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A national grain sampling and analysis system for improved food marketing and safety

by

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Abstract

The objective of this project was to develop an innovative, independent national structure for cereals sampling and analysis that would significantly improve the marketing of UK grain and bring about cost reductions.

There were two basic lines of approach. 1. Development of robust and practical sampling protocols that delivered representative samples. 2. Devising a standard for all UK grain analysts.

Sampling was investigated on-farm at harvest time, in store, loading out of store and at delivery to processors or merchants/cooperatives. Protocols were developed for harvest sampling (both into store and ex-dryer) and for lorry sampling. The former was used in sampler workshops to explain to growers why and how to take representative samples. The latter was adopted by the relevant trade organisations.

The sampling protocols were based on extensive investigations and designed to be both robust and practical. For the first time these studies gave real data on the variability of bulk grain and hence the approaches used were scientifically based. Part of the education process has been to describe and explain the inherent variability of bulk grain and why it is vital to take multiple samples to ensure that a true representation of the mean values of grain in the bulk is provided. All the sampling work has been reported in HGCA reports and two sampling guides were made available to all levy payers. In addition on-farm sampling was described in detail by a training CD ROM that shows the protocols in action and provides information on marketing and end user requirements.

Standardising grain testing was challenging due to the large number of testing facilities and the existence of a number of proficiency schemes/codes of practice. The solution was to set a standard that all schemes could adopt and ensure that this was set at a sufficiently high level to improve testing. This allowed the current schemes to continue without imposing an additional level of control and expense. The standard developed gives targets to be achieved by individual analysts (repeatability) and laboratories when participating in recognised proficiency testing (PT) schemes. The major trade associations, AIC, nabim and MAGB have adopted the approach and will be responsible for maintaining it in future. The target values set are based on a large body of data taken from existing PT schemes and are robust and achievable.

In order to support this initiative, training by multi-media CD ROM has been provided. The training material covered reference and rapid testing methodology and emphasised the commercial relevance and critical control points of each test as well as describing sample preparation and quality assurance. The CD ROMs were distributed by the trade associations to their members and are in wide use with the AIC's TASCC code of practice specifying that all laboratory staff must use them.

The project was very widely covered by the farming press and findings have been passed on to traders and processors through their trade associations. The wealth of information as well as the practical approaches to sampling and testing has provided a platform for change and improvement in the trading of UK grain. This was confirmed by the very strong feedback from sampling workshops when 93.8% of attendees said that they would adopt the on-farm sampling protocols. In addition a number of trading companies have promoted the adoption of these protocols.

1. A national grain sampling and analysis system for improved food marketing and safety

1.1. Background

1.1.1. Introduction

1.1.1.1. Cereals and oilseeds in the food and drink chain

The cereals and oilseeds industry is an important part of the UK rural and business economy. Production of grain – primarily wheat, barley, oats and oilseed rape – is in the order of 25 million tonnes per annum. The grain based food chain involves 70,000 growers, 650 traders, 350 processors and an extensive retail/consumer base.

The key processors are millers, maltsters, animal feed compounders and starch manufacturers. The livestock and meat sectors are closely linked with the grain industry. The arable sector also plays a key role in land management to optimise environmental, recreational and community aspects of the UK countryside.

1.1.1.2. The role of HGCA

The Home-Grown Cereals Authority (HGCA) is the non-departmental public body whose role is to improve the production, wholesomeness and marketing of UK cereals and oilseeds. With representation from throughout the food chain and from all UK regions, HGCA activities include:

- Provision of market information services
- Development, funding and management of research work
- Supporting the expansion of UK cereal exports
- Stimulating enhanced consumption of UK cereal-based products at home and abroad

1.2. Overview of grain sampling and analysis

Grain harvesting takes place in the UK during July to September. Most of the crop is stored on farm or in co-operatives stores for use throughout the year.

The most common approach to grain sampling and analysis before the start of this project can be briefly summarised as follows:

- Small grain samples were usually taken as trailers (loaded from a combine in the field) entered the store. In many cases only a few samples were taken throughout the harvest day. These samples were tested for moisture content to define the drying requirements of the grain. Very rarely were these samples retained or tested for other parameters.
- Grain is then either dried, if necessary, using high temperature dryers (30-40% of the crop) or stored directly. Many on-floor grain stores are capable of drying the crop with ambient air over a period of time.
- If grain is stored in vertical bins then subsequent sampling is usually confined to the top 1-2m and hence the majority of contents of the bin were not sampled. Sampling bins can be considered to be a dangerous activity.
- Where possible, different grades of grain are stored separately and large flat stores may be sub-divided by partitions. In many instances large quantities of grain are stored in a single large heap on the assumption that all the grain in that heap has very similar properties.
- Shortly after harvest grain merchants visit farms and take a small number of spear samples of the stored grain. In some cases 5 or more merchants will take and analyse

samples. The farmer is not charged directly for this service but the ‘indicative’ results are usually given to the farmer.

- Grain is then sold on the basis of these ‘indicative’ results when the farmer wishes to sell.
- As a number of samples are taken and analysed the farmer will be presented with a range of test results and has to make a decision on which set of results to base his marketing. Often those who sell to the highest (best) values are disappointed when the grain is tested at the point of delivery and find it either rejected or subject to claims (discounted).
- Grain is checked for moisture and temperature whilst in store. This may be done by taking spear samples or hand-fulls from the grain surface or using moisture- and temperature-probes. The latter can be installed and hard wired to measuring (monitoring) equipment, although this is the exception, or used periodically at set positions on a grain heap.
- When the grain is sold it is usually loaded into lorries using bucket loaders (typically ~2-3 tonnes per bucket load) and then taken to the point of delivery. A few farmers will take loading samples from each bucket full. This is time consuming, potentially dangerous and the samples are not accepted by buyers as representative of the load.
- On arrival at the processor (miller, maltster, feed compounder) or export terminal the grain is sampled whilst in the lorry and tested before authorisation is given to tip the load. Merchants and co-operatives taking grain into store will also sample the lorry to determine where to store the grain.
- Lorry sampling is generally performed using manual or vacuum spear samplers. There is an international standard (ISO 13690) for sampling grain in bulk and this includes a section on lorries. It is included in most contracts but not rigorously observed.
- The sample taken from the lorry will be tested in the processor’s laboratory and the results are used to assess whether the grain delivered fulfils the contract and to ensure that the grain is stored in the correct bin.
- In general, single determinations are made on the sample taken at intake. Payments are made on the basis of the analysis of the grain at the point of delivery.

It is vital that growers, buyers, processors and the consumers have immediate and accurate information about the characteristics of the grain crops being harvested and stored. This information is needed to ensure that the grain is stored safely. For example, if the storekeeper were to unknowingly store wheat or barley with too high a moisture content, there is a higher risk of pest infestation and toxic mycotoxins may develop.

Accurate sampling information is also needed to ensure that wheat or barley is delivered for the right end-use, to the right location and at the right time. Failure to do so can have serious cost implications.

1.3. Limitations in current grain sampling and analysis practices

The consumer demands increasing knowledge of raw materials in the food chain. The current process of grain sampling and analysis for this purpose has a number of structural flaws.

These include:

- Sampling techniques and analysis protocols neither of which are fully understood nor applied consistently.
- Accessing grain samples from bulk stores carries risks from a health & safety perspective.
- Sampling grain after harvest whilst in store can give misleading results.
- Commercial interests (at farm, trader and processor level) distort distribution efficiencies.
- Multiple sampling results in wasteful industry expense amounting to an estimated £1.5 million/year.

- Rejections on delivery leads to unnecessary transportation, associated costs and has a negative impact on the environment.
- The use of IT based systems for exchange of information is greatly under-utilised.
- Consumer safety and traceability benefits are not maximised.
- The above cause serious mistrust and poor relationships in all parts of the cereal chain.

1.4. Objective of project

The objective of this project was to develop an innovative, independent national structure for cereals sampling and analysis that will significantly improve the marketing of UK grain and bring about cost reductions.

Underlying the above ultimate objective were a number of measurable intermediate and immediate objectives. These included:

- more efficient food chain collaboration;
- less duplication of sampling and analysis;
- fewer rejections and lower administration costs;
- improved operator safety in grain stores;
- more efficient transportation and reduced 'food miles';
- improved uptake of training;
- better uptake of information technology;
- better information for government and the consumer;
- promote food and drink safety.

1.5. Project description

Many of the above issues are of a sensitive nature but an industry wide group, the **Cereal Liaison Group** (facilitated by HGCA) came to the firm conclusion that it would be of significant national benefit if a new and independent structure for grain sampling and analysis was established.

The main elements of this 2-year project were:

- Developing sampling techniques that give representative samples.
- Making the sampling techniques available to all.
- Reducing the need for multiple analyses.
- Harmonising grain testing – setting a standard.
- Providing training for analysts.
- Development of an electronic grain store manager that integrates sampling, analysis and good grain-storage practice.

1.6. Benefits to users

Growers, traders and processors will be the direct users of the new sampling and analysis procedures. The project will result in fewer and better samples being taken and costs will be reduced. Rejections rates at processor intake are expected to fall (by ~1%) and there will be less re-direction of lorries. Transaction administration costs will be reduced.

The Cereal Liaison Group identified the following key user benefits.

<i>Benefits</i>	<i>Beneficiaries</i>	<i>Quantifiable amounts</i>
Less duplication of sampling and analysis	Growers, traders and processors	£1.5 million / year
Less rejection costs and less haulage	Industry and environment	£520k / year
Administration costs reduced	Food chain as a whole	£530k / year

1.7. Project deliverables

The project aimed to deliver the following through a range of mechanisms:

Sampling investigations

- Protocols for on-farm and lorry sampling that are based on in depth practical investigations.
- Documented study of the variation in grain as a basis for establishing protocols.
- Publications (reports and guidelines) delivering the sampling protocols and background information.
- A review of grain sampling with respect to food safety and consumer concerns.

Analytical investigations

- Survey of current analytical practice by UK grain testing laboratories.
- Assemble data of test repeatability and reproducibility to allow testing standards to be set.
- Development of a UK grain testing standard.
- Development of training material to support the testing standard.

Grain storage management

- The integration of sampling and analysis learning along with best practice storage through a CD ROM based software tool.

Delivery mechanisms:

- HGCA reports (sampling projects)
- HGCA guidelines (sampling projects)
- Booklets, including sampling protocols
- CD ROMs
 - Grain sampling
 - Analysts' training (Wheat and Barley testing)
 - GrainPlan (storage management software)
- Press coverage (all aspects of the project)
- Events
 - Grain sampling workshops (2003)
 - Variety Roadshows (2003)
 - Cereals 2003
 - Grain 2003
 - Grain management roadshows (2004)
 - Cereals 2004
- Meetings
 - Cereal Liaison Group meetings
 - Meetings with trade bodies (nabim, MAGB AIC & NFU)
- Website
 - Newsletters
 - Grain testing standard (with links to Trade assoc websites)

2. Project Structure

The project was structured with a number of elements to fulfil the objectives given in section

1. This structure has been used in this final report.

2.1. *The project elements*

- Sampling investigations
- Sampler training
- Grain laboratory standardisation
- Grain analyst training
- Food safety concerns
- GrainPlan
- Information delivery (including IT)

2.2. *Additional sections*

- Project evaluation
- Recommendations
- Acknowledgements
- Appendix 1 (Sampling protocols)
- Appendix 2 (Sampler training evaluation)
- Appendix 3 (Hardness Testing calibration services)

3. Sampling investigations

The aim of this project element was to examine grain sampling at all points in the cereal chain from combine to primary processor (or exporter). The sampling projects were:

1. On-farm, that is ex-trailer and ex-dryer
2. In store, at out-loading (samples from loader buckets)
3. From lorries at delivery points

These investigations were designed not just to examine the principles of sampling but also to define best practice and make recommendations to the cereal industry as how to sample at any particular point and hence improve the chance of taking a representative sample. It became very clear that grain is variable and hence sampling should be designed to reduce the effect of the inherent variability.

The sampling projects are outlined below.

3.1. On-farm sampling

Traditionally sampling on the farm has two facets, 1. as the grain arrives from the combine in the field at the store in trailer; 2. spear sampling of the stored grain, this is usually performed by a grain merchant.

Before the start of this project the samples taken ex-trailer were generally used for moisture measurement alone. The moisture was measured by a meter to determine the drying requirements of the grain. No further use was made of these samples.

The spear samples taken in store were tested by the merchant in his laboratory. Often the sampler is a student with little or no experience of grain and its characteristics. Only a limited number of samples were taken and it is unlikely that they give a good representation of the stored grain. In most cases the depth of the grain exceeds the length of the spear and hence only the top portion of the grain is sampled and subsequently tested.

Experience has shown that when a number of merchants sample the same heaps of grain the test results show large differences. One example came from a Lincolnshire farmer who had 14 individual storage areas containing one milling wheat variety sampled and tested by 4 merchants. For protein content the average difference across the 14 areas was 0.6% with a maximum value of 1.3% difference within one area. The maximum and minimum results for each area are randomly distributed so differences cannot be ascribed to just analytical differences. For Falling Number the same set of results show an average difference of 61 seconds with a maximum of 144 seconds within one storage area. These differences have commercial implications most especially if the results are close to a specification threshold.

In view of the large differences that are experienced when a limited number of spear samples are taken and the need to have more precise information on which to market grain a sampling technique that provides a more representative result was required. To achieve this sampling at harvest was investigated over two harvests 2002 and 2003.

HGCA project 2761 “Development and validation of on-farm sampling protocols for collection of marketing (quality) samples at harvest” was commissioned.

Its objectives were:

i) Overall Aim

To develop and deliver a reliable sample protocol acceptable to the whole industry for use on farm at or around harvest to provide representative marketing (quality) samples.

ii) Specific Objectives:

To prepare and validate practical sampling protocols for farmers to use for collecting representative marketing (quality) samples at harvest in the following situations providing it is safe to do so:

1. Off the combine harvester
2. Off the dryer into a farm store
3. During intake to a farm store
4. During intake to a cooperative or merchant's store

In reality the project started once the 2002 harvest was already underway and was obliged to concentrate on wheat and specific objectives 1-3. The project abstract is given below.

3.1.1. Abstract

The aim of this project was to develop a limited set of protocols for sampling grain to measure quality characteristics. The protocols were tested to establish the variance attached to each quality measurement to enable users to understand the probability of a sample proving to represent a grain lot for parameters measured.

Protocols laying out sampling instructions for grain coming into store directly and after cleaning or high temperature drying were developed in conjunction with input from an expert panel drawn from the grain industry both in the UK and overseas.

Testing of protocols took place during the 2002 harvest at 16 farms from Kent to Aberdeenshire to try to incorporate geographic variability and differing conditions. Samples were taken to assess the variation between and within trailers (using spear sampling, pelican samplers and scoop sampling) and the impacts of cleaning and drying on sample quality. The performance of composite samples versus a series of single samples was also examined.

Results indicated significant variation between trailers but statistically insignificant variation within trailers. There were no major differences between the sampling methods although spear sampling tended to result in increased specific weight. Composite samples were adequate for quality analysis with little difference between the single and composite sample results.

Drying and cleaning resulted in reduced moisture content and fine material. However, the associated handling tended to increase specific weight and some other characteristics underwent significant change. Samples for quality assessment should therefore be taken after, rather than before, drying.

Grain is inherently variable as it comes off the field and requires careful sampling. However, single samples from each trailer provide a practical method that gives an acceptable indication of grain quality.

The full HGCA project Report (No 301) can be found at:

<http://www.hgca.com/content.search/4/4/Site%20Search/Site%20Search/Redirect.msp?fn=redirect&pubId=354>

3.1.2. Discussion

This project gave the scientific background for the development of sampling protocols that will allow farmers to take grain samples at harvest that are a much better representation of the stored grain than the traditional techniques of spear sampling grain in-store. The protocols are given in appendix 1 and were published in 'Grain sampling – a farmer's guide'. This publication is available from the HGCA and at:

<http://www.hgca.com/content.search/4/4/Site%20Search/Site%20Search/Redirect.msp?fn=redirect&pubId=1261>

In addition to developing protocols this in depth study gave information on the variability of grain as it comes off the field. This information has not been available hitherto and was essential in formulating the protocols. It was necessary to provide an approach that was statistically robust and also practical.

The following paragraphs are extracted from Project Report No. 301 and show clearly the reasoning behind the taking just a single sample per trailer as practical approach to on-farm sampling.

Discussion section from report 301.

The main purpose of the experimental work was to investigate the reliability of the sampling methods and the sampling protocol. A number of conclusions can be drawn from these results.

Inherent variation in grain

All the results gathered indicate that there is inherent variation in the grain that comes from a field and is significant at the farm and field level and also between trailers. The variation in the quality of grain within a single trailer was not detected to be statistically different using the methods tested here. However, there was variability and whilst not statistically significant it could be large enough to make the difference between the grain being rejected or accepted. The problem facing the grower, merchant or end-user is to get a reasonable indication of the quality of a batch of grain without expending excess time, and therefore money, in detecting these differences. The experiments here show that a single sample per trailer gives a reasonably reliable estimate of the quality of the grain within a trailer; to take more than a single sample would be impractical and may or may not improve the accuracy of the result. The key point to come out of this work is that grain is not homogeneous and therefore should not be sampled as if it is since this would more than likely result in inaccurate values being measured.

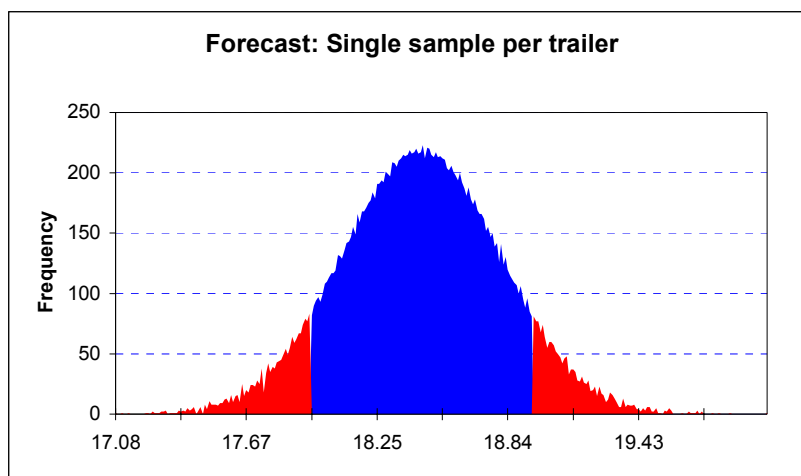
All persons involved in the grain trade should be made aware of the fact that there is a relatively large variation in grain quality and therefore sampling can only ever be indicative of the quality of the grain and never a definitive value. Specifications used for the trading of grain need to acknowledge that this variation exists and criteria should be set to include this variation.

Effect of changing sampling intensity

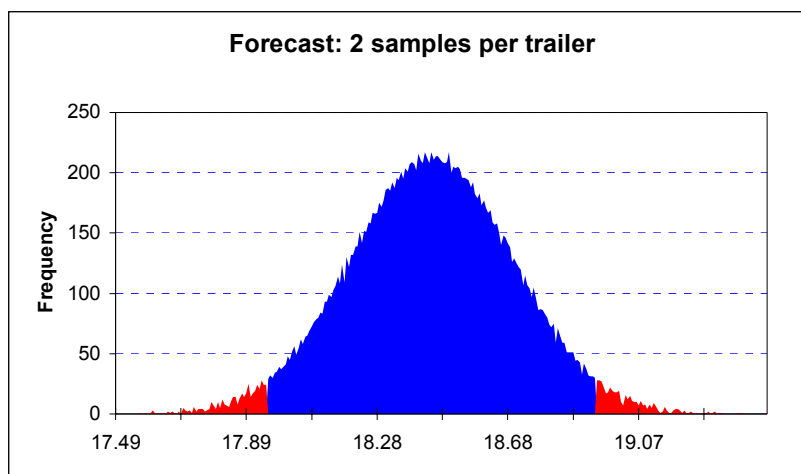
To demonstrate the effect of sampling intensity the variability of a batch of grain (wheat) was used to show the margin of error associated with taking a single sample as opposed to taking two samples from a trailer of grain. The diagrams below show the sort of level of variation that was obtained and the effects of taking one or two samples to get a measure of the moisture content for each load. The principles are the same for the other factors measured (protein, specific weight, hardness, fines).

The first diagram shows the range of values that are likely to be obtained from a series of samples of grain coming from a single field. Ten samples were taken from 4 trailers giving a total of 40 samples. The mean and standard deviation were calculated and used to produce a probability distribution curve of the range of moisture contents that may be found.

The blue area is the region that contains samples that are within the value of the mean plus or minus 0.5%, i.e. $18.45\% \pm 0.5\%$. This region contains 83.7% of the possible results, that is to say there is a probability of 83.7% that the result will lie within this area or a 14.3% chance (1 in 7 chance) that it is outside. If the tolerance is extended to $18.45\% \pm 0.7\%$ then 95% of the values will fall within this range, i.e. a 5% chance (1 in 20 chance) that a value for moisture content is 0.7% more or less than the mean, i.e. it lies outside the range 19.15% - 17.75%.



The second diagram shows the impact of taking two samples. The probability of getting a value that is greater than 0.5% (1 in 20) of the mean is only 3.4% and if 0.7% is used then the probability of getting a value outside this range is reduced to 0.05% or one chance in 200.



Given the error associated with measuring moisture content (and the other parameters) it was felt taking a single sample was a simple and reasonably reliable method of estimating the qualities of the grain. It is obviously possible to get greater accuracy with more samples but it was felt that the extra time, effort and storage space for samples would make this unacceptable to the majority of growers.

Sampling methods

The different sampling methods tested did not appear to show any statistically significant differences for the important quality parameters although spear sampling did serve to increase the specific weight of a sample by the polishing effect that the extra handling had on the grain. The level of fines detected by different sampling methods varied but the fines in the samples were a continual problem and require further work to clarify the situation. No definitive statement can be made about their measurement at this stage. The use of a pelican sampler, a scoop or spear sampling appears to be equally effective and do not give significantly different results for nitrogen, protein, hardness or moisture content values. Thus it would appear possible to sample grain safely and reliably on intake from the combine whatever method is being used to tip the grain.

Single versus composite samples

The use of composite samples can save time since the measurement of the sample need not be done immediately for each trailer of grain but the samples can be taken from each trailer, placed in a container, mixed thoroughly and then sampled and the measurements recorded. This reduces the number of sample bags that have to be handled and stored and the number of samples for analysis. The results indicate that for most of the measurements the results from composite samples are essentially the same as the average of individual samples. There may be some variation in the value that is obtained for fines between the single samples and the bulk. This can probably be explained by the extra handling of the grain giving greater opportunity for the fines to work their way to the bottom of the sample during handling and mixing if not done very thoroughly. The difference in the specific weight detected is probably the result of the extra handling that has taken place resulting in a polishing of the grain and therefore a higher specific weight. The one record of a difference in hardness is not easily explicable and may have been a rogue result.

Cleaning and drying

The impacts of cleaning and high temperature drying are largely as expected, with drying causing highly significant changes in specific weight, moisture content and hardness; and cleaning causing significant increases in specific weight and reductions in the level of fines. The change in protein content remains unexplained but none of these findings should be of concern since the recommendation that comes from them is that samples for quality determination should be collected after high temperature drying or cleaning, although obviously samples for the determination of moisture content need to be collected as the grain comes in from the field to determine the necessity for drying.

3.1.3. Conclusion

Although the 2002 study of sampling at harvest time had been very successful and generated robust and practical sampling protocols it had concentrated heavily on wheat. It was started when the barley harvest was well underway and as a consequence few barley samples were collected. In addition, it was felt that there was insufficient information on Falling number and the effects of drying on grain properties. It had also proved difficult to obtain clear information on screenings (sieving). As screenings are of particular interest to Maltsters there was a clear need to examine sampling of barley with reference to sieving in greater detail.

Hence it was deemed necessary to perform a follow-up project during 2003.

HGCA project 2978 "Sampling ex-combine: Part 2" was commissioned.

Its objectives were:

i) Overall Aim

To test the sampling methods developed during the previous harvest as part of HGCA project 2761 more widely to see if the protocol developed requires revision for sampling barley. In addition, to assess in more detail the impacts of high temperature and on-floor drying on quality.

ii) Specific Objectives:

1. To use the sampling methods laid out in the current Protocol to sample barley ex-combine.
2. To use the data collected to check if any revisions in the Protocol are needed to accommodate sampling barley.
3. To collect samples of grain before and after high temperature drying and to test and compare the properties of both sets of samples.
4. To assess changes in grain properties that occur during slow drying.

This project was reported as an annex to Report 301.

3.1.4. Abstract (supplementary study)

Protocols giving sampling instructions for grain coming into store directly and after cleaning or high temperature drying were developed for testing during harvest 2002. Due to lack of time it was not possible to sample sufficient quantities of barley to get a statistically valid result. This work was aimed examining the variability of barley in particular to see if the results varied from those obtained when sampling wheat.

Samples were taken to assess the variation between and within trailers, between different sampling techniques such as pelican and scoop sampling, and the impacts of high temperature and on-floor drying on sample quality.

Results indicated that there was significant variation between trailers but the variation within trailers was statistically insignificant. The method of sampling did not give any major differences in the results.

Drying resulted in changes as would be expected with reductions in moisture content. However, the handling associated with these operations tended to increase the specific weight of the grain. It is recommended that samples for quality assessment are taken after rather than prior to drying.

The work confirmed the findings of the work done in 2002 that demonstrated that grain is inherently variable as it comes off the field and therefore requires careful sampling. However, this work indicates that single samples from each trailer provide a practical method for obtaining samples that give an acceptable indication of the quality characteristics of the grain whether it is wheat or barley.

3.1.5. Discussion (supplementary study)

The results produced during this project confirm the data collected during the earlier sampling work reported in HGCA Research Report 301. The more extensive data set for barley confirms that the recommendations for on-farm sampling at harvest provided in the HGCA Grain Sampling Guide (Spring 2003) can be applied to both wheat and barley. The lack of change in most quality characteristics during drying and storage over several months reinforces the concept of using samples collected at intake to make an effective assessment of grain quality. The greatest change that occurred during drying, a reduction in moisture content, was something that was under the control of the farmer and was a necessary part of the storage process. The small upward change in specific weight is a positive factor in quality and tends to confirm the suggestions from earlier work that specific weight is not a constant and can be influenced by physical factors such as drying or moving grain.

Falling Number was not affected by high temperature drying but was found to vary greatly within one days' intake of a single variety of wheat from one field. The limited mixing that occurred during the drying and conveying process did little to reduce this variation. It is not common to be provided with the results of replicate analysis when dealing with grain quality assessments and the results for Falling number giving data for 2 replicate analyses are the exception. These showed that there was about 5% variability in the method of measurement but that this was very small when compared to the variability between samples taken from a relatively small batch of grain. Indeed, the data for Falling Number clearly illustrate that whilst there must always be some error associated with any method of measuring quality, large errors can occur because of poor sampling.

Once again, data collected during this work shows the substantial variation in important quality factors within relatively small batches of grain (30 –100 tonnes). This variation is often of commercial significance with the potential to move a batch of grain from acceptable quality to incurring a penalty or even to result in rejection. The only way to mitigate these potential errors is to take sufficient samples. The recommendation made in the HGCA Sampling Guide to collect 1 sample from each trailer-load at harvest, still holds as the best advice for on-farm sampling.

Samples collected during storage gave a good indication of the mean quality of the grain but they did not show the full range of variability. The apparent effectiveness of in-store sampling needs to be treated with some caution because the number of samples taken during this work was much greater than would be practical. For example, commercial practice involves taking 1 sample/50 – 100 tonnes, whereas 6 samples were collected during this work. Even the large number of individual samples collected each time grain was sampled in-store during this work, still represented a lower rate of sampling than the number collected by sampling each trailer-load at intake (for 100 tonnes in 10 tonne trailers 10 samples would be taken). This, coupled with the samples only representing the upper half of the bulk, explains why in-store sampling was less effective at predicting the variability of a batch of grain compared to intake sampling.

The statistical analysis of the data was hampered by the large degree of variability compared with the number of samples collected. However, it did confirm that the greatest variation within a farm was between trailer-loads rather than within a load. From a practical point of view, it is important to be aware of the commercial implications of the variation found in grain. Farmers must appreciate that the quality of their grain will fall within a range rather than achieve a specific level and, if quality is marginal in relation to the contractual requirements, some loads may be accepted whilst others are penalised. End users who sample and assess grain as it is delivered to their premises must also accept the variability that is inherent in all grain and make appropriate allowances in both their production processes and their attitude to incoming supplies.

As with all previous work on this topic, screenings proved to be the most variable of all quality parameters of both wheat and barley. The error of assessment was about double that of any other characteristic even when good sampling procedures were used. It would appear certain that, in the event of a disputed result, a batch of grain was re-sampled, the level of screenings would be different from the initial value, although the result could equally well be lower or higher.

3.2. In-store sampling

Although the two previous projects collected detailed information on the variability of samples taken from farm trailers and after high-temperature drying the results they were not related to grain tested on delivery at a processor. Hence, the link between the growers' samples and test results and those of the end-user was missing. Therefore, a project was designed to follow grain from the trailer or dryer through storage and at out-loading. It covers the traditional in-store spear sampling approach and compares the results and variability with those obtained when the store was filled and looks at the stored grain over a storage period to describe any changes that occur. Finally, using a situation where wheat was supplied directly from the farm to a flour mill the results of sampling the heap of grain to be loaded (by spear), the loaded grain (scoop from 2t loading bucket) and mill samples (from the lorry) were compared. This allowed an assessment to be made of the best prediction of the delivered sample.

HGCA project 2748 "Development of practical methods for monitoring grain during farm storage and relating the results to quality determinations done by end users" was commissioned.

Its objectives were:

i) Overall Aims

To develop and deliver a reliable sample protocol for on-farm stored grain to provide representative marketing (quality) samples at out-loading.

To provide the farmer with a method of providing reliable indicators of actions needed during storage to prevent deterioration of grain quality.

ii) Specific Objectives

1. To relate the results of in store sampling from this project with sampling during filling of farm stores and the sample results obtained by end users to ensure comparability of results.

2. To integrate work done during filling of farm stores with information collected during storage to improve storage strategies and consequently grain quality.
3. To provide a protocol for sampling at out-loading that will give reliable information about grain quality.

3.2.1. Abstract

The aim of this project was to establish whether sampling of grain whilst in store provides a reliable method of determining the quality of the batch of grain sampled. The results of in-store sampling were compared with those obtained from sampling at intake and during out-loading.

Grain was sampled on a total of 9 farms starting from harvest 2002 through into 2003. The farms selected used a variety of drying methods (high and low temperature and ambient air) and storage methods (bin and on floor). All sampling in the store was done using a 1.7m grain spear. Results for sampling and grain quality at harvest were from previous work investigating sampling at intake (HGCA Report 301). The stored grain was sampled after approximately 1 month, 4 months and 6 months and in one case 10 months. The comparison of in-store sampling with sampling at out-loading was done by taking samples from the bulk to be loaded using a spear and then taking 1litre of grain from each 2 tonne bucket as it was loaded into the lorry. The results of the quality analyses were then compared for the two sets of samples. The grain sampled at out-loading was also sampled at intake to the mill and the analyses done by the project were compared with the results obtained by the mill.

Results showed that the quality parameters measured (protein, specific weight, moisture and hardness) did not vary markedly during the period of storage and sampling in store gave broadly similar values for the quality parameters compared with the samples taken at intake and at out-loading. However, because fewer samples are usually taken in store it is unlikely that the whole range of variability will be covered.

Results for mill samples were not statistically different from the results obtained on farm but were sufficiently different to have made a commercial difference. However, the differences in results were random and did not consistently favour or penalise either the mill or the supplier.

Despite the limitations of in-store sampling it would appear that it gives a reasonable sample for use in determination of quality characteristics and obviously is essential for monitoring the quality of grain during storage.

The full HGCA Project report No. 325 can be found at:

<http://www.hgca.com/content.search/4/4/Site%20Search/Site%20Search/Redirect.msp?fn=redirect&pubId=314>

3.3. Lorry sampling

The study of grain sampling would not be complete without an investigation of lorry sampling. Taking samples from lorries was raised at a number of farmer sampling training events (see section 4.1) and it is clear that it was necessary to examine the existing standard (ISO 13690) and gain first-hand knowledge of the variability and hence frequency required to give a fair representation of a grain lorry's contents.

As part of the initiative to standardise grain testing, a survey of laboratory practice was undertaken (see section 5) and this included a set of questions on the collection of samples from lorry-loads of grain. The information requested is shown below:

Sampling lorries/trailers at intake

What method is used? IOB/BS 4510:1980 or ISO 950-1979/ Other. Please state.....

Equipment used.....

Operational mode: Programmed/Manual*

** delete as appropriate*

Vehicle size, t	No of dips	Total Quantity taken	
		Volume, l	Weight, kg
<15			
15-30			
>30			

Sub-sampling for analysis

Do you blend your bulk sample? Yes/No. If yes state method.....

Do you take a sub-sample for analysis? Yes/No

How do you sub-sample? Divider/Riffle/Quartering/Scoop/Other

If other please specify.....

Comments

The questionnaire revealed there was no industry-wide common equipment or practice. The most frequently used equipment was the Samplex CS90 (45%) followed by other vacuum samplers (34%) then manual sampling (18%). The number of samples collected per load ranged between 1 and 10 and the weight of grain collected varied between 0.4 and 11kg.

3.3.1. Responses to the survey

The questionnaire revealed there was no industry-wide common equipment or practice. The most frequently used equipment was the Samplex CS90 (45%) followed by other vacuum samplers (34%)

then manual sampling (18%). The number of samples collected per load ranged between 1 and 10 and the weight of grain collected varied between 0.4 and 11kg. Most respondents indicated that the bulk sample taken was sub-sampled before testing, this was not universal and only a small percentage appeared to use a divider.

It was clear that there was a very wide range of sampling practice and that some of it was not likely to give a representative sample for analysis.

HGCA project 2955 “Sampling grain in lorries” was commissioned.

Its objectives were:

i) Overall Aim

The degree of variation in the methods and approaches currently in use at commercial stores and by end users made it unrealistic to design an experiment that covered all combinations of variables. Therefore, the work concentrated on the most commonly used approaches with the understanding that the results may indicate the need to either offer guidance on the restriction of sampling methods used or conduct more experimentation in the future.

ii) Specific Objectives:

1. To provide clear guidance on an effective method of collecting samples from lorry-loads of grain that will give fair and consistent assessment of the properties of the grain.
2. To examine and quantify some of effects of variation currently occurring when lorries are sampled on the sample produced.

3.3.2. Abstract

Practical assessments were made of two methods of the collection of samples; the Samplex SC90 and manual spear. Initially, the aim was to follow the practices laid down in the UKASTA contract using the technique detailed in the ISO and BSI Grain Sampling Standards. However, in practice this was not possible for reasons explained below.

The work was undertaken at 3 sites with the aim of collecting data that would allow some conclusions to be drawn on the basic requirements for collecting samples from lorries. Samples were collected from 5 or 8 different points from 8 or 10 loads at each site and assessed individually and also when mixed to form a composite. Assessments were made using a Foss Infratec grain analyser and a manual sieving process. In addition, some samples were tested for germinative capacity (barley) and Falling Number (wheat).

	Site 1	Site 2	Site 3
Method	Samplex CS90, auto	Samplex CS90, manual	Manual spear
Grain	Malting barley	Milling wheat	Feed wheat

At site 1 malting barley was assessed using a CS90 in automatic mode to collect 8 samples/load. It was immediately apparent that the reach of the sampler could not cover the entire load in a standard, 28-tonne trailer unit. Without moving the lorry, samples could only be collected from ~60% of the load with arcs at the front and rear of the load being beyond the reach of the sampler.

There was considerable variation in the weight of individual samples because the depth of grain varied within the lorry. The same problem of access to the whole load and variation in sample size was also found at the site 2 (CS90, manual mode).

When samples were collected with a manual spear (site 3) the size of sample was much more consistent although the 1.7m spear was unable reached down to the bottom third of the load. Access to all parts of

the load was seriously restricted because food safety and HSE regulation discourage walking on the grain. Therefore, samples could only be collected down part of one side of each load.

Results

There was considerable variation between individual samples in a load. The figures on pages 4 & 5 show typical distributions of variance for 2, 3, 5 and 8 spear samples in a load. Distributions have been run for all loads and although there are minor differences the loads selected are typical.

The probability of obtaining a result within defined limits of the average value of the load is summarised in the following tables.

Barley

Number of samples	Probability of results with $\pm x$ of mean result		
	Nitrogen $x=0.01\%$	Moisture $x=0.1\%$	Screenings $x=0.3\%$
2	52%	58%	67%
3	61%	70%	76%
5	74%	79%	87%
8	84%	89%	95%

Wheat

Number of samples	Probability of results with $\pm x$ of mean result			
	Protein $x=0.1\%$	Moisture $x=0.1\%$	Specific weight $x=0.4\text{kg/hl}$	Falling number $x=10\text{sec}$
2	59%	69%	77%	79%
3	69%	79%	85%	88%
5	82%	90%	94%	96%
8	91%	96%	98%	99%

Although there are differences between each parameter it is clear that there are very significant risks of obtaining an incorrect result if only 1, 2 or 3 samples/lorry are taken.

The variability of screenings (as a percentage of the mean value) between samples was greater than for other quality parameters.

There is no figure for germinative capacity as this did not vary between sampling points.

Discussion

The method of collecting the sample or the exact point of collection did not appear to affect the quality of sample. Therefore, they are not of critical importance.

The analysis demonstrates that there is large variability of most quality parameters within a lorry-load of grain. This cannot be represented by a single sample from a single point in a load, furthermore it was found that variation was random within lorries so no single point can be identified as satisfactory.

The acceptable range applied to the calculation of confidence limits has been selected with respect to both commercial significance and analytical variation. An examination of the potential differences between individual samples that were taken from one load shows that they are clearly of commercial significance. The maximum and minimum values are given on each graph.

The graphs and associated confidence limits show that the higher the number of samples taken the greater the probability of the composite sample, produced from the individual sample, being close to the

mean values for a load. The confidence limit applied to screenings is proportionally much larger than those applied to other parameters and this reflects the difficulty in predicting this parameter.

Recommendations

Irrespective of the method used, as many samples as possible (up to a maximum of 8) should be taken and thoroughly blended and sub-sampled for analysis.

Production of lorry sampling guidelines should be considered.

Reference to ISO and BSI standard methods of sampling should be removed from contracts as, in practice, these cannot be followed.

Considerations

1. The practicality of taking multiple samples.
2. Developing an agreed industry approach.
3. Publication of the two points noted above.
4. Revision of the ISO sampling standard.

3.4. Discussion

Sampling is not a precise exercise and although this was known, by some, before the start of the project there were no robust data on UK grain sampling that described the variability in bulks of grain. A full understanding of the inherent variability of grain was required in order to undertake the development of sampling protocols that will manage and reduce the impact of variability.

When describing taking representative samples a useful summary is as follows:

- **The ideal** – a sample accurately representing all characteristics of all parts of the bulk – *impossible to achieve in practice*.
- **The norm** – a sample called "representative" without any chance of being so.
- **The practical ideal** – a series of samples from different parts of the lot, analysed separately and data used to calculate one representative result.
- **The compromise** – a series of samples collected from different parts of the lot, then blended thoroughly, sub-sampled and analysed to produce an average result to describe the lot.

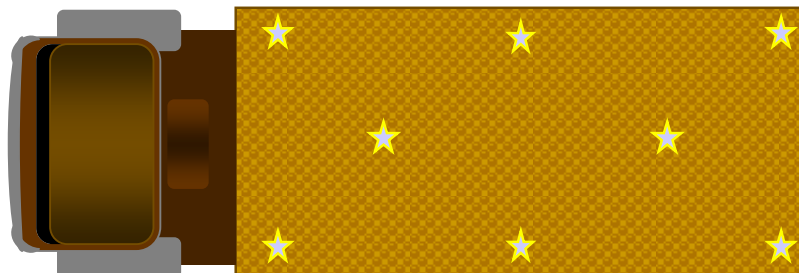
This project set out to investigate the best ways to achieve 'the compromise'. It must be appreciated that sampling is often undertaken under conditions of extreme pressure in terms of time and expense and as such a practical solution that involves little time and money must be sought. However, all efforts were made to ensure that any recommendations delivered more reliable results than the previous 'common practice'.

In summary, it has been shown that for on-farm sampling the normal practice of taking samples by spear after the grain is in store is far less satisfactory than sampling as the grain enters the store. This can either be done by sampling individual trailers or if high temperature drying is used then as the grain exit the dryer. Even though it was shown that in-store spear sampling gave an average results close to the ex-trailer sampling it did not describe the variability nearly so well and on a few occasions the results were substantially different, indicating that the patch of grain that had been spear sampled did not approximate to the mean of the total heap in store. In addition, bins (silos) cannot be satisfactorily sampled once they have been filled, hence it can be concluded that sampling stored grain is less reliable and that sampling into store has been shown to be the most satisfactory method. Protocols for on-farm sampling were produced and published both in HGCA project report No. 301 and the booklet 'Grain sampling – a farmer's guide'. The guide can be retrieved as a pdf file at:

<http://www.hgca.com/content.search/4/4/Site%20Search/Site%20Search/Redirect.msp?fn=redirect&pubId=1261>

This guide was very widely distributed to farmers both at training sessions and by a mail-shot covering ~8,000 cereal growers.

Although there has been an ISO (and BS) standard for lorry sampling available for a considerable time (I estimate in excess of 20 years) and this was recommended practice by millers and maltsters it was not always observed and there were no data to support the methodology given in the standard. ISO 13690:1999 (replaces IOS 950:1979, ISO 951:1979 and ISO 2170:1980) specifies that lorries from 15 to 30t should be sampled at 8 points and that increments should be taken throughout the whole depth of the load. The pattern of sampling is also given.



Extensive sampling of lorries containing wheat or barley using the current vacuum spears showed that it was not possible to follow the recommended sampling procedure. The length of current 30tonne trailers is such that the arm of the spearing equipment can only reach ~60% of the total load. Hence without moving a lorry during sampling coverage is incomplete.

However, the study showed that:

- Variation within a lorry is random (no one point can describe the load).
- The more samples taken the greater the probability of producing a reliable mean result.
- Sub-samples (8 recommended) must be thoroughly blended before extracting the test sample.
- Re-sampling a lorry is likely to give a slightly different result.

The full HGCA Project report No. 339 which includes the protocol for the sampling of lorries can be found at:

<http://www.hgca.com/content.search/4/4/Site%20Search/Site%20Search/Redirect.msp?fn=redirect&pubId=1256>

The whole of the sampling work was summarised in a booklet 'Grain sampling from field to buyer – *Understanding variation*' This was widely distributed to cereals farmers (~9,000) and is available as a pdf file on the HGCA websites at:

<http://www.hgca.com/content.search/4/4/Site%20Search/Site%20Search/Redirect.msp?fn=redirect&pubId=1259>

In conclusion, the sampling investigations described above have provided all sectors of the UK cereals industry with robust protocols for sampling grain at any point in the chain. These protocols are based on sound science and have been devised to reduce the impact of the inherent variability that has been shown to exist in bulks of grain.

The lorry sampling protocol has been widely adopted but the on-farm techniques have yet to be fully implemented. The constraint to implementation is the heavy workload at harvest time but it is believed that the added value in taking reliable samples will be realised and that over the forthcoming years more and more growers will adopt the recommended approach and submit their own samples for testing. The uptake of the on-farm protocols likely to be strongly encouraged by merchants and cooperative stores and a number of them have already advised their farmer clients to adopt the sampling protocols.

4. Sampler training

One of the objectives of the Grain Sampling and Analysis project was to train a large number of farmers in the new on-farm sampling protocols developed during 2002 so that they could be adopted from harvest 2003 onwards. The newly developed and validated protocols had been shown to provide sufficiently representative samples when one per trailer was taken and combined with other trailer samples from the same field.

4.1. Workshops

The training was designed to pass on the new sampling protocols to as many growers as possible. The workshops were structured to put sampling into a marketing context with the strong message “know what you have to sell”. The workshop outline was:

Samplers Training Workshop

Welcome and Introduction
GSAP explained

Background
Why sample?
Storage potential
Commercial value – the market context
What will it cost/save

Sampling Theory
Heterogeneity of grain
Current sampling practice¹
Deficiencies

The new approach
New theory
More detailed and informative picture (a storage/marketing management tool)
Validation of protocols
Variability

The Sampling protocols (ex-combine and ex-drier)
Equipment
Where and how to sample
Frequency of sampling (each load) – composite for a lot (define a lot)
Initial testing (mc each load) – storage potential
Sample and store identification
Mixing and sub-sampling – your samples to test and keep (storage of samples)
Possible problems

Monitoring stored samples
Sampling and testing to monitor mc and temp

Sampling for out-loading
Explain the on-going investigations

Summary
The Key messages

Q & A

¹ Ask participants what they do now – check whether they think this gives reliable samples.

The presenters were provided with a set of Powerpoint slide shows that covered the elements in the above programme. In addition, they had a number of props and photographs to demonstrate the actual sampling protocols and sub-sampling of composites to give analytical samples. Using the material provided, the workshops were run by staff members from 5 organisations. These were, Scottish Agricultural Colleges (SAC); Morley Consulting; Arable Research Centre (ARC); ADAS and Central Science Laboratory (CSL). The persons presenting the workshops were either agronomists or storage experts.

Over a period from mid January to mid March 2003 a total of 203 Grain Sampling Workshops were held. These covered the major grain growing areas of England and Scotland and 2 workshops were held in Northern Ireland and one in south Wales. Some 2230 people attended these events.

Workshop attendees were given a copy 'Grain Sampling – *a farmer's guide*' and after the event were sent a copy of CD with the same title. These publications contained the new on-farm sampling protocols in both written and visual format. In addition to the protocols they contained sections on:

- Grain Marketing – sampling and analysis
- Milling wheat – quality criteria and tests
- Malting barley – quality criteria and tests
- Feed grains - quality criteria and tests
- Sampling equipment
- Moisture meters – use and maintenance.

4.2. Workshop assessment

The workshop attendees were asked to complete a questionnaire (see page 27) at the end of the session.

The results of the questionnaire as percentage of responses have been inserted in the questionnaire. The full analysis of the questionnaire can be found in Appendix 2.

Examination of the responses shows a high satisfaction rating for the course and the material provided. It also supplied useful information on current use of merchants to sample grain and the level of rejections and claims experienced in the previous harvest year. These figures (see questionnaire table below) reinforce the data provided in the proposal for this project and indicate that there is considerable room to reduce both the number of merchant samples taken and analysed and the number of rejections and claims.

The workshop attendees were invited to discuss the issues raised and their comments were collected and then collated under the following headings:

- Lack of value of farm taken samples
- Moisture meters and measurement
- Feedback of results from purchasers
- Testing variation
- Lorry testing
- Laboratory testing
- Trust between seller & buyer
- Trading Standards involvement
- Sliding scales for quality and contracts
- The value of harvest samples
- General

The feedback was used to guide certain aspects of the remaining project. In particular the Lorry sampling project (section 3.3) was commissioned and issues surrounding testing variation and laboratory testing were fed into the laboratory standardisation and training activities (sections 5 and 6).

HGCA Sampling Workshop exit questionnaire.

Venue.....

X Month 2003

In order to monitor the success of this workshop and to allow the HGCA to keep in touch with you and provide updates and your attendance certificate I would be grateful if you could complete the questions below:

Please tick the appropriate box and add any comments in the space provided. Please score on the basis of 1 very low to 5 very high.

	1	2	3	4	5
Did you find the workshop useful and informative?	3	7	25	46	19
Do you understand the need for representative sampling?	2	1	6	33	58
Was the session the right length?	2	3	15	41	39
Did the presenter run a good session?	1	3	12	39	44
Would you recommend others to attend this event?	4	7	22	35	32
Was the booklet provided useful?	2	3	17	46	32
Will you use the CD as supportive information?	11	8	24	33	24
Comments. <i>See Appendix 2 for a summary of comments.</i>					

As we need to gather data to allow us to measure the success of the GSAP project can you also please answer the following questions:

Will you implement the protocols next harvest? Yes/No

Yes 93.8%

Will you use a merchant to take samples? Yes/No

Yes 72.7%

If yes, how many merchants/traders will you ask to take samples?

1-15%; 2-36%; 3-36%; 4-12%; 5-4%; 6-1%
--

What % of loads were rejected in 2001/02?

1. Wheat

3.9%

2. Barley

6.4%

What % of loads subject to claims in 2001/02?

1. Wheat

12.0%

2. Barley

20.6%

5. Grain Laboratory Standardisation

The aim of this project element was to identify current practice for grain analysis at all points in the cereal chain. Having established this, an approach to standardisation was developed and agreed with all interested parties. Training to support the standard was then developed.

The activities undertaken were:

4. Establish a cross-industry working party
5. Survey of current practice
6. Ascertain existing ring test and proficiency schemes
7. Develop a testing standard
8. Agree the standard with industry bodies – publish the standard
9. Develop training for analysts
10. Deliver training.

5.1. Laboratory Working Party

In order to ensure that all the major sectors of the UK cereal industry that test grain for the purposes of trade were involved in the standardisation of Grain Analysis and working party was formed. The following persons were invited to join the Laboratory Working Party (LWP).

- Bruce Johnson. Group Quality Assurance Manager, Greencore Malting Group; MAGB Technical Committee Chairman.
- Gillian Fisher. Quality Assurance Manager, BRi.
- Nicky Lockey. Laboratory Quality Coordinator, Banks Cargill Agriculture; TASCC laboratory working party Chairperson. AIC representative.
- Jeremy Smith*. Trade Policy Advisor, GAFTA
- Susan Salmon. Head of Cereals & Milling Department, CCFRA
- Damian Testa**. Trade Policy Manager, nabim.
- Paul Ibbott. Senior Cereals Advisor, NFU
- Chris Prevett. Rural Payments Agency RPA.
- Martin Albertini. Tini Tec; NIR network manager; LWP secretary.

* Jeremy Smith joined in April 2003 to replace Randall Waring who left GAFTA.

** Damian Testa left the working party after the first meeting and gave responsibility for nabim's interests to Mrs Susan Salmon.

It can be seen that the LWP had representation of all the farmers, end-users, traders and the RPA. Hence the interests of all the organisations who are concerned with grain properties were taken into account.

The LWP agreed the following terms of reference.

- To devise ways to harmonise testing of UK grain testing laboratories
- To review the standards to which laboratories currently operate
- Agree the tests to be included within scope of the working party
- Define performance parameters for each test
- Harmonise approaches where necessary
- Devise a control mechanism that will measure performance
- Set-up and monitor the necessary control mechanism to demonstrate on-going proficiency
- Define education and training needs for analysts.

The working party met 10 times during the course of the project. Its activities and outcome are described in the following sections.

5.2. *Survey of current practice*

In order to establish how grain was tested, that is by which methods and equipment, the LWP drew up a comprehensive questionnaire that was circulated to traders (AIC, formally UKASTA) and end-users (nabim and MAGB) by their trade associations. The questionnaire is presented below:

5.3. Questionnaire

HGCA Grain Sampling and Analysis Project

Survey of current intake laboratory practice

November 2002

Company..... For companies with multiple sites –please answer for all sites and give the number of sites

Contact name..... Contact Number Tel:

Business. Merchant ☐ Maltster ☐ Flour Miller ☐ Feed miller ☐ Export/import ☐ Other ☐ please specify.....

Please tick the box for the technique you use for routine testing (if other please specify) and quote the method you use e.g. instrument manufacturers', in-house, published (please specify). If your technique is a 'secondary method' please quote the reference method against which it is calibrated.

Technique		No*	Equipment (make and model)	Method	Reference method (if applicable)
-----------	--	-----	----------------------------	--------	----------------------------------

*Wheat Protein % (N*5.7)*

NIR whole grain	<input type="checkbox"/>				
NIR ground grain	<input type="checkbox"/>				
Dumas	<input type="checkbox"/>				
Kjeldahl	<input type="checkbox"/>				
Direct distillation	<input type="checkbox"/>				
Other	<input type="checkbox"/>			Please specify	

*Wheat & Barley Protein % (N*6.25)*

NIR whole grain	<input type="checkbox"/>				
NIR ground grain	<input type="checkbox"/>				
Dumas	<input type="checkbox"/>				
Kjeldahl	<input type="checkbox"/>				
Direct distillation	<input type="checkbox"/>				
Other	<input type="checkbox"/>			Please specify	

Barley Nitrogen %

Technique		No*	Equipment (make and model)	Method	Reference method (if applicable)
NIR whole grain	<input type="checkbox"/>				
NIR ground grain	<input type="checkbox"/>				
Dumas	<input type="checkbox"/>				
Kjeldahl	<input type="checkbox"/>				
Direct distillation	<input type="checkbox"/>				
Other	<input type="checkbox"/>			Please specify	

Moisture Content %

NIR wholegrain	<input type="checkbox"/>				
NIR ground grain	<input type="checkbox"/>				
Moisture meter	<input type="checkbox"/>				
IR balance	<input type="checkbox"/>				
Oven	<input type="checkbox"/>			state temp °C and Time mins...../.....	
Other	<input type="checkbox"/>			Please specify	

Falling Number, sec

Falling number. With moisture correction	<input type="checkbox"/>				
Falling number. (7g) As is	<input type="checkbox"/>				
Other α -amylase method				Please specify	

Specific Weight kg/hl

Chondrometer	<input type="checkbox"/>		Please specify volume of chondrometer.....		
Dickey John	<input type="checkbox"/>				
Sinar	<input type="checkbox"/>				
Infratec	<input type="checkbox"/>				
Other	<input type="checkbox"/>			Please specify	

Screenings

Sieving mechanical	<input type="checkbox"/>		State sieve sizes and cereal.	State weight taken and time shaken	
--------------------	--------------------------	--	-------------------------------	------------------------------------	--

Technique		No*	Equipment (make and model)	Method	Reference method (if applicable)
Sieving hand	<input type="checkbox"/>				

Admixture and Sensory Evaluation

Hand picking	<input type="checkbox"/>				
Sensory evaluation	<input type="checkbox"/>		State wheat or barley and common observations made. e.g . ergot, splitting		

Germinative Capacity

Tetrazolium staining.	<input type="checkbox"/>				
Hydrogen peroxide & peeling	<input type="checkbox"/>				
Other	<input type="checkbox"/>			Please specify	

Gluten Content

Gluten washing					
Wet gluten content	<input type="checkbox"/>				
Dry gluten content	<input type="checkbox"/>				

Wheat Hardness

SKCS	<input type="checkbox"/>				If NIR, please state 'scale' e.g . SKCS, Stenvert etc. or quote numbers
NIR whole grain	<input type="checkbox"/>				
NIR ground grain	<input type="checkbox"/>				
Stenvert	<input type="checkbox"/>				
Other	<input type="checkbox"/>			Please specify	

* please enter approximate number of tests performed annually

The questionnaire was sent to 300 companies and completed and returned by 129 (45%). In numerous cases large companies returned the questionnaire on behalf of all their sites and hence the results represent information from rather more than the 129 returns.

The breakdown of returned questionnaires by business areas was as follows:

Millers	38
Maltsters	26
Merchants	36
Co-operatives	4
Stores	15
Export/import	11
Others	6
Laboratories	4
Grain dryers	4
Feed compounders	2

5.3.1. Summary of Intake Laboratory Practice questionnaire

Wheat protein – N*5.7

- Split between whole- and ground-grain (40:60). A few very old InfraAnalysers (2 or 3).
- Numerous gaps in the reference methods – does this mean that the recipients do not know what they are or do not check secondary instruments against reference methods, i.e. they just use them (manufacture's instructions and installed calibrations)?

Wheat and Barley protein N*6.25

- 20 labs declared this testing, equal split between whole grain NIR, ground grain NIR and Dumas.
- The 6 labs using Dumas did not use a secondary method.

Barley Nitrogen

- Relatively high % use Dumas (15% solely or predominantly Dumas) - Reference method usually quotes as Dumas – is this the draft BS Std or manufacturers instructions?
- Where NIR is used (ground grain) do we know how often instruments are checked against Dumas?
- Assumes whole grain instruments use the NIR network.

Moisture

- All appear to use ISO/IOB reference method – no indication of frequency of checking secondary instruments.
- Quite a range of secondary instruments.
- Where ground NIR is used – is this for direct MC measurement or just P or N moisture content adjustment?

Falling Number

- Mostly (~70%) use 7g corrected. Others need to be convinced to change from 'as is'.
- What checks are in place to ensure correct operation of the instruments?
- How can we validate/check Falling Number testing?

Specific weight

- 25 use chondrometers (of which 13, 52% are 1L).
- If small (less than 1L) are used what checks are made?
- A large % of those using Dickey John and Sinar do not appear to be linked to reference methods. Are these checked and how and how frequently?

Screenings

- 4 mechanical instruments – how do they compare?

- Mostly 100g .
- Times of sieving are very variable, 30 to 300 seconds.
- Very few quote a reference method – those who do use IOB.
- Sieves – wheat 2.2mm (1 also uses 2.0mm).
- Sieves – Barley 2.8, 2.5 2.25mm (a few at 2.2 and 2 at 2.0).
- Numerous hand sieving methods (seems to be predominant method for wheat with all millers declaring by hand).
- Should we try to compare mechanical v hand or is this covered by BSi sub-group?

Admixture

- Forms were completed in various ways, from a long list to “anything not wanted” or no categories given. Hence valuable comment is difficult.
- Of those giving categories the following were most prevalent:
 - Ergot 83%, bugs/insects 50%, smells 38%.
 - For barley specifically – splitting 100%, skinning 54%.
 - Need to look at overall picture with reference to each sector. Need millers breakdown before this can be done.

Germinative capacity

- Tetrazolium method is favoured. Some also use hydrogen peroxide method.
- Possibly 12 different methods/equipment for tetrazolium testing.
- Generally 50 grains, some use 100.
- Time vary from 4 to 30 minutes
- Only a few gave temperatures, 40° and 60°C.
- Ref method – IOB 1.6 1997 for tetrazolium (100 grains).
- Ref method Hydrogen peroxide – IOB 1.5 1997 (200 grains).
- Are there any recognised ‘rapid method’ parameters? What are sensible operating conditions that fit within the requirements of a busy intake lab?

Gluten content

- All wet.
- Only 6 non-millers do gluten testing.

Hardness

- SKCS not used.
- Split between whole and ground grain NIR – more ground than whole. (Whole grain Ok for Hard but not soft).
- Only Stenvert and SKCS given as ref methods, but over 50% didn’t give one.
- A very confused picture – how many check calibrations?
- Is this possible if Stenvert is used as the ref method?
- Lots of different scales – SKCS, Stenvert, +5/-5, Perten whole grain (70-76), 1-20 soft/20+ hard.

The above summary notes make it abundantly clear that for most if not all the tests there is no single method or piece of equipment used. In some cases e.g. germinative capacity there is a very wide range of test variant used despite the fact that this method has an IOB standard. It is unrealistic to proscribe a method or equipment but the working party agreed that the practical approach was to provide focused training on each intake test so that all who test grain have a full understanding of the factors that affect test results and the commercial impact of poor testing. Analyst’s training is covered in section 6.

5.4. Existing ring test and proficiency schemes and developments

At the start of the project it was known (to the LWP) that a number of industry proficiency schemes and a code of practice were already in existence. However, only one of these was in any way visible to anyone (wide access through a website). In summary the situation was as follows:

5.4.1. AIC (Formally UKASTA)

AIC operates a Trade Assurance Scheme for Combinable Crops (TASCC) within which they have developed the AIC (UKASTA) Code of Practice for the Laboratory Analysis of Combinable Crops. This is available on their website as a pdf document. For AIC members to appear on the TASCC register of fully approved companies they are obliged to adopt the code of practice and undergo verification by an approved verifier. At the start of the project there were some 8 verification companies. However, in October 2003 AIC stated that from July 2004 they would change to having a single verifier – Integra Food Secure Ltd.

The code of practice covered the elements that would normally be found in a testing laboratory quality system. However, the instructions to participate in Proficiency Tests were open to interpretation and there was no evidence of a standard to which the laboratories should perform. The relevant section of the code of practice (2003/04) is as follows:

B.9 Proficiency (“Ring”) Tests

- 9.1 Proficiency or ring tests provide an independent external check against an established or reference value that the Laboratory is achieving a consistent level of results, and that the results are in line with other facilities performing the same analyses.**
- 9.2 Rings can be set up between a merchant/co-operative and end user, or use can be made of a nationally recognised proficiency test operated by an industry organisation.
- 9.3 Ring tests must be undertaken at least monthly whilst analysis is taking place. **[R]** (A list of ring testing organisations can be obtained from UKASTA – see Useful Addresses).

Although there is a general instruction to participate in ring test it is doubtful that the verifiers are able to audit this clause.

AIC were asked a series of questions relating to their scheme and the standard to which their registered laboratories operated. These are given below in the text of an e-mail from Jeremy Smith (AIC Secretary) along with the replies (in italics).

To: Simon Hook (HGCA)

From: Jeremy Smith (AIC)

Date: 12th August 2003

Thank you both (Nicky and Mark) for taking time out to agree the answers to HGCA's questions. This is what I think we agreed:

1. Do UKASTA want all their TASCC registered laboratories to adopt the standards that the HGCA GSAP project is proposing?

Yes. However, it will be necessary to issue guidance to TASCC Verifiers to ensure that standards are being achieved. HGCA to provide this guidance and advise how compliance can be policed.

2. The TASCC code of practice requires laboratories to take part on (at least) monthly ring tests, but does not set the standards that are achieved? How does it verify that laboratories are working to an acceptable standard (and what is that standard?)

The values for z-scores are the standards to be achieved. Achievement of standards can be verified by way of staff training. TASCC Verifiers also need to be trained.

3. How can we establish in which ring tests schemes TASCC registered labs currently participate?

This can be established by way of a question on the TASCC registration form which is completed annually.

4. Having found out who uses which schemes can we look at their protocols?

Yes.

5. Will UKASTA recommend to their membership that they should operate to the HGCA testing

standard?

Yes, in principle.

6. Will The UKASTA Code of Practice for the Laboratory Analysis of Combinable Crops be modified to incorporate the proposed testing standards?

Yes, with effect from July 2004 if the proposed testing standards are finalised in advance of that date.

7. The TASCC register does not cover Feed compounder/millers -how do their laboratories operate and should they be included? If so how?

I understand that Judith Nelson will answer this question in due course.

8. Are all export facility analyses conducted by TASCC registered laboratories?

No, but the UKASTA Trade Assurance Group will be asked to consider whether existing policy should change to require export facilities to meet TASCC standards.

9. Will UKASTA encourage laboratory staff to attend the HGCA Grain Analysis training sessions? Training will be presentation/discussion based.

Yes, or achieve the same objective by use of the CD Rom.

10. Can UKASTA suggest venues that allow people to travel only a short distance to attend?

We can certainly offer suggestions once we know numbers and geographical spread.

11. Will UKASTA issue invitations to the training sessions? Dates to be decided.

Yes.

Notes

UFAS members are linked to TASCC by the UKASTA Feed Assurance Scheme, UKASTA Code of Practice for the Manufacture of Safe Compound Animal Feedingstuffs. Section 8 Quality Control and in particular 8.5.5 links UFAS with the UKASTA Code of Practice for Laboratory Analysis of Combinable Crops. Does this mean that all feed compounder Laboratories have to be audited to the UKASTA Code of Practice for Laboratory Analysis of Combinable Crops? I.e. is it within the scope of their EFSIS audit?

I hope that Judith will be prepared to answer this question. I would also ask Judith to arrange for a representative of the feed sector to sit on the TASCC Laboratory Working Party.

-ENDS-

It is very clear from the responses that AIC have taken the subject of grain analysis by their members very seriously. Since the above e-mail the major thrust by AIC has been to address the Code of Practice and examine the role of proficiency testing as means of improving the standard of testing.

During early 2004 the TASSC laboratory working party undertook a detailed revision of the AIC Code of Practice for the Laboratory Analysis of Combinable Crops. The report's author was invited to attend working party meetings and took an active part in the re-drafting process. The code which is due for publication on the AIC website <http://www.agindustries.org.uk/> on 1st July 2004 incorporates a revised section on internal quality control and proficiency testing. These incorporate the testing standard developed by the GSAP project (see 5.4 below) and there is also the requirement for AIC member laboratory staff to undertake training using the CD ROMs produced by this project (see section 6.3.1). As of 1st July AIC member laboratories will be verified (audited) by a single company (Integra Food Secure) rather than the 8 used previously. This will ensure better control and that each laboratory will be verified to the same standard. The process will take a full calendar year so it will not be until the end of June 2005 that all AIC member laboratories will have been visited by the verifiers and a register of laboratories approved to the revised code can be issued.

During discussions with AIC it became clear that not all laboratory members were participating in proficiency schemes. In January of 2004 the AIC undertook a survey to establish what schemes existed. A copy of the survey form is shown below:

AIC Questionnaire – Laboratory Proficiency Schemes for compliance with TASCC Laboratory Code of Practice

Please complete following chart to indicate your current participation in Proficiency Schemes

- If you take part in more than one scheme – please copy sheet and complete as applicable. Include any in-house (within company) schemes
- If none, please write ‘none’ against ‘Scheme name ..’ for each commodity as applicable
- If you do not test a particular commodity, please write ‘not tested’ against ‘Scheme name...’ for each commodity as applicable
- Please tick the tests covered and give additional information where requested.

When completed please return this questionnaire by e-mail to Jeremy.smith@agindustries.org.uk or by post to Jeremy Smith, AIC, Confederation House, East of England Showground, Peterborough PE2 6XE by 30th January 2004

Company Name: Certificate No: Contact Name/Tel No:

	Wheat		Barley		Oats		Pulses		Oilseeds	
Scheme name and/or Scheme administrators										
Tests covered:	Moisture		Moisture		Moisture		Moisture		Moisture	
	Specific Weight		Specific Weight		Specific Weight		Specific Weight		Admixture	
	Protein		Nitrogen		Others – please specify		Admixture		Oil	
	Hagberg Falling Number		Screenings – please specify sizes below				Others – please specify		Others – please specify	
	Screenings & admix									
	Gluten		Germinative Capacity							
	Hardness		Others – please specify							
	Others – please specify									

The responses to this survey showed that participation in recognized proficiency schemes was very limited and as AIC have undertaken to provide contact details for scheme administrators it became clear that there was a need to develop a number of proficiency schemes. At least 2 companies have developed schemes, they are Banks Cargill Agriculture and Larkwhistle Laboratory Services (a division of Grainfarmers plc).

It is now clear that systems are in place that will bring about substantial improvements in grain testing within this sector.

5.4.2. nabim

The nabim intake proficiency scheme had been in existence for approximately 6 years but was unknown to any other than nabim members. This meant that as far as most of the cereals industry was concerned the flour millers were not operating a proficiency scheme and they were doubtful over the testing capability of millers. The scheme is run in conjunction with Campden and Chorleywood Food Research Association (CCFRA) and operates to a high standard, with the requirement of third party auditing for participants to be accredited. The scheme also has a category of proficient. Those classified as proficient have met the schemes performance standard over a minimum of 6 months but have not yet been audited.

The scheme was announced to the Cereals industry at the HGCA Milling Wheat Conference in May 2003. In September of that year the scheme protocol and a list of participants was placed on the nabim website (www.nabim.org.uk) for all to see. Subsequently in February the 2004 nabim wheat guide contained the following text.

Intake Sampling and Testing: nabim Code of Practice and Laboratory Scheme

Millers depend on testing to control their flour mills. They must know the qualities of the wheat they take in and the quality of the flour produced before it is sent to bakeries. Therefore sampling and testing must be both accurate and consistent. With regard to sampling of wheat, millers observe the **nabim** Recommended Code of Practice for Mill Intake, which sets out what suppliers can expect at grain intake and how any difficulties will be handled should they arise. **nabim** members observe a recognised sampling system (e.g. BS 4510) to produce samples at intake that are as fully representative as possible. This involves the taking of 5-11 sub-samples/ 'dips' depending on the size of the lorry delivering the grain. For a standard lorry load of 15-30 tonnes, it is normal practice for eight sub-samples to be taken.

With regard to testing, millers participate in the **nabim** intake proficiency scheme, which requires millers to follow established laboratory procedures and to reach a standard of proficiency, independently assessed by the Campden and on the basis of monthly tests. In addition to this measurement of proficiency in achieving the correct results, millers may also choose accreditation under the scheme after an independent third part audit (such as ISO) verifies that the processes required under the scheme are observed. A list of participating laboratories can be viewed on the nabim website (<http://www.nabim.org.uk/>). The list also indicates whether labs are proficient in intake testing and whether they are accredited to the **nabim** intake scheme. A copy of the scheme protocol can also be viewed.

It is apparent that nabim and its members have embraced the requirements of high quality testing and almost all millers are included in the scheme. During Spring of 2004 they indicated that their intake proficiency scheme was open to non-millers and that they were considering extending its scope to include specific weight.

Nabim made proficiency test data for 1 full calendar year available to the project to help define the standards for testing.

5.4.3. MAGB

The UK maltsters do not run their own proficiency testing scheme, however a large number of UK malting, brewing and distilling companies take part in the malting analytes proficiency testing scheme (MAPS). This was established by Pauls Malt (now Greencore Malting Group) in conjunction with the Laboratory of the Government Chemist (LGC). It is now run exclusively by the LGC and hence offers an independent proficiency testing scheme to anyone who tests barley and malt products. MAPS although run and administered by the LGC has steering committee with the majority of members representing the major malting, distilling and brewing companies. The scheme is run in accordance with VAM guidelines and hence fulfills the requirements of a proficiency scheme.

The MAPS scheme was not easily visible to those who do not take part in the scheme. Each participant receives a confidential report for each round of testing and although the majority of participants allow their names to be used it is only the participants who have a direct knowledge of the scheme and its working. Details of the operation (but not the participants) could be found on the LGC website.

After extensive discussions with MAGB representatives the MAGB agreed to describe the MAPS scheme on their website (www.ukmalt.com/labs/labs1.html) along with a list of UK participants. This took place in June 2004 and so for the first time gave anyone access to the scheme and UK participants of MAPS. The scheme does not include a third party audit as a requirement of participation but MAGB state that the scope and participation in MAPS should be included in quality audits of UK maltsters.

MAPS made proficiency test data for 1 full calendar year available to the project to help define the standards for testing.

5.4.4. NIR network

Although this is not a proficiency scheme the NIR network offers a scheme whereby members attach their individual NIR instruments to a sub-master instrument. The Network is administered by Martin Albertini (a member of the project's Laboratory working party) and uses Allied Technical Centre as a reference laboratory to provide monthly check samples and generate and up-date calibrations. As network members are connected to the sub-master instrument by modem they receive calibration changes when they are necessary. This means that all members are operating with the same calibrations at any point in time. Although this does not guarantee that the results produced by individual NIR machines are accurate it improves the agreement between them. It has been found that most maltsters and many AIC members are part of this scheme. It is not used extensively by nabim members.

5.5. The Grain Testing Standard

It was not deemed practical or achievable to set up a new grain testing laboratory proficiency testing (PT) scheme for the whole of the UK grain industry. It was estimated that there are in excess of 400 grain testing laboratories in the UK (in 2004) and that to produce sufficient quantities of a homogeneous bulk and divide that into sub-samples that had identical (in analytical terms) properties was not possible. Furthermore, there are cost implications in participating in ring checks (PT schemes) and many laboratories were already participating in existing schemes. Therefore, it was deemed sensible and practical to integrate the schemes by setting a standard to which their participants should operate and making visible the schemes and their participants.

5.5.1. Setting the standard

In order to devise a standard which all grain testing laboratories should achieve it was necessary to define realistic, achievable and robust targets. The targets that were required for each test were repeatability and a measure of proficiency when taking part in ring check schemes. These are defined

in the standard document (see below). The laboratory working party requested data from existing and well established proficiency testing schemes and was supplied with a year's worth of data by both MAPS and the nabim intake proficiency scheme. In addition, data was provided by CCFRA from other check schemes and repeatability values contained within their Manual of Methods for Wheat and Flour Testing. Values from standard methods e.g. ISO, BS, ICC, IOB, EBC were also used.

The data supplied were used to generate a list of repeatability values (not all were available) and either reproducibility values or Route Mean Squared Deviation (RMSD) for the calculation of z-scores when partaking in proficiency testing. The former are applied when the scheme uses robust mean values for z-score calculation and the latter when a reference value is used.

In addition to the values to be used to assess performance the standard gave the scope of tests included and a brief description of the requirements for the operation of a grain testing facility. Most importantly the document which was placed on the HGCA's web site and publicised fully contained hyperlinks to trade association websites to all anyone to see the schemes that are in operation and those companies and laboratories that participate in them.

The standard is reproduced in the following pages:

Grain Testing Standards for testing



Introduction

One of the objectives of the HGCA Grain Sampling Analysis Project is to improve the agreement of test results across the UK Cereals Industry. Part of the approach to this was to establish standards for all grain testing laboratories. A working party with representatives from all sectors of the industry has developed these standards.

The standard

This document describes the elements that are needed for best laboratory practice. It gives straightforward guidance on the requirements for equipment, methods and people. It is not designed to supersede any quality systems that are already in place and are subject to third party audit and accreditation. However, it will provide a framework for those who do not operate to these standards (see pages 44 & 45).

In addition to the framework it includes targets for testing. They are measures of the proficiency of a laboratory and are given as the limits of variation that are acceptable for repeat testing by the laboratory and also limits of deviation from mean/median values or reference values when participating in proficiency test schemes. These values have been derived from a very large pool of actual testing data. An explanation of terminology and derivation of standard value is given in page 4 followed by standard values in the table on page 5. The standard for running proficiency testing scheme is given by VAM (Valid Analytical Measurement) and can be found on <http://www.vam.org.uk>

Who should adopt this standard?

All UK laboratories that test grain for trading purposes.

Registers of participating laboratories (along with their testing protocols) can be found the relevant trade association websites. Click on the relevant link to view the register or scheme.

<http://www.nabim.org.uk/millintake.asp>

<http://www.agindustries.org.uk/assurance/tascc/laboratory.pdf>

<http://www.agindustries.org.uk/assurance/tascc/tasccreg.xls>

<http://www.ukmalt.com/LABS/labs1.html>

http://www.lgc.co.uk/pts_schemes_children.asp?id=53_2_3_4

Scope – Tests to be included in the scheme.

Ideally all participating laboratories should include the following tests within ring testing schemes. Those laboratories not undertaking the full range of tests will have a reduced scope.

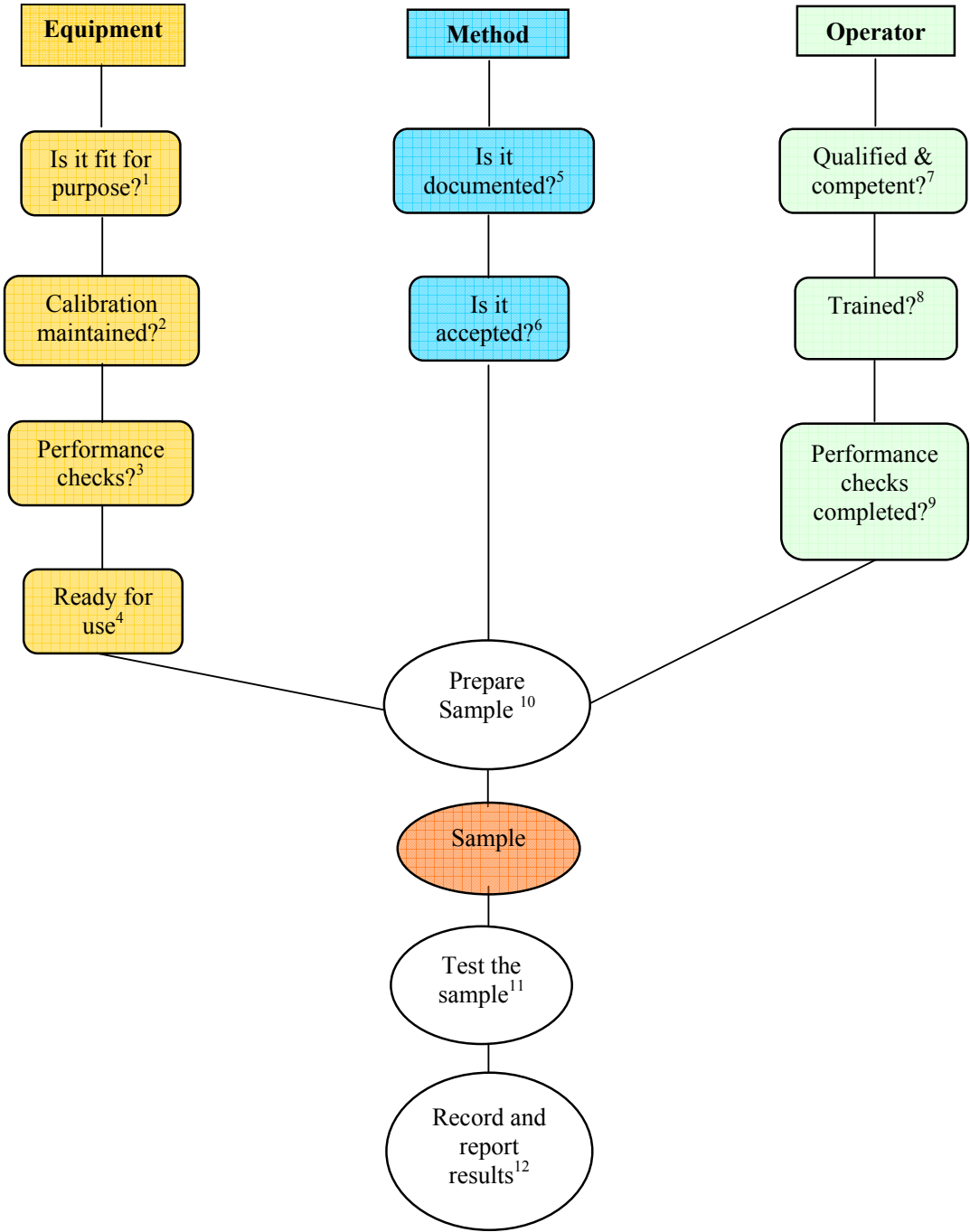
Test	Barley	Wheat
Nitrogen, %	✓	
Moisture content, %	✓	✓
Specific Weight, kg/hl	✓	✓
Germinative capacity	✓	
Sieving test. >2.5mm; <2.25mm; <2.20mm	✓	
Protein, %		✓
Falling Number, Sec		✓
Hardness, SKCS		✓

Training for analysts

To support the standardisation of training in the UK Cereals two training CD ROMs have been produced. When requesting a CD, please quote wheat or barley. These can be obtained from the HGCA free of charge from HGCA publications: Tel: 0207520 3920, Fax: 02075203931 or e-mail: publications@hgca.com

Grain Testing Best Practice

These elements are essential for the reliable testing of grain.
See following page for explanation of each element.



The standards to be applied to grain tests are given on page 5.

Notes to accompany each element of grain testing.

Equipment

1. All equipment used for testing must be fit for purpose, serviced and maintained in compliance with the laboratory's quality system. Requirements for equipment e.g. balance accuracy, should be given in the test method.
2. Equipment shall be calibrated according to routines within the method and/or against a defined schedule.
3. Performance checks must be done before use.
4. When all the above (1-3) have been fulfilled the equipment is ready for use.

Method

5. The method shall be documented – this can be an official method or an in-house procedure. If the latter is used, the relationship to the official method must be known. Procedures must be in place to ensure that only current methods are used.
6. Is the method accepted by the grain industry? Ensure you only use methods that give results that others recognise, e.g. SKCS scale for wheat hardness.

Operator

7. All staff must be competent in those tests that they are expected to undertake.
8. All staff (full-time and temporary) shall be trained in the methods they are required to perform. A record of competence will be held by the laboratory manager. Preferably staff will have undertaken the necessary HGCA laboratory training modules.
9. All staff must ensure that any instrument of test performance checks are completed before routine testing can begin.

Sample, testing and reporting

10. Only when all the above elements have been fulfilled can the sample be taken and testing start. Ensure that the test sample is representative of the sample provided to the laboratory (either in bag or from the laboratory taken sample). Rules about sub-sampling, grinding and mixing must be followed.
11. Undertake the test according to the documented method. Observe all the critical control points.
12. Results shall be reported in a format agreed with the customer. All results shall be reported with units of measurement as recognised in the grain industry.

Standards to be achieved when testing grain.

The performance of a laboratory and its staff can be measured in a number of ways.

There are two measure of proficiency:

1. The first is **repeatability**, a measure of the competence of a single analyst in one laboratory. The repeatability r_{95} value (given in the table on page 5) represents the difference between two independent single test results using identical material. *One in 20 results can exceed these values.*
2. The second compares a laboratory with other laboratories testing the same samples. This is usually carried out by using a ring test and operated by proficiency schemes. Laboratories can be judged in two different ways.
 - Where participants are judged against the other participants in the proficiency scheme. In this case either a mean or median value is used to calculate z-scores. The results are relative to the group taking part in the scheme and are a measure of **reproducibility**. This approach only gives a measure of agreement with others. In these cases the standard deviation of test results is applicable for establishing a value for z and the guideline maximum values are given in the following table column labelled v (versus) mean. Generally the exact method used is not stipulated and hence can be either a reference or secondary method.
 - Where participants using secondary methods are assessed against a reference test value. In this case, as participants are judged against the agreed reference results for each test there is an element of accuracy included in the scheme. In these cases the **Root Mean Squared Deviation (RMSD)** is applicable and these values are given in the column labelled v reference.

Most proficiency schemes use z-scores to assess proficiency. Values are given in the table to be used for z-score calculation of ring test results. These values are for $z=1$. For an explanation of z-scores see page 6.

The figures presented in the following table are based on proficiency testing schemes data provided by end-users where significant amounts of data, often a years worth, was available. Reference has also been made to standard deviation data published in IOB, EBC, BSI and ISO standards.

For a number of tests compromises have had to be made and these are based on the knowledge and experience of members of the Grain Sampling and Analysis Laboratory Working Party. This reflects the fact that the data available from different sources covered different ranges of test results.

In addition, for some secondary tests e.g. moisture, protein and nitrogen, it has been necessary to group together a range of equipment.

The figures given on the following table are for guidance and are the maximum values that should be achievable by individual analysts (r_{95}) or maximum values to use for z scores when assessing laboratories. When running proficiency schemes where lower values than those shown can be achieved, the scheme administrators are encouraged to implement these tighter criteria.

Standard values

The repeatability r_{95} values given below should be used to assess the competence of a trianee analyst. The values represent the difference that should not be exceeded for two independent single test results using identical material. Statistically one in 20 results can exceed these values.

When assessing a laboratory's proficiency the values to be used for z-score calculation of the individual laboratory's ring test results are given for the two differing approaches. When comparing with your peers (v mean) or against reference values (v reference). See page 6 for an explanation of z-score calculation. The values given in this table are for s. The values for s given in the table below are for guidance for organisations running proficiency schemes. All schemes should review scheme operations (ideally annually) and set s values that are appropriate. When participants in a scheme perform significantly better than the standard set then s values should be reduced accordingly.

Wheat Tests	Repeatability, r_{95}	Values of s for z-score calculation		
		v mean ²	v reference ³	dps ⁴
Protein (N*5.7), dm %, Dumas	0.23	0.14	-	1
Protein (N*5.7), dm %, NIR	- ⁵	0.22	0.26	1
Moisture %, Oven	0.11	0.20	-	1
Moisture Others ⁶	-	0.22	0.24	1
Falling Number, sec	24	26.5	25	0
Specific weight, kg/hl, Kern	0.37	0.30	-	1
Specific weight, kg/hl, Others	-	0.70	0.85	1
Hardness units, SKCS	3.1	2.4	-	1
Hardness SKCS units, NIR	-	-	-	-
Gluten %, wet weight	4.87	3.67	-	1
Barley Tests				
Nitrogen dm %, Dumas	0.056	0.030	-	2
Nitrogen dm %, NIR	-	0.033	0.048	2
Moisture %, Oven	0.11	0.20	-	1
Moisture %, NIR	-	0.17	0.29	1
Moisture %, meter	-	0.21	0.32	1
Specific weight, kg/hl	-	0.70	-	1
Germination capacity %, Rapid ⁷	5.7	2.4	-	0
Germination capacity %, Peroxide	-	2.2	-	0
Screenings >2.5mm %	-	-	1.00	1
Screenings <2.25mm %	-	-	0.35	1
Screenings <2.2mm %	-	-	0.30	1

² Based on R sd. Applicable to ring tests that assess results against either mean or median values.

³ Based on RMSD. Applicable to ring tests that assess results against reference method values.

⁴ Number of decimal places to be used for test results in proficiency testing and when calculating z scores. When reporting z-scores round to 1dp.

⁵ No data available to the GSAP Laboratory Working Party. This applies to all boxes containing a dash (-).

⁶ Covers a range of methods incl. NIR and meters.

⁷ Applicable to barley with a germination capacity of >90%

Proficiency testing schemes

Using z-scores

Participants results are collated by the scheme administrator and a z-score calculated for each result, using the equation:

$$z = \frac{x_i - \text{assigned value}}{s}$$

Where x_i is the individual result. The assigned value will be either the median value for that analyte, or the 'established value' derived by reference testing, and s is a target value for the acceptable deviation from the assigned value. Values in the table on page 5 in the column headed v (versus) mean applies to schemes that operate using a mean value whereas those who compare individual test results against a reference (established) values should use values in the column headed v (versus) reference.

In the case of these value for each test has been derived from a very large body of proficiency scheme test data and should be achievable by laboratories.

Z-scores are normally interpreted as follows:

$|Z| \leq 2$ is satisfactory

$2 < |Z| < 3$ is questionable

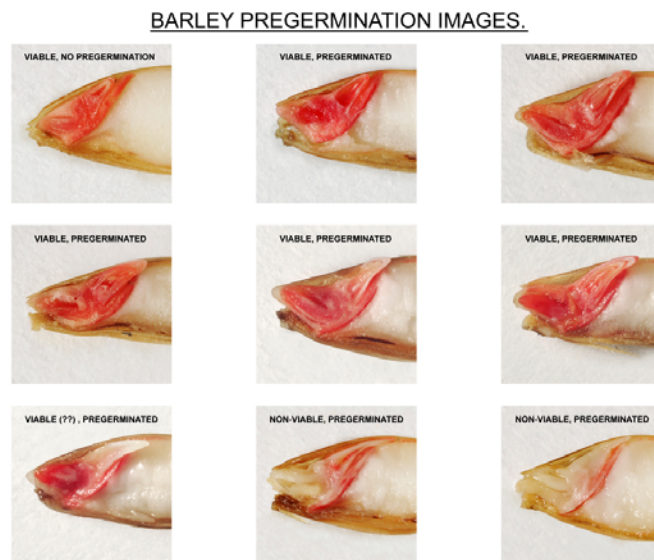
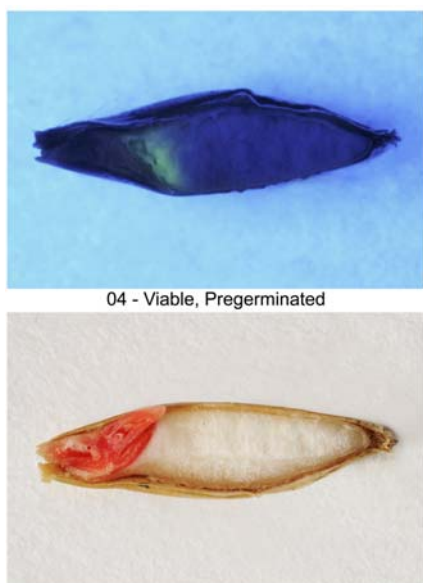
$|Z| \geq 3$ is unsatisfactory

5.6. Pregermination

It became apparent as the development of the grain standard progressed that in addition to the normal intake tests for malting barley that there was a need to be able to agree on what the term pregermination means. This term was used by maltsters and traders without there being any agreement as to its meaning and hence led to confusion and sometimes disagreement between two trading parties. As pregermination has an impact on the ability of barley to malt there are commercial consequences of incorrect identification.

The project offered an ideal vehicle to resolve this problem and AIC and MAGB agreed to call a workshop with experts from both organisations to define the various stages of pregermination and the test that should be used by all. The reference test (IOB 1.11 Pregerminated grains in barley: Fluorescein dibutyrate method) was rarely used due to the high level of expertise, specialist equipment and time required. Although not an integral part of the rapid test (IOB 1.6 Germinative capacity of barley: rapid staining method) it is referred to within the method but no instruction on how to recognise or classify pregermination are given.

Samples of barley which were known to contain pregerminated grains were examined by the experts using both the reference and rapid methods. A single sample was selected for a further exercise at which a professional photographer was present to record high quality images of pregerminated grains as visualized by fluorescence and tetrazolium staining. Figure 5.1 below shows one example of a pair of images (separate halves of the same grain) and figure 5.2 shows the range of pregemination seen with brief descriptions.



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Figure 5.1 A comparison of fluorescein dibutyrate and tetrazolium treated pregerminated barley grains

Figure 5.2 Levels of pregermination as shown by tetrazolium staining.

These images and descriptions of the state of pregermination were burnt onto a CD and provided to all AIC and MAGB testing laboratories and will be placed on the MAGB website. In addition, members of the MAGB technical committee have proposed to the European Brewery Confederation (EBC) that the images be used to develop a standard method for the determination of pregermination in barley.

Hence this initiative has provided UK grain testing laboratories with an objective means of assessing pregermination and hence allows agreement between trading parties.

5.7. Discussion

The complexity of controlling the testing standard of a very large and widely dispersed number of grain testing laboratories was the major challenge in harmonising UK grain testing. It soon became clear that a single scheme for all laboratories was neither practical nor desirable. In order to provide a proficiency testing scheme for 400+ laboratories the administering laboratory would have to source ~12 tonnes of both wheat and barley annually (assuming 2 samples/month). Each sample ~500kg would have to be thoroughly homogenized and then divided into 400+ individual samples. Consultation with expert laboratories indicated that this was not feasible. In terms of desirability, the fact that a number of schemes were already in existence and many laboratories were already participating (at a cost) meant that it was considered sensible to make use of the schemes and bring up to standard those that were not satisfactory.

As the major benefits are to be gained in the trading of premium crops (malting barley and milling wheat) the project concentrated on these processors and the supply trade, represented by AIC. The principles established are transferable and can be extended to the feed compound and export sectors.

As indicated above the flour millers (nabim) and maltsters (MAGB) already had well established and well run proficiency testing schemes. However, they were not visible to non-participants and in the case of the nabim intake proficiency testing scheme not open to non-nabim members. This project has provided the necessary platform for both these schemes to become visible to all, and for nabim to offer their scheme more widely. AIC already published their Code of Practice and a register of laboratories. The project established that the code needed considerable strengthening to bring it up to the level required and to that operated by the processors. AIC undertook the necessary improvements and although these will not be delivered within the time-frame of the project they aim to achieve this by the end of June 2005. As the schemes are run by or closely associated with the trade organisations the responsibility for maintaining the standard lies with those organisations and hence ensures on-going maintenance.

The conclusion is that over a three year period (two of which were covered by the project) grain testing laboratories operating in the premium market will all be working to the same standard and that their operation will be overseen by the relevant trade organisations.

In addition to standardising grain testing this project has provided the necessary platform for the development of a standard for testing pregerminated barley using tetrazolium stained grains. Previously this has been an area of much confusion but with a single agreed set of photographs showing the various stages of pregermination there is every prospect of improved agreement and the development of a standard test method.

6. Grain Analyst Training

6.1. Introduction

The aim of grain analysis standardisation was a very challenging one and it was felt very strongly by the Laboratory working party that there was a considerable need for training so that all who test grain could work towards the standard that had been set.

Although all analysts working in laboratories that operate a quality scheme should have undergone training in specific tests before they are considered 'trained' and allowed to test without supervision it was believed that many do not know exactly what or why they were testing. As the results of grain testing nearly always have commercial or financial implications it was felt necessary to provide a different form of training to the classical test method training referred to above.

6.2. Training course design

The design of the training modules for each intake test was as follows:

- What does it measure? – a plain English description of the test.
- Why measure it? – the commercial relevance of the test.
- Sample preparation – specific to the test. It will include grinding, mixing sub-sampling as appropriate.
- Equipment – Pictures and brief description.
- The method – what the analyst does.
- Results - what they mean with relevance to the end-user.
- Check samples. The specific requirements of check samples for each test.
- Factors affecting the test. Things that can and do go wrong. This is all about critical control points and gives you pointers to trouble-shooting.
- Critical Control Points.
- Competency – what the test can actually deliver – repeatability and reproducibility.
- Safety – any specific points you need to be aware of to do the test safely.

It can be seen that the emphasis is on creating a much fuller understanding of why testing is undertaken and the implications of poor quality testing. This fully compliments the overall thrust of the GSAP project in that once representative samples have been taken they should be tested to the highest possible standard.

In order that all UK grain analysts work to the same standards and have received the same background information through training it was necessary to devise a mechanism that would reach all analysts. The aim was to develop a range of training modules that covered current intake tests along with supporting material that is essential to high quality testing. The modules are as follows:

All grain analysts

- Introduction (basic testing requirements)
- Preparing samples for testing
- Quality Assurance
- Moisture content
- Specific weight

Barley analysts

- Germinative capacity
- Nitrogen content
- Barley sieving

Wheat analysts

- Protein content
- Falling Number
- Gluten washing

- Hardness
- Screenings/admixture.

The sub-divisions were necessary to cover the various industry sectors. Every sector should receive the modules listed under 'All grain analysts' and these would also be sufficient for the feed milling sector. In addition to these, flour millers would need the 'wheat analysts' modules and maltsters the 'barley analysts' modules. Members of AIC, the merchant and co-operative sector would need all the modules as most test both wheat and barley.

6.3. Training material

6.3.1. CD ROMs

Development of the training modules proved to be a very exacting exercise and it became clear that it would not be possible to provide a sufficiently robust package that could be delivered by a number of trainers during January to March 2004 as was originally planned. The laboratory working party agreed to concentrate on producing high quality CD ROM training material. This would have the same content as described above, be picture rich and where appropriate contain video clips of the tests being performed by experts.

The individual test modules contain the reference methodology and where appropriate rapid (routine) testing methods. In all cases there is an emphasis on good control of testing and a need to understand the relationship between rapid and reference methodology.

Each individual test module was accompanied by a set of questions that allowed assessment of the student/analyst undertaking the training. These questions are not held on the CD but a link was given to the HGCA website where the questions could be answered. On completion of the questions the results could be printed and compared with the correct answers. This printed form could become part of the analyst's training record.

6.3.2. Visual inspection

When grain arrives in a laboratory it should be inspected visually for defects, other cereals and foreign matter. There was no standard set of images to assist analysts in making the correct identification. This is important as some features can cause health hazards and others processing problems. A range of high quality photographs were taken that showed both physical and pest defects along with weed seeds and cereals commonly grown or traded in the UK. In addition to printed sheets that are designed to be placed on laboratory notice boards, a poster was produced and the images were included on the analysts' training CD ROMs. These three approaches ensured the widest possible coverage that would allow farmers to identify undesirable features before marketing their grain and analysts to make objective judgements when inspecting grain on arrival in a laboratory.

The cards and poster can be found at:

<http://www.hgca.com/content.search/4/4/Site%20Search/Site%20Search/Redirect.msp?fn=redirect&pubId=1264>

<http://www.hgca.com/content.search/4/4/Site%20Search/Site%20Search/Redirect.msp?fn=redirect&pubId=1258>

6.4. Dissemination

The CDs were completed in May 2004 and the trade organisations AIC, nabim and MAGB undertook to send them to all member companies with grain testing laboratories. Each of these organisations gave full endorsement to the training packages and they were distributed very widely.

The printed sheets that showed defects associated with wheat and barley were distributed along with the CDs. In addition, these were printed as a poster and inserted in Crops magazine (May 2004) and hence reached ~25,000 farmers.

CDs, and visual identification sheets and posters are also available on request from the HGCA publications department.

7. Food Safety Concerns

The sampling activities covered in section 3 are primarily concerned with extracting grain samples for the measurement of moisture content to determine drying and storage requirements and for analysis of quality characteristics. In these cases it is assumed that the parameter to be measured is homogeneously distributed. Hence these procedures rely on taking a number of individual samples within a bulk of grain followed by combining those individual samples and mixing the composite thoroughly before sub-sampling to provide the analytical sample.

However, it was considered that these sampling regimes were unlikely to be adequate for due diligence testing of heterogeneously distributed analytes. This was presumed to be the case for adventitious contamination of grain by mycotoxins and genetically modified (GM) grains. These were considered to be of potential food safety or consumer concern. In view of the limited information on grain sampling for most non-homogeneously distributed analyte a desk study review was commissioned.

7.1. Project brief

Approaches to consumer confidence and food safety concerns.

The HGCA Grain Sampling and Analysis project has a primary aim of developing and validating sampling protocols that are designed to test end-user specification requirements. The analytical harmonisation element of the project also only focuses on these tests. Although these approaches should assist both the seller and buyer of grain, they do not address the issues of consumer confidence and food safety. These concerns are currently driven by legislation and consumer pressure groups.

Because of the nature of the factors that affect food safety and consumer concern and the way in which the minor contaminants that relate to these factors are distributed in raw agricultural products it may be necessary to sample differently in order that representative samples can be obtained. Further homogenisation and sub-sampling is required to provide a meaningful analyst's sample and the size of the sub-sample may vary with the analyte.

The areas of interest include:

- Genetically modified organisms
- Mycotoxins of both field
- Mycotoxins of storage origin
- Micro-organisms
- Heavy metals
- Agrochemical residues (including storage pesticides)
- Pests (including mites).

A desk study is required to survey the sampling protocols that have been published to deal with the above areas of concern. It should include analysis of the scientific basis for such protocols and comment on their validation. This should not be confined to UK practice should be undertaken on an international basis.

Where there are similarities between the sampling requirements (which are based on sound science) between the various analytes their appropriateness for use with other analytes should be considered. The aim should be to identify as few sampling protocols as possible that will deliver robust test data for the analytes listed above. In addition you should explore the potential and relevance of existing 'quality' sampling protocols to food safety testing.

Sampling requirements should focus on in-land storage requirements e.g. farm or co-operative storage (both flat and bin storage), intake at buyer's premises and where appropriate define lot size. Sampling of vessels should be included to ensure coverage of conditions affecting imports and exports.

Attention must also be paid to the blending (homogenisation) and sub-sampling to provide an analyst's sample. The testing of these sub-samples is excluded from this review.

Recommendations should be made for practical sampling procedures for surveillance testing of any or all the items listed within the scope of this review.

This is a desk study and should not include experimental work. However, it may lead to proposals that will result in experimentation to develop or validate new protocols. The output will be a review document written in accordance with HGCA review guidelines that can be found on the HGCA website.

The full HGCA Research Review C50 can be found at:

<http://www.hgca.com/content.search/4/4/Site%20Search/Site%20Search/Redirect.msp?fn=redirect&pubId=806>

7.2. Report abstract

The report abstract is as follows:

Grain is sampled for one, possibly, two reasons:

- to determine the average quality based on a representative sample.
- to detect contaminants. This information may trigger rejection of a load or determine whether the levels of a contaminant in a bulk exceed a regulatory threshold.

This review examined published sampling regimes for a number of contaminants that now, or in the future, may affect food safety. These were: genetically modified organisms, mycotoxins, micro-organisms, heavy metals, agrochemical residues and arthropod pests.

A common, ISO 13690-based approach using 5-11 samples from 15-500t is used for some contaminants. This is reasonable when the contaminant (analyte) is homogeneously distributed, although sample size and number of samples/tonne are often poorly defined, standards used may have no scientific basis and there are rarely validation details. Sampling regimes for insects and in particular, mycotoxins, which are heterogeneously distributed, are very demanding.

An EU directive recommends taking 100 samples of 100g from 50-1500t for regulatory purposes for mycotoxin determination. Live insect contamination is best estimated using traps but the regulatory mycotoxin sampling may be adaptable for sampling insects and would also apply to dead insects.

It is recommended that the ISO-based sampling method be validated experimentally for a variety of analytes since it is widely cited and convenient to use. However, its effectiveness is unclear. A simplified method of sampling for mycotoxins should be developed that will give results comparable to the regulatory sampling. This would demonstrate 'due diligence' and avoid costs associated with the 'regulatory' sampling protocols. (If such a method proved 'substantially equivalent' to the regulatory sampling, it could be used for regulatory processes if there were cost savings). The pattern of mixing grain during outloading has considerable influence on the distribution of analytes. It therefore affects the sampling regime and merits study.

The project overview and recommendations were:

UK industry would benefit from a single validated sampling protocol for all the analytes discussed, which would ensure representative results from analysed laboratory samples. However, it is clear that the distribution of each analyte is different; some are heterogeneous, others homogeneous and others unknown or the opinion thereof held by different authorities is contradictory. In addition, this report shows the purpose of sampling to vary. Some samples are taken for detection (GMO, Salmonella, insects) while in most cases the aim is for determination to gain a representative sample that predicts average quality.

Not all analytes have formal sampling protocols and even where protocols exist, these have rarely been validated by experiment. The number of samples required by a sampling protocol varies by analyte and there is little consistency in defining size of samples and in expressing the sampling frequency in a consistent way (e.g. number and size of samples per unit of bulk) or even using SI units (see table below).

Specific recommendations for heavy metal sampling, for GM and for pesticide residues are ISO-based and although as yet unvalidated may prove to be largely appropriate. However, it is clear that sampling for the very heterogeneous biological analytes, e.g. arthropods and fungi and their metabolites, mycotoxins require more detailed protocols and sampling regimes.

One approach to a 'one size fits all' solution, would be to adopt the most rigorous regulatory sampling requirement, which is undoubtedly that for storage mycotoxins, and divide the resulting bulk sample to provide the necessary laboratory samples for other analytes. (In the case of insects, there would be considerable advantage in examining the entire bulked sample, for instance by passing it over an inclined sieve).

However, before such an approach is adopted, it would be highly desirable to simplify the statutory sampling plan for storage mycotoxins which has the potential of considerable extra costs for industry. Design of such a plan would depend on a greater understanding of mycotoxin formation during drying or storage of damp grain, than currently exists. Anecdotal information received from 'Euromalt' suggests so far that only the EU regulatory sampling for mycotoxins reliably detects the regulatory mycotoxin level but there is a definite need to find a simplified sampling regime that is substantially equivalent to the regulatory procedure and thus demonstrates 'due diligence'.

Another approach would be to adopt the ISO standard for those analytes that are likely to be homogeneous - pesticides, heavy metals, GMOs, mites, microbial contamination. Sampling for Ochratoxin A (OA) could be carried out at a lesser frequency to demonstrate due diligence. Should surveys by FSA, DEFRA etc. show the inadequacies of this approach, greater frequency of OA sampling would be required.

HGCA sampling recommendations are to take a sample from 1kg from each trailer (or 1kg/t from driers) and make a composite sample to represent every 50t. This does not specify a rate of sampling per tonne since a trailer can be anything up to 20t. This has been shown to be adequate for determining market quality but needs to be validated to see if it is also suitable for determination of homogeneously distributed analytes such as pesticides, or heavy metals or to see if it can be adapted for heterogeneous analytes such as mycotoxins.

However, adopting any of these approaches would first require experimental validation and testing of the applicability to practice by sampling from farm and commercial stores. The first approach would require estimation of the size of sub-sample to be taken for each analyte.

Finally, the pattern of mixing of grain during unloading of bins or floor stores has considerable influence on the distribution of analytes and ultimately therefore upon the sampling regime. For instance, during the unloading of hopper-bottom bins, the grain empties as a column above the bin centre and grain from the surface is some of the earliest to be discharged. In view of the importance of the grain surface as a primary source of some contaminants such as mycotoxins and arthropods, due to the fluctuating moisture contents there, it is easy to see that by failing to sample this earliest discharging grain one might also miss the prime source of these contaminants. Equally, this pattern of discharge suggests only limited mixing of the surface grain might occur. Since this factor has such an important effect on the assumed and actual distribution of analytes, it requires its own experimental study.

The table below summaries the sampling recommendations derived from the literature at the time of publication of this review (May 2003).

The review highlighted the problems of sampling mycotoxins. As further work in this area was outside the scope of the Grain Sampling Analysis project the report and its findings were discussed with the Food Standards Agency (Chemical Contaminants and Animal Feeds Division) so that they could consider the need for further work. However, it has provided a comprehensive overview of the state of sampling grain for reasons other than quality characteristics. It is now available to all who wish to take this forward and could provide a basis for discussion with regulatory bodies.

Table. Summary of current sampling recommendations for different analytes.

Analyte / Purpose	Authority	Samples Incremental	Nos/t	Bulk/Aggregate	kg/t	Laboratory
<i>Usually Determination</i>	ISO 13690	5-11 from 15-500t	1/3-4.5t			
	AACC 64-70A	1/50 bushels	1/1.5t			
	AACC 64-71	1/5.5t	1/5.5t			
	ISTA	1/700 kg (from 28-40t)	1/0.7t			Min. 1 kg
	GIPSA			1.25kg from 5000 bushels	1kg /116t	
<i>GM Detection</i>	EEP As ISO	30	1/3-4.5t	1/20 bulk		3000 kernels
	USFDA Cry 9C	As GIPSA		2400 kernels	1kg/116t	
<i>Mycotoxin Determination</i>	EU 2002/26/EC	100 from 50-1500t	1/0.5-150t	10 kg		
	USFDA	10 x 1lb				
	GIPSA			2-3lbs		200g lab, 50g sub-sample
<i>Salmonella Detection ?</i>	USFDA	15 x 100g				
	MAFF COP	40 samples (no size)		1 aggregate (no size)		
<i>Heavy metals Determination</i>	EU 2001/271 EC	3-10 from <50->500kg	1/16-50t			
<i>Pesticides Determination</i>	Codex	3-10 from <50->500kg	1/15-50t			
<i>Arthropods Detection</i>	DEFRA	3 kg from 3 pts/lorry	1kg/7t			
	Phyto. Certificate	4kg/10 min				
	ISO 6639/C		1kg/t			1 kg

8. GrainPlan

8.1. Objective

The aim of the GrainPlan project was to deliver a user-friendly CD software package to farmers and grain store managers that complements the major activities of the HGCA Grain Sampling and Analysis Project. Using the information contained in the Integrated Grain Store Manager as a foundation the new system was designed to deliver updated information and sampling and risk analysis support within an extendible DESSAC (ADS) compatible graphical software shell.

GrainPlan was designed to include the ability to export records in a standardised format to aid trading and using records of grain moisture and temperature over time to provide a powerful management tool to track the grain's condition during storage. Quality records that are associated with defined grain lots will allow growers to plan and execute sales with improved confidence and reduce the likelihood of rejections and claims at the point of sale. The risk analysis features will provide a real-time means of monitoring grain quality and hence reduce the risk of spoilage and loss associated with moulds, pests and loss of germination. These functions are contained within a graphical user format specifically designed to facilitate user interaction.

The Grainplan software tool contributes directly to the overall GSAP project. This project has identified an annual cost to the cereals industry of £2.5m. This is associated with poor sampling and multiple analyses. By providing a means of recording test data and hence better quality information against which to sell the stored grain Grainplan will help to achieve the saving identified in the parent project. This has become critical with falling commodity prices and profit margins and can represent the difference between profit and loss for growers and merchants alike.

8.2. GrainPlan Version 1

To develop the first version of GrainPlan it was necessary to establish user needs and specific requirements. It was acknowledged that software was being used increasingly on the farm and that this applied almost exclusively to cultivation and did not cover post-harvest activities (storage). To identify user needs a number of forums were run at HGCA workshops during late 2002 where the project leader (a specialist in communications) discussed the outline of GrainPlan and with the help of a number of growers defined their needs and the overall shape of the software. This process continued throughout the life-time of the project and wherever it was possible the software was demonstrated to farmers and feed-back was sought and acted upon.

Version 1 contained the following features:

- The virtual grain store, user configured to his/her farm (see figure 1 below).
- Virtual grain entry. Crop, variety, tonnage, field of origin. (one only), intended use.
- Temperature and moisture monitoring (entry of sensors by 3D graphic).
- Risk analysis and warnings based on grain temperature and moisture.
- Pest trap location and monitoring (entry of traps by 3D graphic).
- Test results entry – associated with each storage location. Ability to add multiple sets of results (different test laboratories).
- Export data to Excel.
- Archive feature.
- Move grain to a different store.
- An encyclopaedia (linked to warnings. Sections: in store operations; pest identifications and management; quality management, safety & strategic advice). See figure 2 below).
- Text sensitive help.
- Web LINKs.

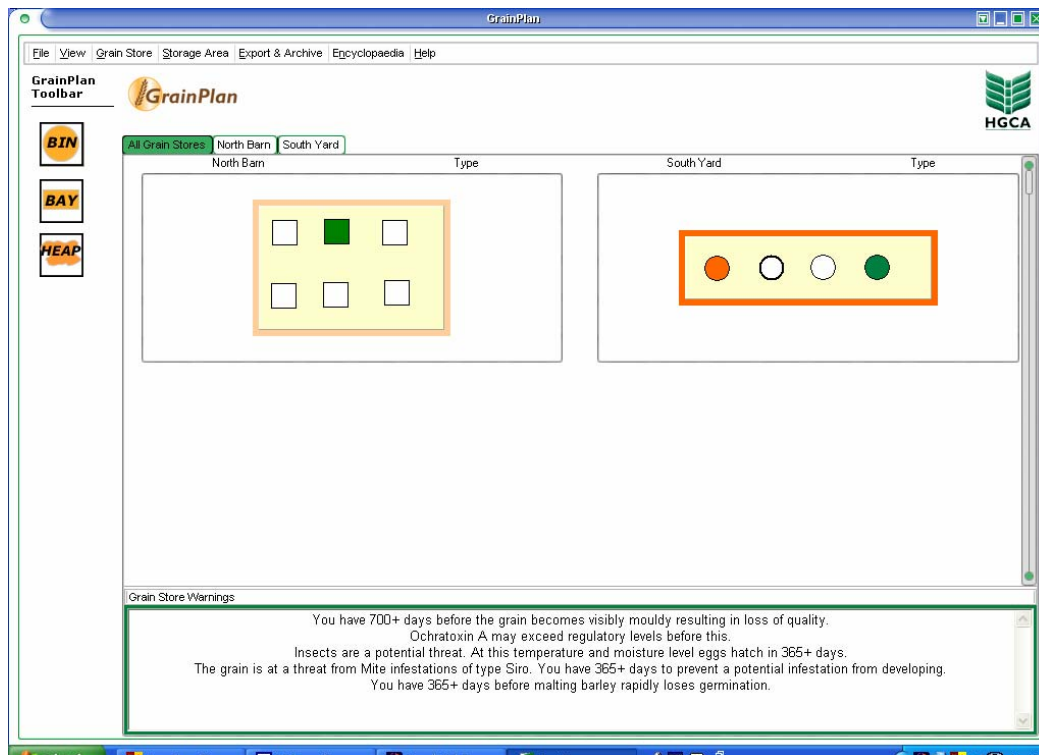


Figure1 – Over view of the main screen in GrainPlan version 1.

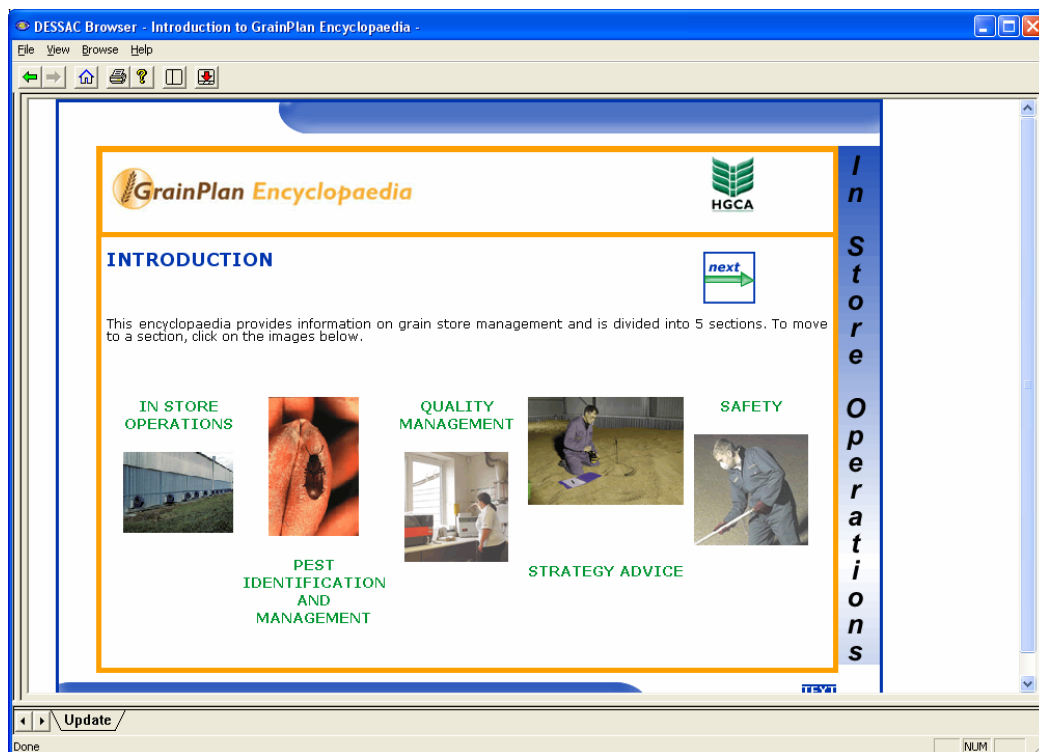


Figure 2. Front page of encyclopaedia.

8.3. GrainPlan Version 2

Although version 1 was accepted enthusiastically by many, like all software it had its shortcomings and these became clear with feedback at the 2004 Grain Management Roadshows when GrainPlan was demonstrated to some 400 growers and agronomists. Their comments were extremely useful when designing version 2. It was emphasised that there was a necessity to ensure that GrainPlan conformed to Assurance Scheme requirements. In addition, a number of features were incorporated to improve the functionality and ease of use. These features are listed below.

New features:

- A number of farms can now be handled (as separate identities).
- Improved store plans - door placement and vertical and horizontal dividers.
- Positioning and monitoring of bait stations on the main screen.
- Store preparation and cleaning (including equipment maintenance & calibration).
- Moisture/temperature probe and trap placement - on screen at the individual grain store level.
- Improved trend graphs for moisture & temperature. Ability to select by storage area, probe, moisture and temperature.
- Revised warning messages. Practical messages. Count-down from date of message generation.
- Grain treatment records.
- Ability to add to a store over a number of days and from a number of fields.
- Grain movement - between storage areas and off farm (sale).
- Reports to conform to Assurance scheme requirement (on screen and printed).
- Note pads linked to individual storage records.
- Data entry by PDA.

We talked at length to Assurance Schemes to make sure that GrainPlan version 2 complies with their requirements and is flexible enough to cope with future requirements. This is seen in the new and revised items listed above.

8.4. Discussion

GrainPlan is widely considered to be a very useful grain store management tool. It goes much further than a simple record keeping system by incorporating the facility to provide warnings and suggested actions. The software will undoubtedly lead to save storage for those who use it. By providing a visual representation of whole farm's grain storage the user can see the storage status at a glance. As each bin or bay or heap has its associated test results, GrainPlan can also be used as a marketing tool, for the user has at their fingertips all the information about every parcel of grain.

GrainPlan integrates the major aspects of the GSAP project by providing a means of managing stored grain and related test data with each identifiable bulk of stored grain. As all the necessary information is held in one place it completes the project by ensuring that the store keeper will always know the characteristics of the grain in store and be able to market the grain accordingly.

8.5. Availability

The GrainPlan CD ROM will be widely distributed but for those who have not received a copy it will be available on request from the HGCA.

9. Information delivery

The outputs of the Grain Sampling and Analysis project has taken a number of forms:

- Press coverage
- Events
- Newsletters
- HGCA reports and a review
- HGCA Guides
- HGCA Posters and information sheets
- CD ROMs.

9.1. Press coverage

9.1.1. Project launch

- Arable Farming, 13th April 2002. Solving the sampling bugbear.
- Farmer's Weekly, 29th March 2002. Sampling project aims to end grain disputes.
- Farmer's Weekly, 7th June 2002. 2 articles. Sampling on entry to gain best results. Tackle rap for sampling squabbles?

9.1.2. Farm Sampling Protocols

- Farmer's Weekly Interactive, 23rd August 2002. Sampling survey gets started
- Darlington & Stockton Times, 6th September 2002. New protocols should help growers.
- Arable Farming, 7th September 2002. Grain sampling. Into-store grain sampling validation under way.
- Farmer's Weekly, 30th August 2002. Photo and caption.
- Farmer's Guardian, 30th August 2003. Store sampling project could lead to more efficient grain marketing
- Crops, 21st September 2002. Testing times

9.1.3. Sampling Workshops

- Farmer's Weekly Interactive, 13th January 2003. Workshops to ease grain pain.
- Farmer's Weekly, 17th January 2003. Cut costs with better sampling.
- Farmer's Weekly, 15th August 2003. Spotlight on south barometer.

9.1.4. Farm Sampling Articles

- Farmer's Weekly, 13th June 2003. Ways to take reliable and robust samples.
- Crops, 19th July 2003. Spot-on samples.
- Crops, 22nd May 2004. Grain Sampling. Quality Control.
- Crops, 11th June 2004. En-users' pledge for GSAP.

9.1.5. GrainPlan Publicity

15 press articles – generated by the launch at Grain 2003 19th/20th November at Stoneleigh Park.

- Darlington & Stockton Times, 24th October 2003. Quality is only key to new grain markets.
- Scottish Farmer, 25 October 2003. Quality needed for exports.
- Western Daily Press (Bristol), 28th October 2003. Get grain gains.
- Western Daily Press (Wiltshire edition), 28th October 2003. Get grain gains.
- Farmer's Weekly, 7th November 2003. 4 articles. New software to launched at Grain 2003. If you can't measure it you can't manage it. GrainPlan. Fingertip management.

- Yorkshire Post, 15th November 2003. Expert help on the best practice for good grain storage.
- Farmer's Weekly, 28th December 2003; 3 articles. Managing records. Software developed by the HGCA. Software for grain storage.
- Farmers Guardian, 28 November 2003. HGCA's software to help manage grain in store.
- Farmer's Weekly, 11 June 2004 Software makes store management easy PC.

9.2. National Cereals Events

- Cereals 2003 Seminar given
- Grain 2003 Press briefing
- Cereals 2004 Press briefing

9.3. HGCA Roadshows

During December 2002 to February 2003, the initial stages of the project and plans for its future activities were presented by the project manager to farmers, merchants and agronomists at 14 HGCA meetings with a total audience of 1451.

From mid January to mid March 2004 the sampling projects and GrainPlan were a major part of a series of 10 Grain Management Roadshows attended by 385 farmers and agronomists.

9.4. Newsletters

The report progress was given in 3 monthly news letters that were placed on the HGCA website. They were also mailed directly to Cereal Liaison Group members.

9.5. HGCA reports

Full reports of all sampling investigations and reviews were published throughout the life of the project. These are HGCA final reports and can be found on the HGCA website at: http://www.hgca.com/cms_publications.output/2/2/Publications/Crop%20Research/Publications%20Search.msp?fn=search Search using sampling as the key word under 'publication title'.

The reports are:

- Report 301. Development and validation of on-farm sampling protocols for collection of marketing (quality) samples at harvest. (incl. annex to cover investigations in 2003).
- Report 325. Developing and validating on-farm sampling protocols: sampling in store and during out-loading.
- Report 339. Grain sampling and assessment: Sampling grain in lorries
- Research review C50. Grain sampling methods to achieve consumer confidence and food safety.

9.6. Guides

- Grain sampling – *a farmer's guide*. Spring 2003. A 24 page booklet explaining grain sampling on-farm with information of purchasers' requirements.
- Grain sampling from field to buyer – *Understanding variation*. Summer 2004. A 12 page booklet summarising the grain sampling projects and detailing the variation that was found and how best to deal with it.

9.7. Posters

- Grain sampling – *on-farm* Spring 2003. Distributed in Crops magazine (26,000 copies)
- Inspecting grain for defects and impurities. Summer 2004. Distributed in Crops magazine (26,000 copies)

9.8. CD ROMs

- Grain sampling – *a farmer's guide*. Spring 2003. Distributed at sampling workshops ~6500
- GrainPlan V1. Spring 2004. A limited edition (2000) used as a development tool.
- Grain Analyst Training – Wheat. Summer 2004.
- Grain Analyst Training – Barley . Summer 2004. Both training CDs were sent to all UK grain testing laboratories.
- Barley pregermination images. Sent to all MAGB and AIC laboratories.
- GrainPlan V2 – to be issued Winter 2004. Anticipated run of £10,000

10. Evaluation – the effects of GSAP

10.1. Sampling presentations and workshops (Dec 2002 to March 2003)

The project manager presented the preliminary findings of the sampling aspects of the project to 1450 attendees at a series of HGCA events during December 2002 through to February 2003. These were, Variety Roadshows (7); Marketing Forums (4), Malting Barley Conferences (2), Topic Breakfast (1), North Eastern Millers group (1) and AICC storage training course (1). The events took place throughout the UK, including Scotland, Northern Ireland and Wales. They were the first opportunity to promote the new sampling techniques to a very wide farmer and trader audience.

Once the on-farm sampling protocols had been developed and tested they were presented to as many farmers as possible so that they could adopt the techniques at harvest 2003. In total, 203 workshops were held during January to March 2003. Five farmer focused organisations were used to provide the training. These were SAC, Morley, ARC, ADAS and CSL. Between them they supplied 31 trainers and covered all parts of the country with a particular emphasis on the major grain growing areas. In all they presented the new sampling protocols to 2230 and all were asked to complete a feedback questionnaire. Each delegate was given a booklet ‘Grain sampling – a farmer’s guide’ which contained not only the new sampling protocols but information on the reasons for good sampling to focus on marketing requirements. The workshops can be considered a considerable success as judged by the summary of the workshop questionnaires (appendix 2).

10.2. Grain sampling CD

In addition to the booklet guide (see 10.1 above and 10.3 below) all attendees of sampling workshops were provided with a CD version of the guide. This contained similar information but showed the new sampling techniques in video clips. So in addition to the printed word growers were able to fully visualise the new techniques.

6000 copies of the CD were printed and in addition to distribution at the sampling training workshops were made available at HGCA events throughout the life of the project. There success can be measured by the fact a number of organisations requested them for educational purposes. These included:

Dick Taylor, Life Sciences Teaching Group, SAC, Aberdeen

Dr Grant Campbell, Satake Centre for Grain Process Engineering, UMIST, Manchester.

10.3. Grain sampling booklet

As referred to in section 10.1 the participants at sampling workshops were provided with the ‘Grain sampling – a farmer’s guide’ booklet. On completion of the workshops in March 2003 distribution of the booklet was extended to all levy payers on the HGCA’s topic sheet mailing list. This ensured that ~10,000 growers received copies and hence there was excellent coverage of the major cereal growers. In addition, there was a very specific request for a number of copies of the booklet. Keith Golesworthy, Senior Trader, UCOS requested (May/June 2003) 200 copies of the Grain sampling booklet so that they could be distributed to their members. Mr Golesworthy stated in his e-mail of 2nd June 2003 “UCOS Ltd had a very successful HGCA seminar in which your colleagues presented the on-farm sampling recommendation and are pleased to promote the benefits for both farmers and traders alike.”

10.4. Grain sampling poster

The elements of the newly developed grain sampling protocols were used to produce a poster that showed in pictorial form the requirements of on-farm sampling. This poster was distributed to growers as an insertion into Crops magazine (26,000 copies). Prior to the 2003 harvest Banks Cargill Agriculture requested 4,000 copies to include in a mailing to all their customers in which they invited them to take their own samples rather than have a company representative visit to sample their grain.

10.5. Wheat Hardness testing

The GSAP Laboratory working party agreed that wheat hardness testing should only be performed using the SKCS scale. Up until this time there had been a number of hardness scales used and none could be shown to have traceability. Most laboratories use NIR to measure hardness. The two major NIR instrument suppliers in the UK were reluctant to promote the SKCS calibrations or sell them to their clients. However, in May 2003 two organisations offered the calibrations to UK grain testing laboratories. Details of the services offered are given in appendix 3. This effectively made a unified approach to UK wheat hardness testing available for the first time.

10.6. Reductions in merchant sampling and the number of UK grain testing labs

Before the project started Glencore Grain had decided to discontinue the practice of sending staff (often students) to farm stores to sample grain which was then returned to their laboratories for testing. They launched a service whereby their clients were provided with printed sample bags which they filled and then sent to a contract laboratory, NRM in Selby. This allowed them to close their existing testing laboratories. However, at this time (harvest 2002) the sampling instructions still relied on taken spear samples from the stored grain. The GSAP on-farm sampling protocols were not available at this time. They reported that sampling in 2003 (when the new sampling protocols were available) was successful and that they will continue with their scheme.

Banks Cargill Agriculture requested Sampling posters (Crops insert of February issue 2003 - 30,000 printed) to send to all their farmer clients along with a faxback form asking them if they wished to have samples taken by Banks Cargill staff or would take their own samples as defined by the GSAP protocol. The uptake on farmer sampling was ~5% and although disappointing it was felt that this was not surprising at this early stage and that numbers should increase in the future.

Feed back from David Houghton, NFUS, was that in Scotland during 2003 harvest on-farm sampling was extensively adopted and seen to be quite successfully. A maltster also confirmed that in Scotland Maltsters expected farmers to sample their own barley and supply the maltings with a sample. Again this was operating successfully in 2003 and barley was supplied to contract in almost all cases.

SGS took on grain testing for Gleadeall Agriculture in 2003. Testing will be done at their Hull Laboratory run by Steve Stokes. The laboratory does not have UKAS accreditation but is TASCC registered. They are likely to look for other contracts next year (2004).

Grain Farmers considered writing to all their clients asking them to take their own samples for harvest 2003. In reality this did not happen as the decision was not made in time for harvest. However, they accepted farm taken samples from clients who took their own samples and they provided sample bags to these clients. They wrote to their clients during summer 2004 to advise them that they should take their own samples according to the protocols given in the HGCA guide 'Grain sampling - a farmer's guide'. They are very strong supporters of the project. They have 5 laboratories (one per store) and they are ISO 9002 accredited. I

suggested they run one 'central lab' to do the difficult tests (Falling Number, germination, gluten) and used just NIR (on the network) for intake and segregation at their stores. In early 2004 they appointed a new laboratory manager who has taken on the role of incorporating the new grain testing standard into their operation and has developed a proficiency testing scheme which will be offered widely.

Allied Grain one of the largest grain trading companies in the UK wrote to their customers in early July 2004 quoting from the HGCA 'Grain Sampling – *a farmers' guide*' "Each year poor grain sampling and analysis cost the industry around £2.5m". This letter specified the points at which to sample and the number of samples to take. These recommendations are essentially those given in the o-n-farm sampling protocols and clients were strongly advised to take their own sample.

10.7. Lorry sampling

nabim accepted the principle of taking multiple samples (8 per 30 tonne lorry load) and although this principle was already part of the 'nabim Recommended Code of Practice for Mill Intake' where it referenced BS 4510 (replaced by ISO 13690) all milling companies were reminded by letter in September or October 2003 that representative samples should be taken and that 8 per load is required.

MAGB confirmed at a CLG meeting (20th October 2003) that their members are required to sample lorries to the IOB method which in essence is ISO 13690 and hence requires that 8 samples be taken.

AIC – have undertaken to include sampling requirements into TASCSC codes of practice. The Cereal Liaison Group (1st April 2004) discussed the possibility of producing a Cereal Industry lorry sampling Code of Practice. It was recognised that nabim and MAGB already had one. AIC still needed to devise one. The three trade organisations undertook to consider the development of a single industry code and the project manager was asked to co-ordinate the preparation of this code. A draft was distributed in May 2004 just before the end of the project. This is included in outline in the HGCA report on lorry sampling (Report 339) and appendix 1.

The lorry sampling project demonstrated that ISO 13690 'Cereals, pulses and milled products – Sampling of static batches' cannot be followed in practice. This standard is due for review (or revision) and findings from GSAP will contribute to the revision of this standard.

10.8. Laboratory Harmonisation

Details of the grain testing schemes by industry sector are given in section 5.3.

The UK grain testing standard was developed throughout 2003 and early 2004. During the latter stages drafts were sent to nabim, MAGB and AIC for comment. The standard was accepted in principle by nabim in July 2003. Shortly afterwards in September 2003 nabim published on its web site its scheme protocol for the 'nabim Standard for intake laboratories'. In addition to the scheme the names of participating companies (at site level) were also placed on the website. nabim first made their scheme public at the HGCA Milling Conference in May 2003. This proficiency scheme is run on behalf of the milling industry by CCFRA and meets all the requirements of the project. In 2004 nabim indicated that their scheme would be offered to non-nabim members and hence became widely available.

Although AIC (UKASTA) previously published (on their website) a list of TASCSC registered laboratories they were part of an overall register that also included storage and haulage

providers. In discussion with AIC the project manager suggested separating the registers and making modifications to the format. During September 2003 AIC had separated their Laboratory, Storage and Haulage lists so that it became possible to see all companies that are TASCSC registered for laboratory services along with their certification numbers and dates on a single list.

The TASCSC laboratory working party recognised that the system in place in 2003 did not guarantee that laboratories on the TASCSC register were operating to the necessary standard of testing. In particular it was recognised that few laboratories participated in proficiency schemes and hence could not demonstrate the standards to which they tested. The discussions with AIC culminated in a number of questions to which Jeremy Smith (AIC secretary) replied. These are included in section 5.3.1.1. The outcome is a revised AIC Code of Practice for the Laboratory Analysis of Combinable Crops which incorporates new requirements for Internal Quality Control (IQC) and Proficiency Testing and operating to the testing standard defined by this project. In addition, AIC have decided that all laboratories will be audited (verified) by a single company. Hitherto 7 companies had been involved. This will ensure that all laboratories are assessed to the same set of guidelines. The Code will be published on 1st July 2004 and it will require a full calendar year before all laboratories have been audited and a complete register can be compiled.

As the requirement for proficiency testing (PT) has been increased it has become necessary for AIC members to join PT schemes. At least two companies have set up PT schemes that were offered to AIC members. They are Larkwhistle Laboratory Services, a subsidiary of Grainfarmers and Banks Cargill Agriculture. AIC will maintain a list of organisations operating recognised PT schemes.

The MAGB does not operate its own PT scheme but many MAGB members participate in the Malting Analyte Proficiency scheme (MAPS) run by the Laboratory of the Government Chemist (LGC). However, this was not known to those outside the scheme and hence the standard to which maltsters were testing was not visible. MAGB announced at the Cereal Liaison Group meeting (Monday 8th December 2003) that they would put a list of Companies (by site) who participate in MAPS on the MAGB website. This happened in June 2004 and in addition to the participating laboratories, the MAGB website included pages on intake laboratory operation and MAPS.

At the meeting on 1st April 2004 the Cereal Liaison Group discussed the concept of producing a Cereals Industry Code of Practice for Laboratory testing. This goes beyond the aims of this project but undoubtedly shows the change in attitude of the industry and the willingness to work closely together to solve problems like the reduction in the number of rejections. It is anticipated that a working party will be established to address this initiative.

10.9. Analysts' training

To support the new developed grain testing standard it was necessary to provide training. This was made available in the form of two CD ROMs, one covering wheat testing and the other barley testing. Hence for the first time all those who test grain for the purposes of trade had the same training material thereby increasing the likelihood of all operating to the same (high) standard. The CDs were endorsed and distributed by the trade organisations with a very strong recommendation to use them. In fact, AIC have written into their Code of Practice a requirement to study the training modules and answer the test questions. These will become part of an analyst's training and be subject to audit.

Feedback from laboratories regarding the CDs was extremely positive. One letter from Plasmore (Lowestoft) Ltd., to AIC contained the following paragraph. "On a related issue to the above: the discs you sent through with the latter dated June 2004 are extremely helpful

and will be used on this site for training as suggested. If you have a response system to the HGCA then please note out response is very, very positive.”

A further message was received from Greencore Malting Group as follows “I received your pack and letter this morning; fabulous. The discs are a tremendous success and (I know) will be used by the industry. Similarly the A4 sheets on defects are the best I've seen and represent the definitive collection of photos IMO. I know the scope of the project got re-moulded somewhat at the start but I wish to congratulate you on achieving such a high quality output. At recent MAGB Technical Committee and Exec Committee meetings the project output received nothing but positive feedback.”

In addition a number of phone calls have been received with congratulatory comments these include, Allied Mills, Grainfarmers plc. and Soufflet Grain Terminal Ltd and Gleadell Agriculture Ltd.

10.10. Pregermination workshop

During the evolution of the analyst's training material it became apparent that there was no definition of pregerminated barley and no official test and hence little agreement between laboratories. As maltsters may reject or discount barley that contains grains that exhibit pregermination it was decided that a way of recognising pregermination was required. MAGB in collaboration with AIC held a workshop to define pre-germination of malting barley. The workshop was run to establish how to test for pre-germination by the tetrazolium and fluorescein dibutyrate methods. The project provided a professional photographer to record images of the stained grains so that all had a record of 'agreed' pre-germination. The photographs and descriptions are available from both MAGB and AIC and will be used by the maltsters as the basis for developing an EBC method.

10.11. Summary

The many aspects of this project were needed to improve the trading of UK grain. One part on its own would not have brought about any substantial measure of success. Although the project has provided a huge body of information to growers traders and end users the greatest change during the time span of the project has been one that has led to a culture change. Not only has the enthusiasm for the various parts of the project increased as it progressed but the demand for information in an easily digestible form has also increased. The final publication 'Grain sampling from field to end user – understanding variation' was received with enthusiasm and the realisation that although grain is inherently variable it can be sampled effectively if the new guidelines are followed.

At the start of the project although there were a number of grain testing schemes in operation some were completely invisible and others not of the necessary standard. This project has changed this completely. Now all the major sectors have declared their schemes and participants so that anyone who trades grain can now make objective decisions about who they wish to test their products or even those with whom they wish to trade. This will undoubtedly lead to increased confidence by both sellers and buyers. In addition, the description of variation associated with both sampling and testing is now visible and will allow considered discussion on specifications and even contracts to be undertaken.

Each of the features discussed above are major contributors to improved grain trading and over the following years will reduce the level of conflict and rejections.

During the time frame of the project it has not been possible to quantify the exact reduction in either merchant sampling or rejections on delivery. Section 10.5 above gives a very strong indication that there is a trend to increased on-farm sampling and hence reduced merchant sampling. It is only over a number of years that factual data will be produced by AIC members and hence the financial contribution can be fully assessed.

An assessment of the effect on rejections is already underway. The flour millers conducted a survey covering harvest year 2001/02 and will be repeating this for 2003/04. MAGB will conduct a survey for harvest year 2003/04 and subsequent years. As both nabim and MAGB have undertaken to conduct these surveys and report the findings to the Cereal Liaison Group and measure of success will be available to the whole cereal industry in future years.

10.12. Financial savings.

It is not possible to quantify the exact number of growers who have moved to on-farm sampling but the above information suggests that there is a strong move in that direction and that over time the level of farmer sampling will increase. This trend is likely to accelerate as the confidence in testing increases.

Feedback from sampling workshops in 2003 indicated that 93.8% of attendees would adopt the on farm sampling protocols. Also, three of the major trading companies, dealing with about 40% of UK grain, have already recommended that their farmer customers take their own grain samples. Based on an average 20m tonnes of UK grain traded annually, and assuming a conservative estimate of 25% uptake of on farm sampling by the farmer customers of just these 3 companies, in the harvest year 2004 some 10% of the UK grain tonnage will be sampled on farm.

In 2002 at the start of this project it was estimated that merchants sampled approximately 100,000 grain batches of ~200t. With 10% of samples now taken on farm there will be a reduction in the total number of merchant sampling events by 10,000. As the cost of sample collection ~£3 per sample then the saving to the cereals industry is £30,000 in year one. This is likely to increase significantly in subsequent years. Moreover as confidence in the system grows fewer replicate samples will be taken and the number of analyses will be reduced with an associated cost saving of about £50,000 for each 10% reduction in samples tested.

It is too early to give an exact figure for the value of reduced rejections but with the new analytical standards, analysts training and inspections sheets and poster coupled with improved sampling it is likely that rejections will fall by at least 15% of their current level. Assuming milling and malting premiums at £20 per tonne (as at August 2004) this is equates to £1.26m/annum based on return haulage costs and loss of premium.

11. Recommendations

There are three aspects to potential future activities arising from GSAP.

1. Surveillance activities that will measure the uptake of new sampling protocols and the compliance to testing requirements.
2. Further sampling and analysis development activities. The Cereal Liaison Group needs to consider how or whether to take these forward.
3. Routine maintenance activities.

11.1. Surveillance activities

11.1.1. Sampling

Review the uptake of on-farm sampling protocols by farmers and merchants. This could be achieved by an annual request to AIC members after harvest each year (say November). This should ask for the % of clients that sample their own grain and submit samples for testing by post/courier/collection. Comparison of yearly data will give a measure of the uptake of farm sampling. If required this could be taken further to review the level of 'harvest testing' undertaken by AIC members. This is a more complicated area and might be seen to be commercially sensitive. The practical way to measure the reduction in 'harvest testing' would be to generate an index of samples tested to tonnes sold.

Lorry sampling. Assuming recommendations for lorry sampling have been issued, some measure of uptake/compliance will be needed. This is in effect a measure of compliance with industry codes of practice and requires some method of surveillance by the relevant trade organisations.

11.1.2. Analysis

Assuming that each trade association publishes a register of laboratories that partake in ring tests and that the ring test scheme protocols are also published, then a mechanism to check on the veracity of the registers is required. This could take the form of random spot checks on a % of laboratories per year to ensure that the schemes are working. Feed-back should be to the laboratories that are audited, the relevant trade association and the CLG (in that order). This will require a qualified, independent auditor to visit, assess and report on the laboratories audited each year. Funding will be required to fulfil this. Assuming 1 day/audit, ½day reporting, plus travel expenses, this will require ~£600/site ($1.5 \times £350 + £75$).

Alternatively, a paper audit of proficiency schemes and registers to ensure that they are current and accurate. This will require an element of interview discussion with scheme administrators. Objective: to determine that the proficiency schemes are still operating as they were at the end of the GSAP project. Use an independent assessor and make sure this is a two way process so that the schemes (trade assoc) can comment and give feedback to HGCA.

11.2. Reduction in rejections (and discounts)

Measure % rejections (by sector) on an annual basis to ascertain the value of the GSAP project. Trade Associations to survey their members and report to the CLG.

11.3. Future developments

11.3.1. Application of GSAP principles to other combinable crops

The principles established in GSAP for Wheat and Barley could be extended to other combinable crops. Sampling requirements may well be different but the principles derived for testing are applicable. Training for analysts on tests specific to pulses and oilseed will need to be written.

11.3.2. Coverage of all cereal trading sectors

With respect to analysis the project has concentrated on the milling, malting and merchant sectors. The feed compound and export sectors have not been fully covered. Those that are members of AIC and conform to the TASCC assurance principles are covered but this does not necessary include them all.

11.3.3. Support for smaller companies (testing laboratories)

Some company laboratories may not have achieved the necessary standard of laboratory testing within the time frame of the project. A support mechanism should be established to help them achieve the required standard.

11.3.4. New trading contracts

The GSAP project has produced a wealth of real data on both sampling and analysis and this could be used to review contracts and help devise a contract that is suitable for the whole cereal chain.

11.3.5. Sampling at loading (of lorries)

Consider the value of taking samples as lorries are loaded. This means that such samples must be agreed as having a recognised status. In order for this to be possible a simple automatic sampling device is required. A prototype has been developed and tested.

11.4. Routine Maintenance

11.4.1. Web site

Checks on links to Trade Association sites (visibility of registers and protocols) will be required periodically.

11.4.2. GrainPlan

Maintenance by GCAL may be required. This will cover software issues. We would expect storage issues to be dealt with by CSL.

12. Acknowledgements

This project could not have reached its successful conclusion without the help and cooperation of a large number of organisation, businesses and individuals.

Thanks must go to the Cereal Liaison Group who realised the need for the project and had the foresight to ask Alan Almond (HGCA, Business Development Director) to produce the proposal and present this to Invest to Save (ISB).

My colleagues at HGCA have added considerably to the project throughout its course. They are too numerous for me to mention them all but particular thanks go to Roger Williams, Graham Jellis, Julian Bell and Colin Nunn who formed the project management team. Their help and guidance was invaluable. I must also mention the events team, in particular Zoe Uddgren, for arranging and managing the Grain Management Roadshow held in January to March 2004.

12.1. Sampling projects

The four sampling projects were performed by Robin Wilkin, John Knight and Jane Rivett. There were required to travel widely throughout the UK and work under difficult conditions to produce the high quality data that has allowed them to give a full description of grain sampling and for the first time record the variability that is associated with grain and sampling. However, they would not been able to do this without the help and cooperation of many farmers, maltsters, millers and traders. Special mention goes to the following: Andrew Cragg, Jim Knipe, High and Cliff Jaques, Stuart Somerscales, Paul Strawson, Mr T Robinson, Mr R Tennant, Robin Symthe, Colin Meredith, Philip Bunn, George Marriage, David Green, Peter Jones, Paul Molyneux, Shaun Taylor, Nicky Lockey, Holly Gurley, Alan Johnson, John Halifax and Mark Charlton.

12.2. Farmer training

12.2.1. Workshops

The farmer sampling training was undertaken by 5 organisations who between them supplied 31 trainers who delivered the training at 203 workshops in England, Scotland Wales and Northern Ireland during January to March 2003. My grateful thanks go to the 31 individuals who delivered the training and especially to the five individuals who oversaw the arrangements and training delivery, there are: Graham Brookes (Morley Consultants), Tim Mayhew (ARC), Ken Wildey (CSL), Jim Miller (SAC) and Andrew Wells (ADAS Consulting).

12.2.2. Sampling CD ROM

The farmer sampling training was supported by a CD ROM entitled Grain Sampling – *a farmer's guide*'. My thanks go to Ian Damms of Stile Media for producing the CD and to those who help and took part in its making: Sue salmon (CCFRA), Julian Wiseman (University of Nottingham, Sutton Bonnington), John MacDonald (Coors Brewers), James Peck (Peck Contracting), Rob Heygate (Heygates Flour Mills), Nigel Berriman (Charles Jackson & Co) and Julian Bell (HGCA).

Grain Sampling – *a farmer's guide* was also produced in booklet form. Sue Salmon, Julian Wiseman and Denise Baxter are thanked for their contributions. I also thank Clive Edwards (HGCA) and Geoff Dodgson (Chamberlain Partnerships) for editing and producing this publication.

12.3. Grain Testing Standard

The development of a standard for grain testing and analyst's training material would not have been possible without the help of the members of the Laboratory Working Party. My sincere thanks go to Sue Salmon (CCFRA/nabim), Martin Albertini (Tini Tec), Gillian Fisher (BRi), Bruce Johnson (Greencore Malting Group/MAGB), Nicky Lockey (Banks Cargill Agriculture/AIC), Jeremy Smith (GAFTA), Chris Prevett (RPA), Paul Ibbott (NFU).

12.3.1. Grain Analyst Training CD ROMs

Special thanks goes to Sue, Martin and Gillian for writing the training modules and additional help was provided by Phil Ashton (Muntons plc). The training was provided as a CD ROM and again Ian Damms of Stile Media is thanked for his help in making this. CCFRA, and Greencore Malting Group are thanked for kindly allowed us to film on their premises to provide video clips for insertion into the training package. Alan Davidson of Stills is thanked for his patience whilst photographing grain samples, defects and foreign matter.

12.4. GrainPlan

The development of the GrainPlan software was made possible by the hard work of the team made up of Caroline Parker, Julie Shields, Angela Moran, Simon McConnell (Glasgow Caledonia University), Jon Knight (Imperial College, London), David Armitage and Dean Cook (CSL) Robin Wilkin (Consultant) and Roger Williams (HGCA).

12.5. HGCA publications and posters

Geoff Dodgson of Chamberlain Partnerships and Clive Edwards (HGCA) are thanked for all their hard work in producing the 2 booklet guides, posters and information sheets. Susan Salmon, Denise Baxter and Julian Wiseman kindly wrote sections for Grain sampling - *a farmer's guide*, whereas Geoff and Clive assembled Grain sampling from field to buyer – *Understanding variation* from a miscellany of reports, notes and presentations. They are also thanked for producing the posters and visual identification sheets.

12.6. Trade Organisations

I received much help and cooperation from a number of trade bodies. In particular I would like to thank, Alex Waugh and Damian Testa of nabim; Ivor Murrell and Peter Milne of MAGB; Jeremy Smith and John Kelley of AIC (formerly UKASTA) and Paul Ibbot, Peter Kendall and Arthur Hill of the NFU.

12.7. Funding

Last but not least my thanks to HM treasury Invest to Save Budget (ISB) for providing 75% of the funding that allowed this project to take place.

13. Appendix 1

13.1. Sampling protocols

Sampling protocol - ex trailer

The aim of taking a sample or series of samples is to give a fair representation of a batch or bulk to allow assessment of quality, value and storage potential. Sampling grain going into store is not a substitute for sampling during storage.

Equipment

Keep equipment clean and only use for sampling and storing grain samples.

Samplers

- Pelican sampler
- 1litre plastic jug
- A sampling spear (to collect about 750g grain from one or several insertions). Preferably use a multi-aperture spear that can be opened and closed by the operator to collect from several depths at each insertion.

Containers

- 10 litre or larger plastic drums, boxes or tubs with lids.
- Sample bags of about 1kg capacity – which can be effectively sealed and labelled.

Establish a system to relate samples to specific bins of grain or sections of a bulk store. Number bins and paint bay numbers on the walls of floor stores. Indicate these numbers on the site plan.

Collecting samples

Collect a sample of about 1kg from the tailgate as trailers tip in the store. If trailer tips through a hatch in the tailgate, a jug or pelican can be used. If the whole tailgate is opened, only use the pelican. It may be safer to collect a sample from the tipped heap with a sample spear.

Technical details

Sweep a plastic jug or pelican sampler across the flow of grain from the trailer, so as to cut the stream of grain. Remove the jug or pelican as soon as full. Sample in a consistent manner. Avoid the first or last parts of the load.

Sample the grain after tipping by inserting the spear and removing a sample(s), from at least three positions.

Empty the jug, pelican or spear into a plastic container. Check for moisture content and temperature of some grain from each individual sample first, if this container is being used to build up a composite sample. Blend composite samples thoroughly before sub-sampling.

Testing

Measure the moisture content of each sample to give guidance on intake moisture and the need for drying.

If the meter uses a large, un-ground sample, tip the grain back into the main sample after testing. Measure the temperature of the grain to indicate the need for in-store cooling.

Frequency of sampling

Storage potential

Assess samples from sufficient incoming loads for moisture and temperature to allow proper decisions to be made about drying and cooling. This may mean testing every load as moistures will often change during the day.

Commercial sample

Produce one composite sample to represent each bin or each identified section or bay within a bulk store.

Start a new composite sample whenever moving to a new part of the store or taking grain from a different field.

Make up at least one composite sample for each 50 tonnes of grain irrespective of bin or bay size.

Samples best representing commercial value are made up from sub-samples taken as every trailer enters the store. Sub-sampling frequency depends upon the intake variability.

Sample handling

Label the container holding the composite sample clearly outside and inside. Make sure that the sample can be related to an identifiable batch of grain in the store (bin or section of a store). Make sure that the labels correspond to the site plan. .

Close the container with a lid that will prevent rodent access, stop contamination by dust or other grain and minimise moisture loss.

If grain in the store is moved, amend the site plan and ensure that the sample label still corresponds to the correct batch of grain. Moving the grain may also present an ideal time to re-sample and produce new composite samples.

Store the containers in the grain store under the same conditions as the grain they represent.

Sample storage

Samples with a moisture content of >14.5% may deteriorate long-term storage; those with high moisture contents will go mouldy. Dry those with moisture content >14% by spreading thinly on a tray in a warm dry room for 24 – 48 hours and label as “dried”. Alternatively, samples of wet grain analysis without delay.

Extracting commercial samples

Mix the composite sample thoroughly before extracting any samples for buyers

After mixing, tip the grain onto a clean plastic sheet and divide up using a clean board into halves, quarters and eights, until the correct amount is obtained for the buyer's sample.

Carefully remove all of the buyer's sample (about 1kg) from the sheet, including all the fine material and transfer to a plastic bag.

Seal and label the bag.

It is worth measuring the moisture of this sample as, by doing so, as comparison between the farm and merchant's moisture meter will be obtained.

Labelling

Label information for composite samples should include::

- Date of collection
- Variety
- Moisture content(s)
- Location of grain represented by the sample: e.g. Bin 3, or Shed 1, left bay 2.

Labels on buyer's samples should include:

- Farm address and any other identity codes
- Quality scheme membership Number (attach an assurance scheme identity sticker to the sample bag)
- Location of grain represented by the sample (it must be possible for the buyer to be able to identify the location of the batch of grain covered by the sample. In some cases this may differ from the farm office address)
- Date of harvest
- Tonnes represented by sample
- Variety
- Moisture content

Safety

There are risks associated with the collection of samples. Assess the risks involved with specific tasks and locations, and take steps to minimise them.

Specific risks include:

- working near moving equipment
- conveying equipment – augers and elevators – **must be guarded**
- being engulfed by grain – **never stand or walk on moving grain**
- grain dust – **wear a dust mask**
- grain pits - **must be covered with a protective grill**

When handling treated grain, personal protective clothing must be worn, e.g. gloves and masks.

Working at the back of trailers during tipping can be dangerous because of the risk of being hit by the swinging tailgate or by being engulfed by grain. Only approach the rear of the trailer if it is safe to do so. Always ensure that the trailer driver knows the sampler is present, especially when the trailer has a hydraulic tailgate.

Sampling protocol

- ex-high-temperature drier



The aim of taking a sample or series of samples is to give a fair representation of a batch or bulk to allow assessment of quality, value and storage potential. Sampling grain going into store is not a substitute for sampling during storage.

Equipment

Keep equipment clean and only use for sampling and storing grain samples.

Samplers

- Pelican sampler
- 1litre plastic jug
- A sampling spear (to collect about 750g grain from one or several insertions). Preferably use a multi-aperture spear that can be opened and closed by the operator to collect from several depths at each insertion.
- Diverter sampler inserted permanently into drier input and output flows.

Containers

- 10 litre or larger plastic drums, boxes or tubs with lids.
- Sample bags of about 1kg capacity – which can be effectively sealed and labelled.

Establish a system to relate samples to specific bins of grain or sections of a bulk store. Number bins and paint bay numbers on the walls of floor stores. Indicate these numbers on the site plan.

Collecting samples

Sample collection site depends upon facilities. Options include drier outflow, conveyor discharge or point of grain discharge into bin or floor store. Use samples collected as grain enters drier to assess drier performance. The best and safest option is a permanent diverter sampler in the drier flow.

Technical details

Sweep a plastic jug or pelican sampler across the flow of grain from either conveyor or spout, so as to cut the stream of grain. Remove the jug or pelican as soon as full. Sample in a consistent manner.

Sample the grain after tipping by inserting the spear and removing a sample(s), from at least three positions.

Empty the jug, pelican or spear into a plastic container. Check for moisture content and temperature of some grain from each individual sample first, if this container is being used to build up a composite sample. Blend composite samples thoroughly before sub-sampling.

If using a diverter sampler, allow the grain to fall directly into a plastic container. Collect sub-samples at regular intervals and measure moisture content and temperature.

Frequency of sampling

Sampling frequency depends on drier type, whether batch or continuous flow.

Storage potential:

Measure temperature and moisture content of samples regularly. Base sampling frequency on grain moisture content before drying. Sample grain several times if moisture content varies within the bulk pre-drying.

Commercial sample:

The best samples to represent commercial value compromise many sub-samples taken at relatively short intervals as grain is discharged from the drier.

For batch driers, collect several samples (at least 1/t of grain in the drier) as the dried batch is discharged.

Combine samples from several batches into a single composite sample, provided the grain represented by the sample is stored in an identified section of the store.

Produce one composite sample to represent each bin or each identified section or bay within a bulk store.

Start a new composite sample whenever moving to a new part of the store or taking grain from a different field.

Make up at least one composite for each 50 tonnes of grain irrespective of bin or bay size.

Sample handling

Label the container holding the composite sample clearly outside and inside. Make sure that the sample can be related to an identifiable batch of grain in the store (bin or section of a store). Make sure that the labels correspond to the site plan. .

Close the container with a lid that will prevent rodent access, stop contamination by dust or other grain and minimise moisture loss.

If grain in the store is moved, amend the site plan and ensure that the sample label still corresponds to the correct batch of grain. Moving the grain may also present an ideal time to re-sample and produce new composite samples.

Store the containers in the grain store under the same conditions as the grain they represent.

Extracting commercial samples

Mix the composite sample thoroughly before extracting any samples for buyers

After mixing, tip the grain onto a clean plastic sheet and divide up using a clean board into halves, quarters and eights, until the correct amount is obtained for the buyer's sample.

Carefully remove all of the buyer's sample (about 1 kg) from the sheet, including all the fine material and transfer to a plastic bag.

Seal and label the bag.

It is worth measuring the moisture of this sample as, by doing so, as comparison between the farm and merchant's moisture meter will be obtained

Labelling

Label information for composite samples should include:

- Date of collection
- Variety
- Moisture content(s)
- Location of grain represented by the sample: e.g. Bin 3, or Shed 1, left bay 2.

Labels on buyer's samples should include:

- Farm address and any other identity codes
- Quality scheme membership Number (attach an assurance scheme identity sticker to the sample bag)

- Location of grain represented by the sample (it must be possible for the buyer to be able to identify the location of the batch of grain covered by the sample. In some cases this may differ from the farm office address)
- Date of harvest
- Tonnes represented by sample
- Variety
- Moisture content

Safety

There are risks associated with the collection of samples. Assess the risks involved with specific tasks and locations, and take steps to minimise them.

Specific risks include:

- working near moving equipment
- conveying equipment – augers and elevators – **must be guarded**
- being engulfed by grain – **never stand or walk on moving grain**
- drier exhaust fumes
- grain dust – **wear a dust mask**

When handling treated grain, personal protective clothing must be worn, e.g. gloves and masks.

Sampling Protocol

-ex lorries



Introduction

This protocol is intended to offer advice to any organisation that samples grain in lorries. It is not intended as dogmatic instructions that can be applied at every site and there may be a need for some flexibility in approach. However, if used, the guidelines will help to minimise sampling error and provide a consistent method of collecting samples from lorry-loads of grain.

The aim of the Protocol is to provide a composite sample that will give a better than 90% chance of representing the mean values of the various properties of the load. However, it should be recognised that screenings (fine material) are very difficult to estimate and that the error of estimation may be larger for this than for other properties.

Grain in bulk is variable and commercially significant variation does occur within a lorry. Poor sampling means that the properties of the grain will be over- or under-estimated. The variability within a load is random so the location of sample points is of less importance than the number of samples collected.

General

- All equipment should be clean and in good working condition.
- Operators should be familiar with the equipment and have an understanding of the problems of sampling grain.
- Safety should always be the first consideration in any sampling operation.

Taking manual samples

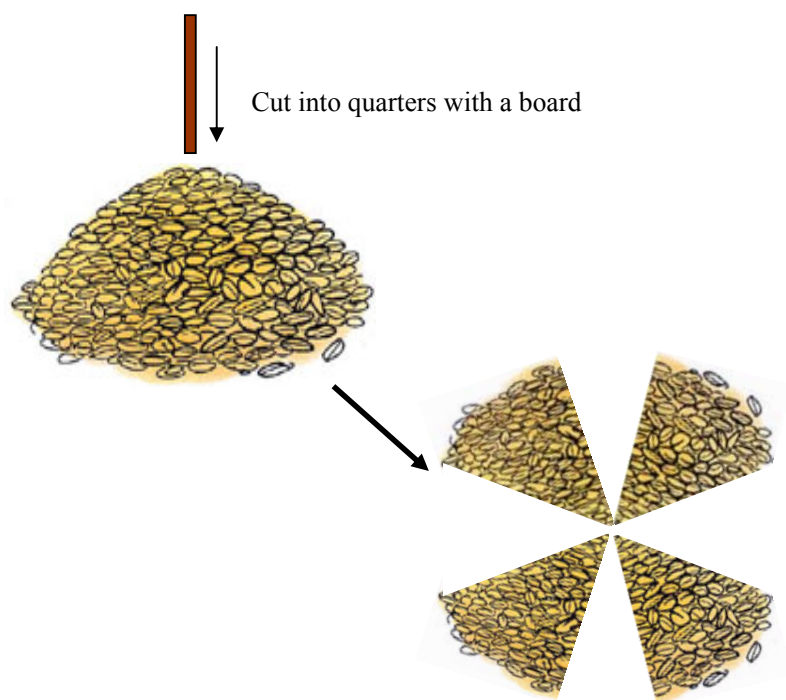
- Use a manual spear that is at least 1.5m long.
- Use a spear that will collect multiple sub-samples from different depths.
- Collect about 500g/sample point. This may require 2 insertions/sample point.
- Collect samples from at least 5 (preferably 8) sample points/load. These points should be spread as widely as possible across the load without risk to the operator. In some cases, it may be appropriate to move the lorry to give better access.
- Add the samples together to form a composite sample representing the load.
- Mix the composite sample thoroughly.
- Divide the composite sample with a sample divider. If this is not available the sample should be divided by coning and quartering to give a working sample. Failure to use a sample divider or to cone and quarter the sample is likely to increase the error in the measurements (particularly screenings).
- It may be appropriate to retain part of the composite sample in case of any dispute over the grain quality.

Taking samples with a remote sampling probe

- Where the amount of grain collected per insertion can be adjusted, it may be appropriate to set this to maximum. This will help to overcome the collection of small samples when the spear is inserted into troughs in the load. The aim is to collect at least 500g/sample point.
 - Try to ensure that the lorry is positioned with the sampler about half way along the trailer so that it can access as much of the load as possible.
 - If the sampler has an automatic programme, choose the option that collects 8 samples from different points.
 - If the probe is controlled manually, collect 8 samples/load from different points spread as far apart as possible over the load. Two lines of 4 samples is acceptable, preferably with sample points not directly opposite each other.
 - Mix the composite sample thoroughly and then divide using a sample divider or by coning and quartering. Failure to use a sample divider or to cone and quarter the sample is likely to increase the error in the measurements (particularly screenings).
 - It is best practice to retain part of the composite sample in case of any dispute over the grain quality
-

Coning and quartering.

Pour the mixed composite sample into a heap



14. Appendix 2

Evaluation of GSAP Sampling Workshops January to March 2003

A series of workshops were run during January to March 2003 to passing on the on-farm sampling protocols to as many farmers as possible.

The workshops were run by staff members of SAC, Morley Consulting, ARC, ADAS and CSL. The 32 trainers were provided with a full package of information, a sampling spear, and booklets and pelican samplers to distribute. The workshops were local events with ~15 invitees per event. The turnout was strongly influenced by weather. In Scotland two events were cancelled due to bad weather and in Southern England good weather in March appears to have reduced uptake.

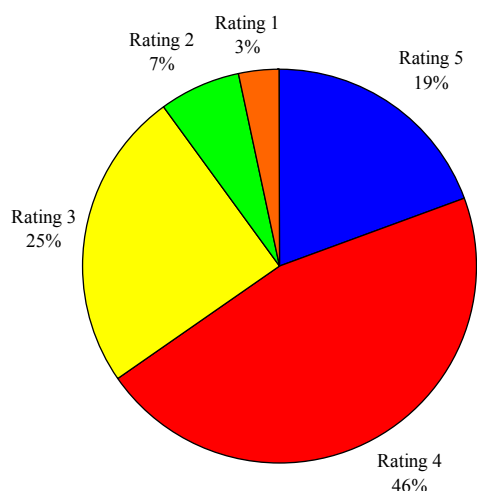
In total 203 workshops were run and some 2230 attended.

All attendees were asked to complete a feedback form that asked them to rate the event on a scale of 1 to 5 (5 being the highest score). The questioned asked were:

- Did you find the workshop useful and informative?
- Do you understand the need for representative sampling?
- Was the session the right length?
- Did the presenter run a good session?
- Would you recommend others to attend this event?
- Was the booklet provided useful?
- Will you use the CD as supportive information?

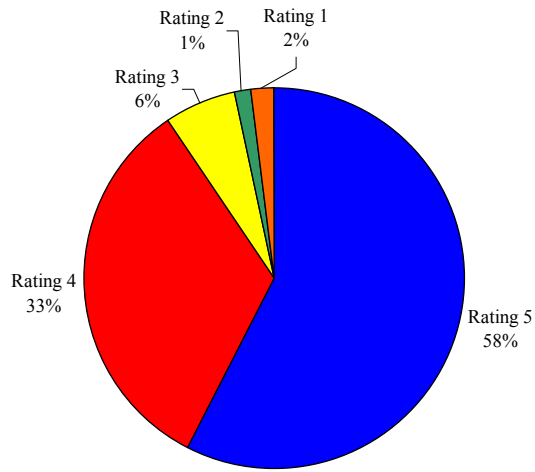
The overall results are shown below:

Did you find the workshop useful and informative?



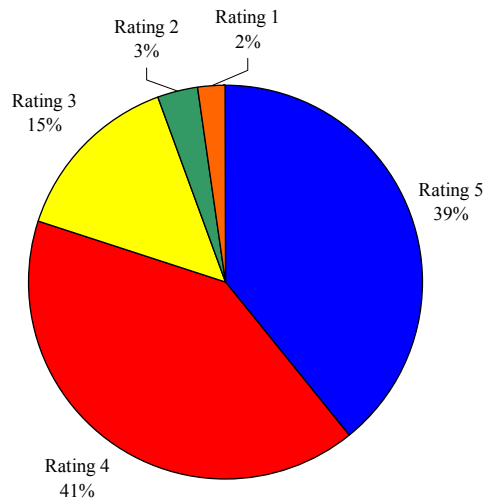
90% of attendees found the workshops useful (score of 3 or higher) with 65% finding them very useful.

Do you understand the need for representative sampling?



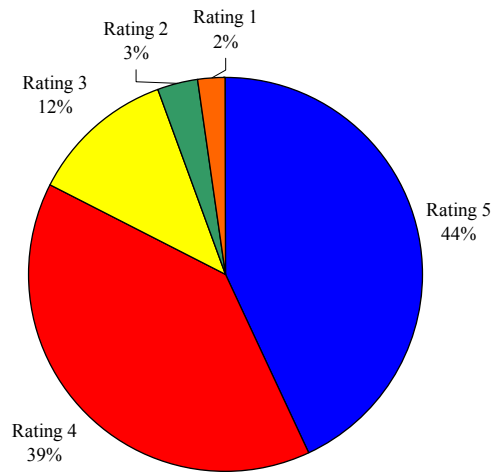
Fortunately the vast majority have a very clear understanding of the need for representative sampling with 91% in the top two categories.

Was the session the right length?



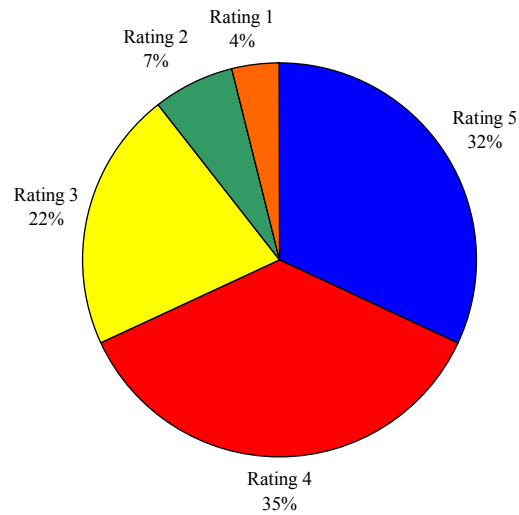
The workshops generally ran for one and a half to two hours, often with quite a long discussion period. This seems to have satisfied the majority of those who attended with only 5% not happy.

Did the presenter run a good session?



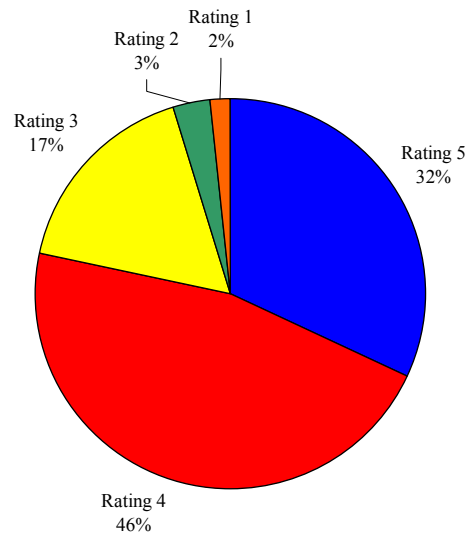
Only 5% were not happy with the workshops with 83% in the top 2 categories. Hence it appears that overall the level and content of the workshops was about right.

Would you recommend others to attend this event?



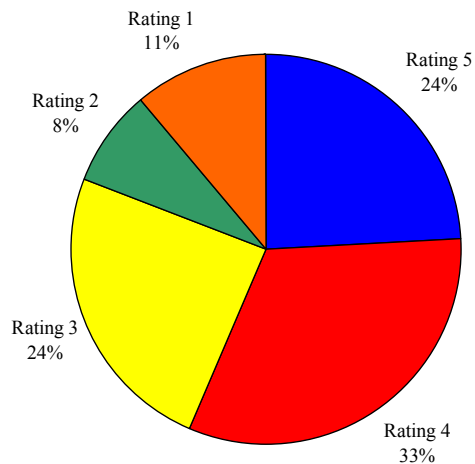
Assuming that the top three categories indicate the likelihood of recommendation to other then 89% of those who attended would do so.

Was the booklet provided useful?



Booklets were distributed at the end of the workshops and hence participants did not have much time to look at it. Only 5% felt that the booklet would not be useful.

Will you use the CD as supportive information?



Unfortunately the CD was not available whilst the courses were being run. So this question really focuses on whether participants are likely to use the CD that was produced to accompany the workshops. The responses were encouraging with 81% likely to use it.

Information about uptake and rejections and claims

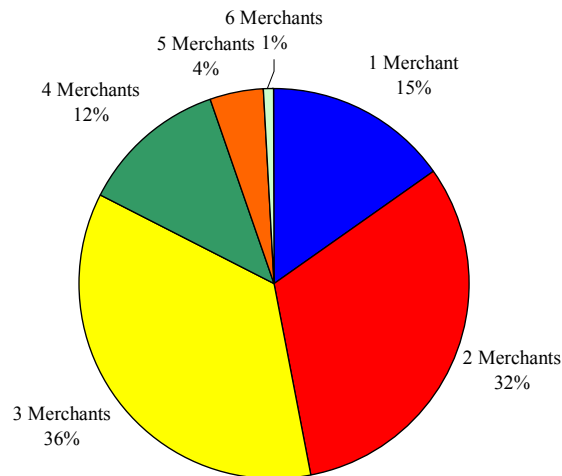
In addition to the above questions designed to assess the value of the workshops we took the opportunity to explore attitudes to sampling and ascertain information about the levels of rejections and claims.

We asked:

- Will you implement the protocols next harvest?
- Will you use a merchant to take samples?
- If yes, how many merchants/traders will you ask to take samples?
- What % of loads were rejected in 2001/02?
 1. Wheat
 2. Barley
- What % of loads subject to claims in 2001/02?
 1. Wheat
 2. Barley

Obviously the participants had very little time to reflect on whether or not to adopt the new protocols for the 2003 harvest yet 93.8% said that they would do so. However, this did not mean that they were ready to abandon the more traditional route and 72.7% said that they would continue to use merchants to sample their grain.

Number of Merchants to sample



There are still some 5% who propose to ask 5 or more merchants to sample their grain. The most popular numbers were 2 (32%) and 3 (36%)

The analysis of rejection and claims levels is based on positive entries only. In many cases no information was given. For rejections only 17.3% (wheat) and 9.5% (barley) gave numbers. For claims the entries were 40.2% (wheat) and 19.1% (barley). It is not clear whether those who did not reply were total free from rejections and claims. Therefore, the results can only be presented based on the numbers given (excluding the nil returns).

Rejections % (of those who had rejections)

Wheat	3.9%	
Barley	6.4%	with Scotland having a 11.2 % rejection rate

Claims % (of those who had claims)

Wheat	12.0%	Scotland 44%
Barley	20.6%	Scotland 20.6%

These results must be treated with caution as it is not possible to say whether those who left this answer blank had no problems. In addition, the results for Scotland are based on very few numbers when compared with the overall data.

15. Appendix 3

Hardness testing – Calibration services.

Two UK laboratories offered calibration service for NIR/SKCS in May 2003

They were:

1. Allied Technical Centre
2. Campden and Chorleywood Food Research Association

The flyers offering this service are shown below:



Is your NIR calibrated for SKCS this harvest?



(The new industry standard for
measuring wheat hardness)

20th May 2003

For a long time now, Plant Breeders, Merchants and Millers have measured wheat grain hardness by numerous methods of which some referenced back to the Stenvert method. Perten Instruments developed the Single Kernel Characterisation System (SKCS), initially for the US Crop Inspection Service to provide an objective method to assess wheat. This technique takes typically 300 individual grains and apart from weighing each grain, measuring the breadth and determining the moisture, it assigns a hardness value following crushing between a set of jaws/rollers which records a crushing force profile. This technique is more meaningful for the industry and has a scale from 1-100.

From work carried out over the past two years, the UK Millers have adopted the SKCS hardness method as the reference technique as from harvest 2003. It is very unlikely that every laboratory in the UK will purchase a SKCS instrument, but we (Central Laboratories) can supply you with calibrations for your NIR instrument derived from samples tested on a SKCS Instrument by our sister company Allied Technical Centre.

Get to know the new values

	Soft wheat					Hard wheat				
SKCS	10	20	30	40	50	60	70	80	90	100
Stenvert	1	2	3	4	5	6	7			>7

Specman: SKCS NIR Calibration statistics

Instrument type	Wholegrain samples		Ground samples	
	SEC	RQS	SEC	RQS
Monochromator	5.74	0.89	3.6	0.97
19 Filter Instruments	6.4	0.91	4.6	0.97
11 Filter instruments	N/A	N/A	4.8	0.96

Specman SKCS includes:

A visit by an NIR specialist to install the calibration and give support as well as reference samples for calibration checking.

£495 plus VAT
(valid till 31st December 2003)

Interested in getting up to speed before harvest?

Then contact Chris Woodley at Central Laboratories, Banbury
Phone 01295 222700
e-mail cwoodley@cental-labs.co.uk

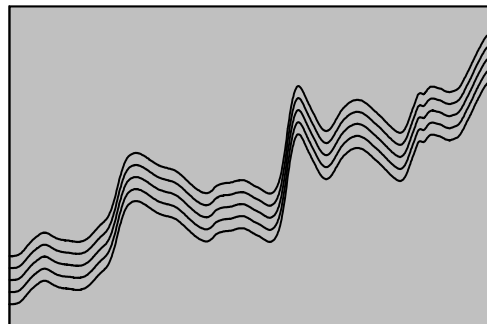
1. New NIR wheat hardness calibration based on reference Single Kernel Characterisation System (SKCS) measurements.

Wheat hardness is measured at intake to check compliance with contract and assess suitability for end-use. The UK milling industry has adopted a new reference for wheat hardness, namely “**Determination of the Hardness Index of Wheat using the Perten Single Kernel Characterisation System**” (Flour Testing Working Group Method No. 22¹).

From September 2003, this method will form the basis of UK wheat trade. A new NIR calibration has been developed at CCFRA on behalf of **nabim** members and is now offered for sale to the UK cereals industry. SKCS based hardness measurement has also been recommended by the HGCA’s Grain Sampling & Analysis Laboratory Working Party in an attempt to harmonise methodology for this key intake test. The use of a single, validated calibration will provide benefits to the entire cereal chain by improving supplier-customer agreement and ensuring that a common scale (SKCS Hardness Index) is used across the industry.

The calibration is based on SKCS reference measurement of over 300 samples covering UK, EU and Third Country wheat and providing a wide range of Hardness Index values. Users should enter the calibration constants into their instrument and use the supplied set of check samples to adjust the instrument to give the correct results.

COST: £250 plus VAT (for calibration constants and check samples)



I wish to purchase the New CCFRA/**nabim** NIR SKCS calibration plus a set of check samples.
I certify that this calibration will only be used on the instrument identified below:

Purchaser Details:

Surname (Dr/Mr/Mrs/Miss/Ms) Initials

Position Company

Address

.....

.....

Tel Fax

e-mail

NIR Instrument make and model.....

Serial No.

Subscription rate: £250.00 plus VAT for 2003 calibration (CCFRA ref XXXXX)

Method of Payment:

☐ Payment enclosed for £..... (Please make cheques payable in sterling to CCFRA Technology Ltd)

☐ Please send me an invoice. Our order number is

☐ I wish to pay by Visa/Mastercard/Delta/Switch/Access. Card No.....

Card Valid from to (expiry date)

Signed

Please post or fax the completed form to:

Mrs Lynda Bromley
Campden & Chorleywood Food Research Association
Chipping Campden, Glos. GL55 6LD, UK.

Tel +44(0)1386 842130. Fax +44 (0)1386 842100 E-mail: l.bromley@campden.co.uk