrogen	Screenings (%)	Germination (%)	
Load 1	Farm	12.8	1.71	2.7	98	
	Maltings	13.0	1.68	2.6	98	
Load 2	Farm	12.7	1.69	2.3	98	
	Maltings	13.0	1.66	2.5	98	
Load 3	Farm	12.9	1.66	2.9	98	
	Maltings	13.1	1.70	2.0	98	
Load 4	Farm	12.7	1.68	2.2	98	
	Maltings	12.8	1.66	2.7	98	
Results using independent test equipment						
		Moisture content (%)	Nitrogen	Screenings (%)		Sp. Wt.
Load 1	Farm	13.42	1.72	1		69.63
Cocktail	Maltings	13.48	1.72	0.8		71.27
Load 2	Farm	13.5	1.7	1		69.4
	Maltings	13.5	1.69	0.8		71
Load 3	Farm	13.84	1.66	0.9		69.6
	Maltings	13.66	1.65	0.6		71.1
Load 4	Farm	13.55	1.62	0.9		69.57
	Maltings	13.49	1.66	0.7		71

Malting barley (var Pearl) from Farm sampled with Claydon Black Box sampler sampled at intake at maltings with Samplex CS90

		Moisture content (%)	Nitrogen (%)	Screenings (%)
Load 1	Farm sample	13.6	1.71	0.5
	Maltings	13.8	1.72	0.4
Load 2	Farm sample	13.2	1.71	0.4
	Maltings	13.1	1.71	0.4
Load 3	Farm sample	13.1	1.78	1.0
	Maltings	13.3	1.76	1.0
Load 4	Farm sample	13.0	1.77	1.2
	Maltings	13.0	1.8	1.3
Load 5	Farm sample	12.9	1.77	1.4
	Maltings	12.9	1.8	1.3
Load 6	Farm sample	13.1	1.77	0.9
	Maltings	13.0	1.77	0.8

Milling wheat from Farm sampled with Claydon Black Box sampler, sampled at port with Samplex CS90

	Sample & analysis	Moisture Content (%)	Protein (%)	Screenings (%)	Hardness	Specific Weight	Hagberg falling number
Load 1	Farm	15.2	12.3	1.6	31.6	76.6	
	Boat-Foss	Insufficient sample					
	Farm-Cargo S	15.3	11.9			75.3	342
	Lorry-Cargo S	15.5	11.8			74.9	308
Load 2	Farm	15.2	12.2	1.5	31.6	76.6	
	Boat-Foss	15.0	12.4	1.8	36.8	77.4	
	Farm-Cargo S	15.2	12.2			76.2	298
	Lorry-Cargo S	15.5	12			75.9	329
Load 3	Farm	15.2	12.4	1.7	33.3	76.8	
	Boat-Foss	15.1	12.4	1.6	32.8	77.2	
	Farm-Cargo S	15.4	12.2			75.9	274
	Lorry-Cargo S	15.4	12.4			75.7	293
Load 4	Farm	14.9	12.5	1.8	32	77.3	
	Boat-Foss	14.8	12.7	2.2	36.7	77.8	
	Farm-Cargo S	15.0	12.2			76.7	314
	Lorry-Cargo S	15.0	12.4			75.7	290
Load 5	Farm	14.7	12.8	2.0	30.7	77.6	
	Boat-Foss	14.4	12.7	2.4	35.8	78	
	Farm-Cargo S	14.8	12.3			76.6	332
	Lorry-Cargo S	15.0	11.9			76.6	308

Sample & analysis
Samples were divided and port analysis compared with independent results

Farm – sample taken on farm using bucket sampler and independent analysis
Boat-Foss – sample taken at port and independent analysis
Farm-Cargo S – sample taken using bucket sampler and test results from port
Lorry-Cargo S – sample taken at port and test results from port

Milling wheat from Farm sampled with Claydon Black Box sampler, sampled at port with Samplex CS90

		Moisture Content (%)	Protein (%)	Specific Weight (%)	Hagberg falling number
Load 1	Farm	15.8	13.6	78.8	278
	Port sample	15.8	13.7	79.2	337
Load 2	Farm	15.5	14.11	78.9	336
	Port sample	15.5	14.35	79.6	264
Load 3	Farm	15.9	14.38	78.5	269
	Port sample	15.5	14.24	79.3	296
Load 4	Farm	15.5	14.26	79.6	219
	Port sample	15.7	14.29	79.8	263
Load 5	Farm	15.8	14.19	79.0	269
	Port sample	15.8	13.99	79.4	237
Load 6	Farm	16.0	14.46	79.0	347
	Port sample	15.9	14.57	78.9	314
Load 7	Farm	16.0	14.37	78.4	335
	Port sample	15.7	14.79	78.3	303
Load 8	Farm	15.6	14.84	78.1	314
	Port sample	15.2	14.95	78.2	293

Milling wheat from Farm sampled with Metcalfe sampler, sampled from lorry with manual spear (8 samples taken from each lorry)

Load	Sample	Moisture content (%)	Protein (%)	Screenings (%)	Hardness	Specific weight
Load 1	Sampler	14.6	12.4	1.9	31.1	76.9
	Lorry	14.3	12.3	2.6	32.0	76.8
Load 2	Sampler	14.4	12.0	2.0	33.5	77.0
	Lorry	13.5	12.0	2.3	39.8	76.9
Load 3	Sampler	13.9	12.2	2.1	31.8	77.1
	Lorry	13.9	11.9	1.9	35.7	76.6
Load 4	Sampler	14.5	11.8	1.7	32.9	76.9
	Lorry	13.9	12.0	2.0	40.1	74.9

Malting barley from store sampled with Claydon black box sampler, sampled at store with Samplex CS90

Load	Sample	Moisture Content (%)	Nitrogen (%)		Specific weight	Screenings (%)
Load 1	Sampler	12.2	1.6		70.7	0.6
	Lorry	12.7	1.6		70.5	0.7
Load 2	Sampler	12.7	1.6		70.3	0.7
	Lorry	12.6	1.6		69.9	0.6
Load 3	Sampler	12.9	1.6		70.1	0.8
	Lorry	12.8	1.6		70.0	0.5
Load 4	Sampler	12.5	1.6		70.2	0.7
	Lorry	12.7	1.6		70.2	0.6
Load 5	Sampler	12.8	1.6		69.7	0.6
	Lorry	12.8	1.6		69.4	0.6

Milling wheat from Farm sampled with Metcalfe sampler, sampled from lorry with manual spear (eight samples taken from each lorry)

Load	Sample	Moisture content (%)	Nitrogen (%)	Screenings (%)	Hardness	Specific weight
Load 1	Sampler	14.0	12.7	1.8	30.6	77.5
	Lorry	14.6	12.2	2.0	27.5	77.7
Load 2	Sampler	13.4	11.6	2.7	29.3	76.6
	Lorry	14.4	11.6	2.0	30.9	77.3
Load 3	Sampler	13.4	11.4	2.4	30.1	76.3
	Lorry	14.4	11.4	1.9	28.7	76.5
Load 4	Sampler	13.4	11.2	2.0	30.3	76.6
	Lorry	13.7	11.5	1.8	27.8	77.1

This farmer loaded some grain from a trailer with an auger to speed filling. Trailer grain was from "hard to get at places" in store i.e. the edges and had a higher moisture content than that loaded with the bucket directly. Resulting spear samples showed a higher moisture content than the bucket sampler in this case.

Milling wheat from Farm sampled with Fletcher sampler, sampled at mill with Samplex CS90

Load	Sample	Moisture content (%)	Protein (%)	Screenings (%)	Hardness	Specific weight	Hagberg falling number	Impurities	Gluten
1	Farm	13.0	14.2	4.7	68.2	75.4	345	0	P3
	Mill	13.8	14.1	6.1	70.5	76.5	391	0	P3
2	Farm	13.4	14	6.6	69.1	76.4	359	0	P3
	Mill	13.2	13.8	6.4	60.4	77.6	343	0	P3
3	Farm	13.2	13.9	5.4	67.0	76.5	357	0	P3
	Mill	13.6	13.8	5.7	69.9	77.6	362	0	P3
4	Farm	13.2	13.8	4.8	66.3	76.2	374	0	P3
	Mill	13.6	13.8	6.1	66.8	76.6	325	0	P3
5	Farm	13.3	13.5	4.8	66.2	76.5	333	0	P3
	Mill	13.6	13.4	6.7	66.3	77.3	384	0	P3
6	Farm	13.0	13.2	5.4	64.4	76.2	367	0	P3
	Mill	13.1	13.3	7.0	56.9	76.2	328	0	P3

Malting barley from Farm store sampled with Metcalfe and Fletcher samplers mounted on same bucket, sampled from lorry with automatic sampler Samplex CS90 and manual spear on four loads (eight samples taken from each lorry)

	Sample	Moisture content (%)	Nitrogen (%)	Screenings (%)	
				2.5mm	2.25mm
Load 1	S1				
	M1	13.6	1.75	92.01	2.43
	F1	13.6	1.71	91.13	2.24
	W1	13.7	1.76	93.03	4.23
Load 2	S2				
	M2	14.6	1.69	90.30	3.04
	F2	13.8	1.75	88.86	3.56
	W2	14.1	1.69	85.71	3.36
Load 3	S3				
	M3	13.7	1.74	92.48	2.29
	F3	13.8	1.67	88.99	3.16
	W3	13.8	1.73	89.50	2.91
Load 4	S4				
	M4	13.7	1.77	87.69	3.54
	F4	13.9	1.70	87.72	3.29
	W4	14.0	1.67	89.90	2.94
Load 5	S5	14.1	1.71	88.51	3.77
	M5	13.8	1.68	89.93	2.71
	F5	13.8	1.71	89.06	3.37
	W5	14.0	1.73	88.08	3.22
Load 6	S6				
	M6	14.2	1.74	91.80	2.64
	F6	14.0	1.72	90.24	2.78
	W6	13.7	1.71	91.62	2.80
Load 7	S7				
	M7	13.4	1.70	86.63	3.28
	F7	13.5	1.73	87.90	3.51
	W7	13.6	1.73	87.30	3.25
Load 8	S8				
	M8	13.5	1.71	84.70	4.58
	F8	13.7	1.76	85.54	4.22
	W8	13.9	1.77	90.29	2.48
Load 9	S9	13.9	1.71	87.06	4.12
	M9	13.4	1.74	84.05	4.35
	F9	13.8	1.69	84.71	4.29
	W9	14.1	1.72	88.43	3.55
Load 10	S10	13.8	1.71	88.51	3.90
	M10	13.7	1.73	86.15	3.81

	F10	14.0	1.70	88.65	2.96
	W10	14.0	1.73	90.27	4.00
Load 11	S11	14.2	1.72	87.19	3.98
	M11	13.7	1.76	86.98	4.10
	F11	13.5	1.71	88.28	3.31
	W11	13.9	1.72	89.74	3.47
Load 12	S12				
	M12	13.9	1.71	93.22	2.88
	F12	13.7	1.69	91.73	2.69
	W12	13.8	1.70	89.88	2.74
Load 13	S13				
	M13	14.0	1.71	86.89	3.66
	F13	13.9	1.70	89.16	3.59
	W13	14.1	1.71	93.52	3.76
Load 14	S14				
	M14	13.8	1.71	85.12	4.14
	F14	14.2	1.71	85.81	4.46
	W14	14.0	1.74	88.58	4.37

Milling wheat from Farm sampled with Claydon Black Box sampler, sampled at port with Samplex CS90

Load		Moisture content (%)	Protein (%)	Screenings (%)	Hardness	Specific weight	Hagberg falling number
1	Farm	14.8	13.21			78.2	245
	Dock	14.6	13.32			78.4	245
2	Farm	14.9	13.8			77.8	252
	Dock	14.8	13.05			77.7	264
3	Farm	14.8	12.83			77.1	268
	Dock	14.7	12.95			77.6	253
4	Farm	14.9	13.04			76.5	217
	Dock	14.7	12.72			76.3	228