



PROJECT REPORT No. 118

**THE COLLECTION OF
SAMPLES OF GRAIN: AN
ASSESSMENT OF CURRENT
METHODS AND PROBLEMS**

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**THE COLLECTION OF SAMPLES OF GRAIN:
AN ASSESSMENT OF CURRENT METHODS
AND PROBLEMS**

by

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SUMMARY

This report summarises the collection of information about grain sampling practices used by farmers, storekeepers and end users of grain. The objectives were:

- To obtain information on current grain sampling practices and the equipment used
- To record the views of participants on the reliability of such methods and the acceptability of the results.
- To present the information to a panel of representatives from the main interested parties
- To use the information collected in conjunction with the views of the panel to highlight problems with the current methods and propose research to overcome these problems.

One hundred and forty completed questionnaires covering all areas of the industry were returned. The bulk of sampling is done to ascertain grain quality and to monitor for storage problems. There appears to be little standardisation in the methods used to sample grain both from lorries and within stores. There is much less variation in the equipment used with hand spears, hand scoops, vacuum samplers and automatic lorry probes being the most common types. Most operators sampled from a variety of positions and depths within a bulk of grain with a few sampling only from a single depth.

Most respondents were satisfied with the accuracy of their own sampling but less confident in those of their suppliers and purchasers. A large proportion of replies indicated that disagreements over results was common although serious disagreement was rare.

Different commodities presented different sampling problems with peas and beans proving to be the most difficult. The detection of pests and the measurement of moisture were identified as the two most difficult quality tests to carry out. More than a quarter of all respondents felt that they did not have sufficient information on sampling.

As a result of discussions with the panel, a number of possible options for further research and development on grain sampling were suggested.

1. INTRODUCTION

Most decisions and calculations made in the trading of grain use an assessment of grain quality based on the examination of a sample. Therefore, it is of fundamental importance that a reliable and accurate method of determining grain quality is available to both buyers and sellers. Essential components in the determination of grain quality are the collection and examination of samples. The method by which these samples are collected, and the intrinsic variability of grain, mean that sampling errors could cause apparent differences to be detected in a range of quality assessments from any given load.

A review of sampling practices, along with a preliminary investigation into the relative efficiencies of different sampling devices, was conducted in 1989 under a grant provided by the HGCA (Project Report No. 34, An assessment of methods of sampling bulk grain). The conclusions of this report were, that little or no experimental work had been conducted on sampling procedures, and that errors resulting from differences in sampling could lead to variation in the estimates of grain quality.

The existing British Standard, BS4510, derived from International Standard, IS950, has not been validated scientifically and is not applicable to modern practices at either commercial store or farm level. The result is that the standard method may be interpreted loosely, perhaps giving rise to variation in the results obtained by different users. An investigation into lorry sampling techniques currently used in the UK was completed in 1993 (Project Report No. 79, An assessment of practical methods of collecting samples from lorry-loads of grain). The conclusion of the report, based on limited experimental data, was that the development and implementation of a simplified sampling procedure was feasible and could assist in ensuring better agreement between parties than at present.

A further proposal for research on sampling was submitted to the HGCA by Imperial College of London University with the aim of collecting information about current practices and completing a proper validation of the earlier work. The opinion of the R&D Committee was that this project should be divided into two parts and the collection of data on current practices should be completed before any experimental work was undertaken. This report covers the first part of the work done by a team from Imperial College, in which information about grain sampling practices was sought from farmers, storekeepers and end users of grain.

Unusually for an HGCA research project, this work has been carried out in close co-operation with groups from the cereals industry. A loose steering and advisory committee has been established with input from The National Farmers Union, The National Farmers Union of Scotland, The Grain and Feed Trades Association, The National Association of British and Irish Millers, The Maltsters Association of Great Britain, UNISTOCK, British Poultry Meat Federation and the United Kingdom Agricultural Supply Trade Association.

2. EXPERIMENTAL DETAILS

2.1 Objectives

To collect information regarding the equipment and methods currently used at farm and commercial grain stores to sample bulk grain.

To collate the information collected and to report the findings to a meeting attended by representatives of all the main parties interested in the estimation of grain quality.

To take account of both the information collected and the views expressed at the meeting to formulate a research programme to address current and future sampling needs.

To bring together the recommendations in the form of a project proposal for submission to the HGCA.

2.2 Approaches

There were limited options available for the collection of data and it was decided that the only sensible approach was to circulate a questionnaire as widely as possible throughout all sections of the cereal industry.

As a first step, a range of organisations was contacted and given details of the project. Of those contacted the following groups indicated that they wished to be involved with the project:

The National Farmers Union,
The National Farmers Union of Scotland,
The Grain and Feed Trades Association,
The National Association of British and Irish Millers,
The Maltsters Association of Great Britain,
UNISTOCK,
The British Poultry Meat Federation,
The United Kingdom Agricultural Supply Trade Association.

A draft form was produced covering the key items of grain sampling such as size of operation, equipment and methods used, and problems encountered. Following circulation of the draft to nominees of the above organisations, a final questionnaire was produced (see Appendix 1).

Approximately 600 questionnaires were circulated to producers, storers, traders and end users of grain. This was done mostly by supplying batches of forms to the various organisations involved, who then passed on the questionnaires as was considered appropriate. The time of distribution was rather variable so that completed questionnaires were returned over a 2-month period.

By the beginning of June, 142 completed questionnaires had been returned and collation and analysis was started. The first priority was to produce a brief summary of the key data and to circulate this to the nominated members of the key organisations involved in the project as a precursor to an assessment meeting. A more comprehensive assessment was then carried out and the comments and views of those participating at the meeting were incorporated into this report.

3. DATA PROVIDED BY THE QUESTIONNAIRES

3.1 Results of collation and analysis

Of the 142 forms, only two had been completed incorrectly. Data from 140 were extracted onto a Quattro Pro spreadsheet to allow totals, means and other statistics to be extracted. A summary of the main data is given in Appendix 2.

The initial examination of the raw data suggested that a disproportionate number of millers and maltsters had responded compared to farmers. However, this is a subjective judgment as the forms were not identifiable to individuals. The respondents were broken down into categories according to the numbers of tonnes sampled per year, giving the following list:

0 - 1,000	19
1,000 - 5,000	33
5,000 - 20,000	8
20,000 - 100,000	40
100,000 - 1 million	28
1 million +	7

These data are displayed graphically in Figure 1. The responses to each of the questions are given for all the respondents and broken down by each of the above groups.

In general the smaller the store the greater the proportion of sampling done in store. This probably reflects the fact that most of the small stores are on farm (Fig. 2). The primary reason for sampling was for assessment of grain quality followed closely by checking for storage problems with the larger stores showing a greater interest in the variability within a load (Fig.3).

Assessment of the sampling methods used suggests that there is little standardisation. More than 50% of respondents used their own methods, with the IOB method being the most widely used "standard" method (25%), this method only being adopted widely in the 20 - 100 thousand tonne per year group. Only 17% of the total used the ISO method (see Fig. 4). Even when a standard method was used there was considerable variation in, for example, the number of sample points per lorry, the total amount of grain collected and the amount examined (Table 1).

There was less variation in the equipment used to sample lorries than for grain in store. Hand spears, hand scoops, vacuum samplers and automatic lorry probes were the most common types of equipment and the vast majority of store sampling was done with a hand spear or hand scoop (see Figs 5 and 6). Hand sampling was more common in the smaller stores than in the larger ones as might be expected. When lorries were sampled, a core collected throughout the load was the most popular approach at the stores handling large quantities of grain whilst smaller

Figure 1 Distribution of quantity of grain sampled per annum

Tonnes

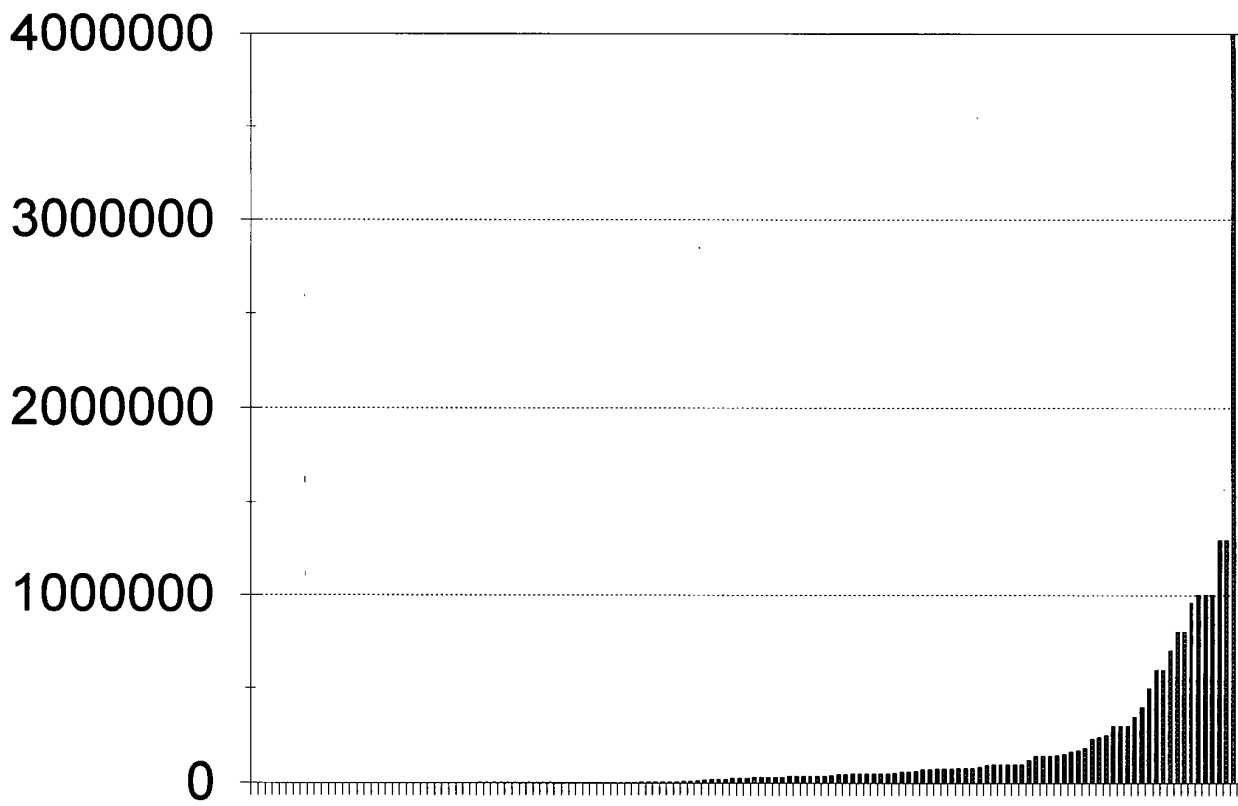


Figure 2. Location of sampling a) percentage figures for all returns b) split by quantity of grain sampled per annum

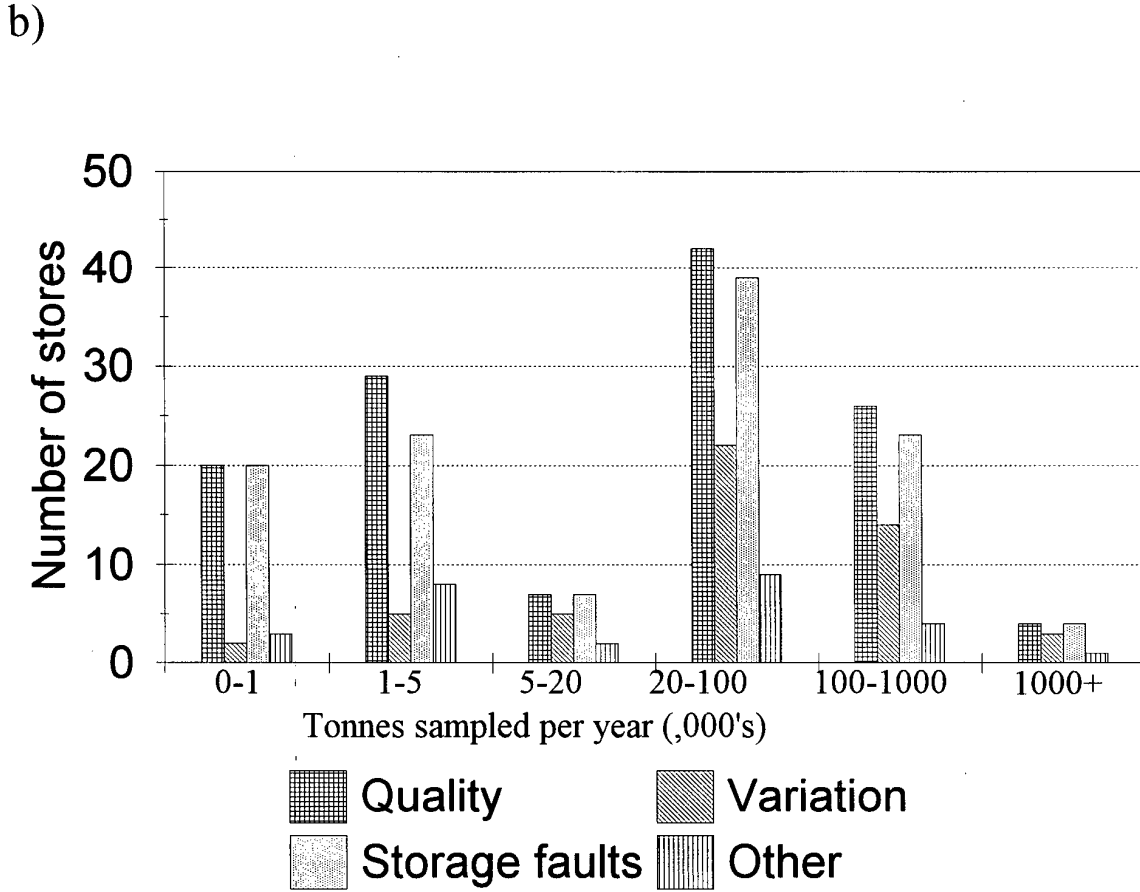
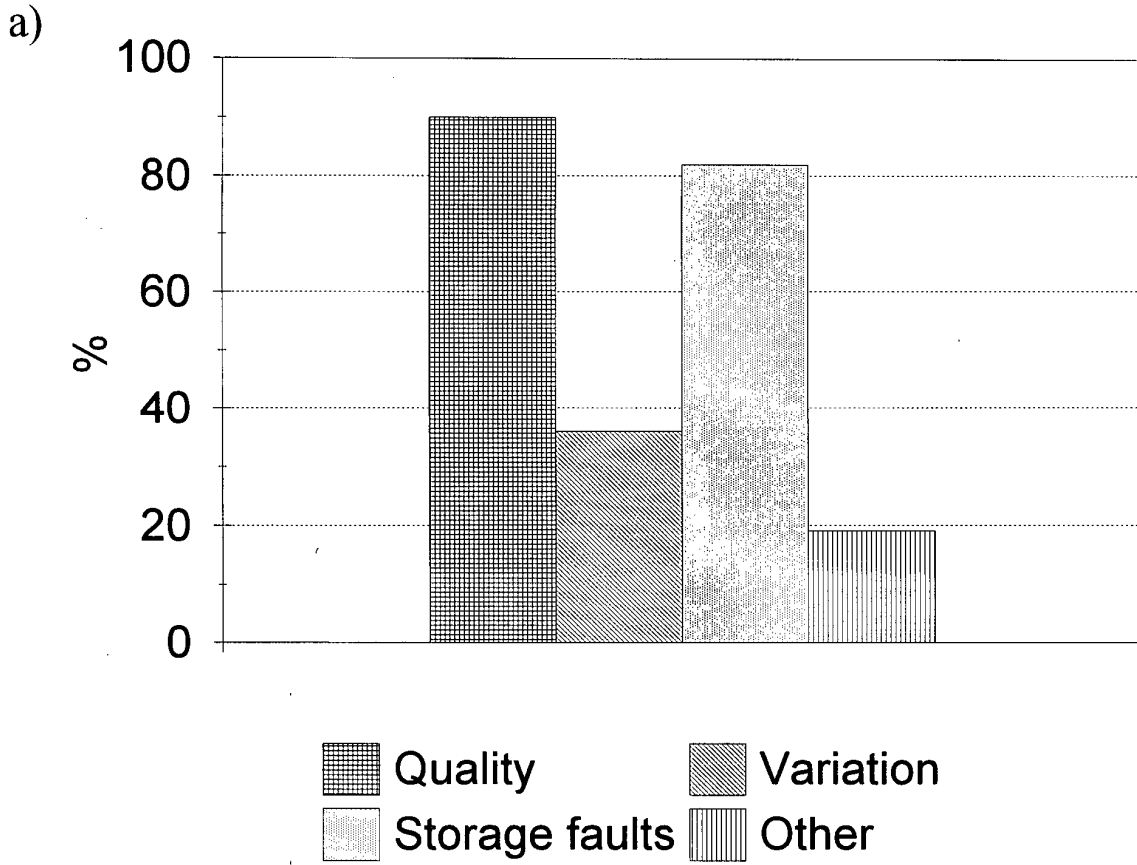


Figure 3. Reasons for sampling grain a) percentage figures for all returns b) split by quantity of grain sampled per annum

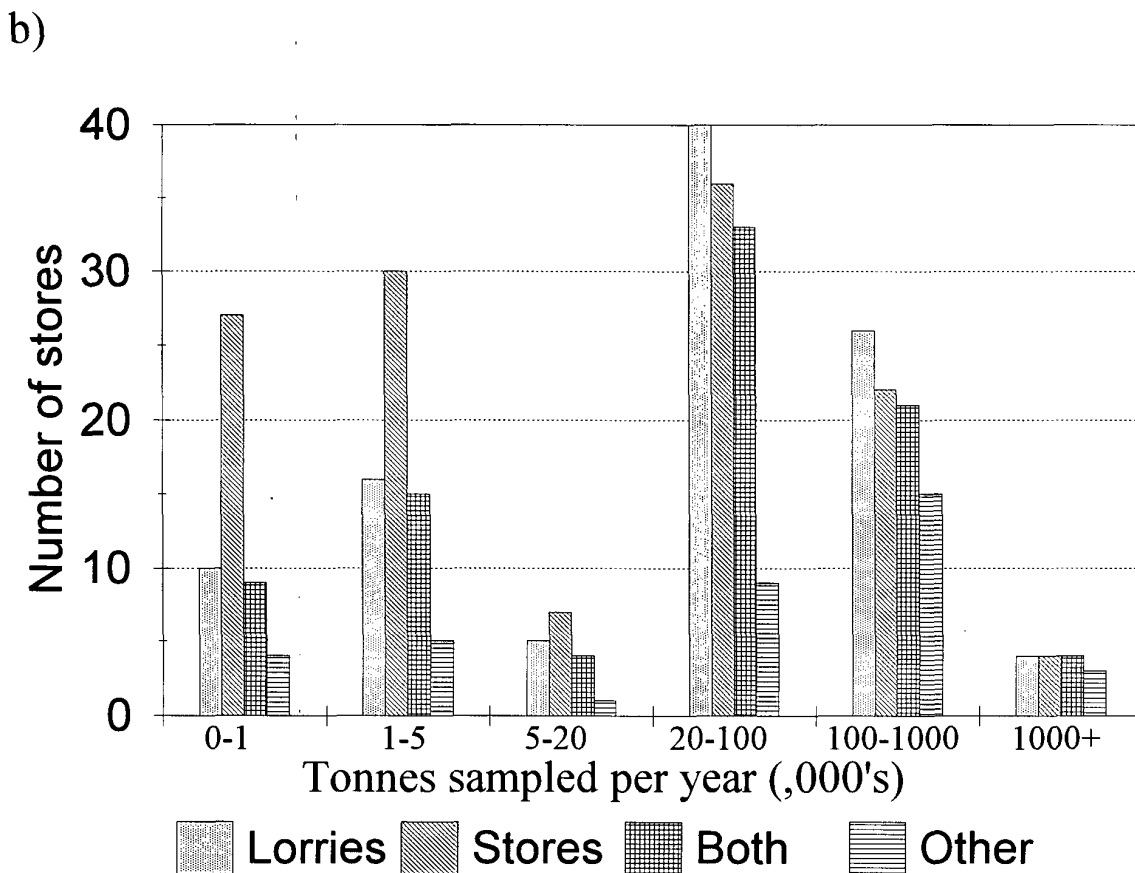
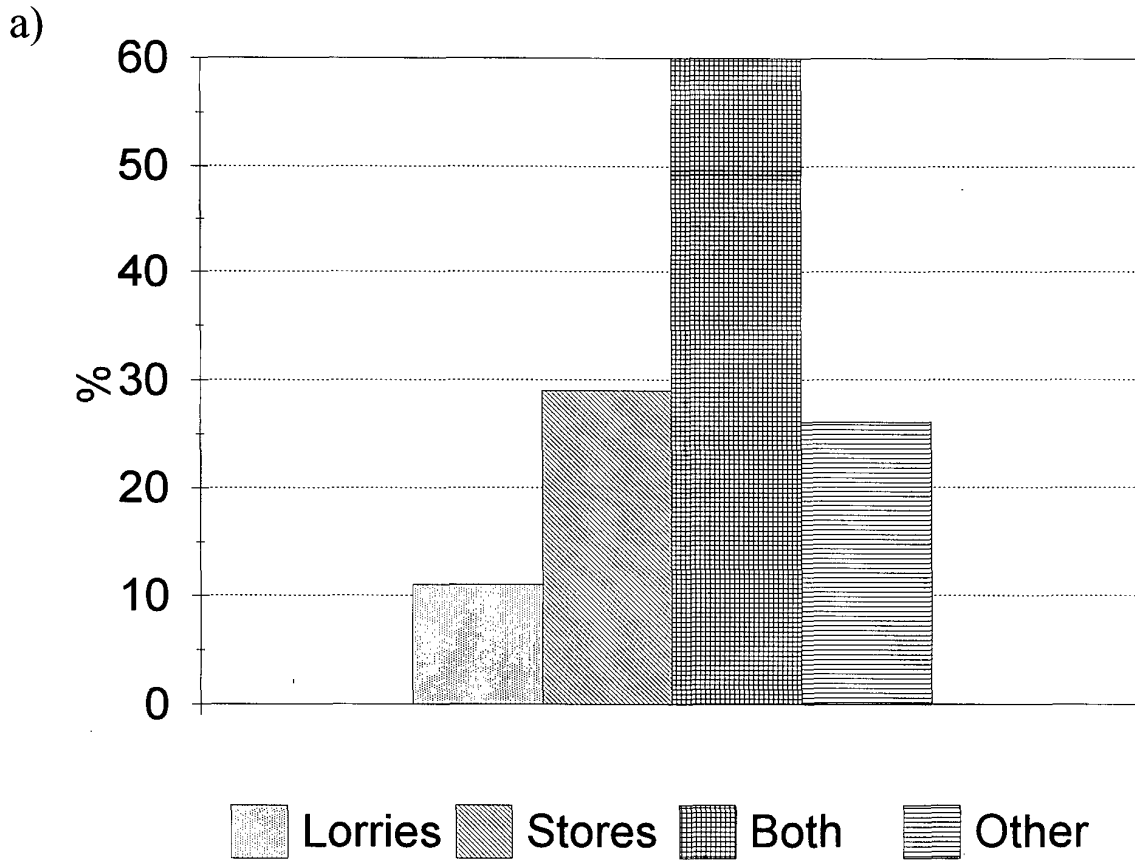


Figure 4. Sampling method used a) percentage figures for all returns b) split by quantity of grain sampled per annum

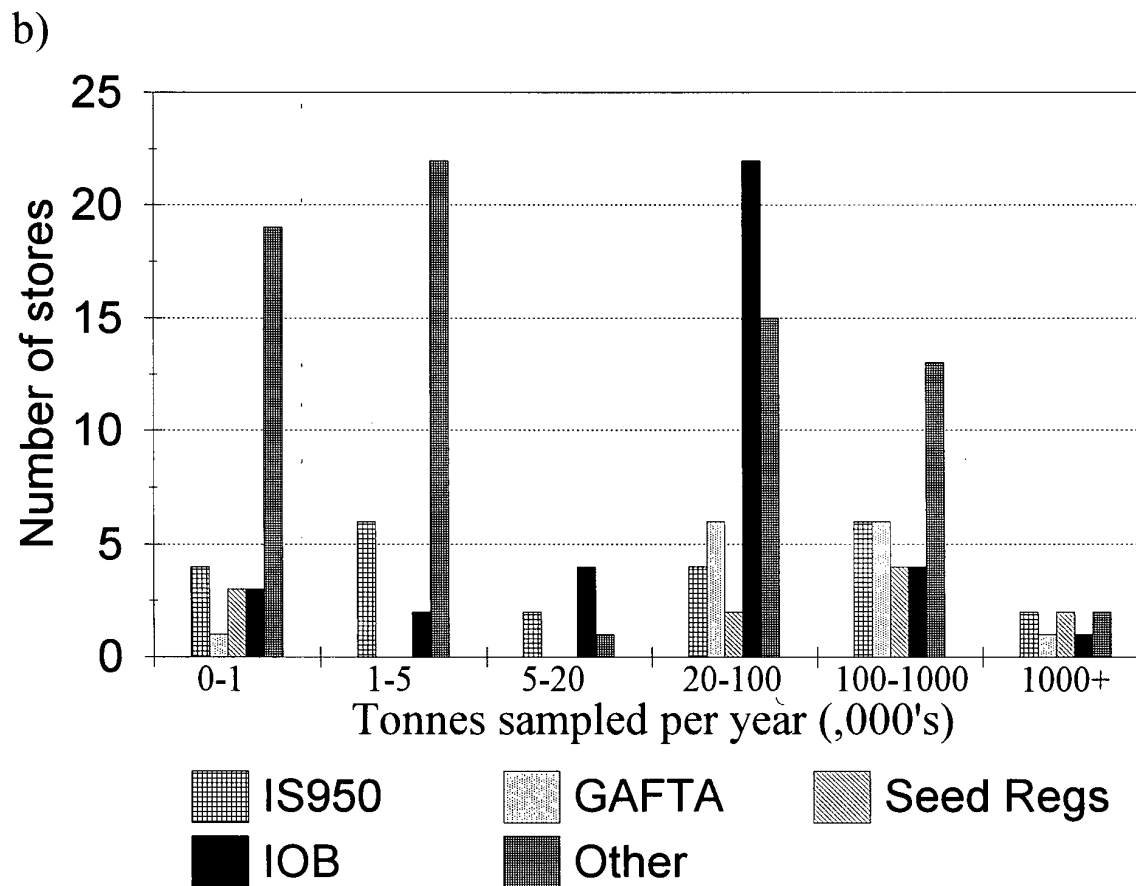
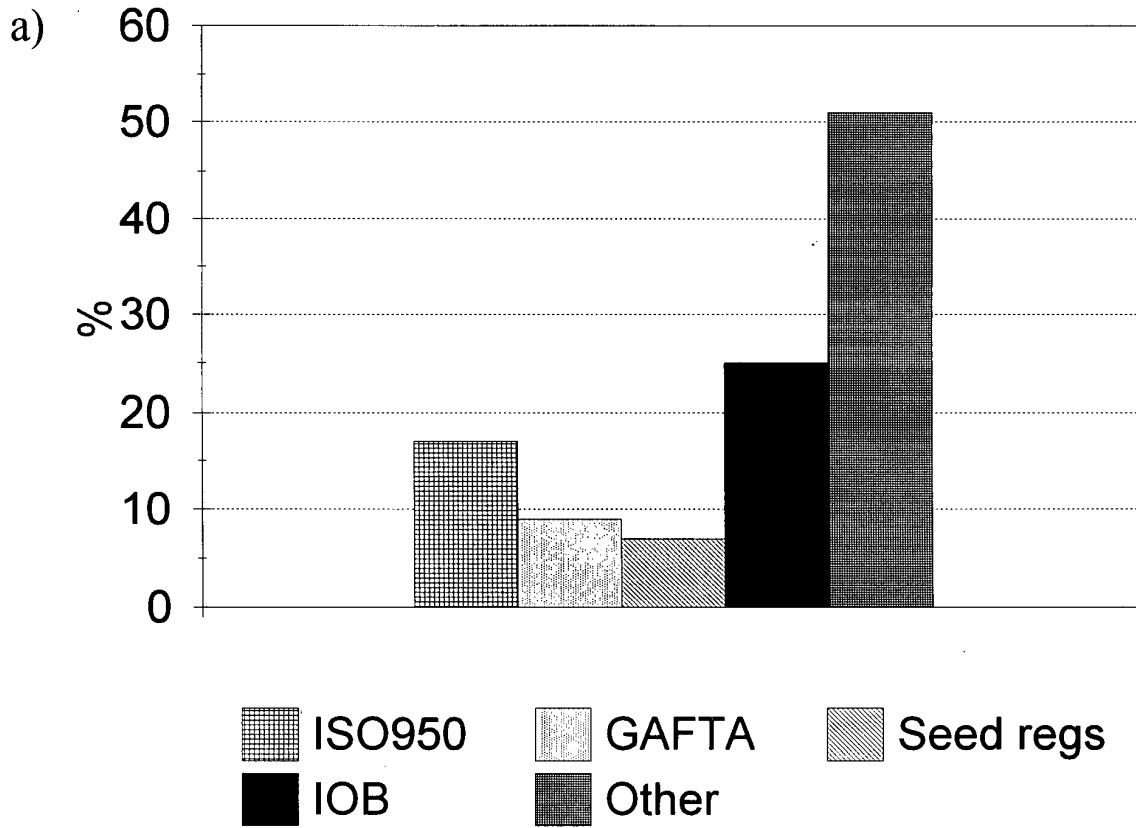
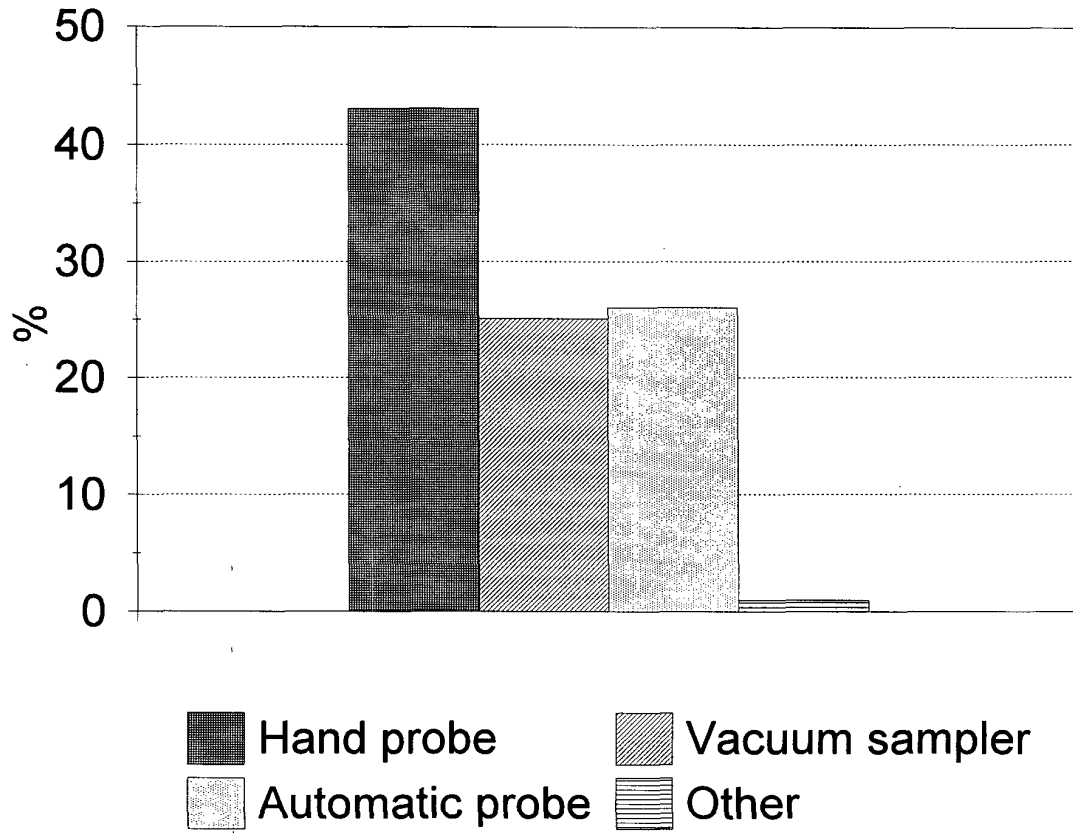


Figure 5. Sampling equipment - lorries a) percentage figures for all returns b) split by quantity of grain sampled per annum

a)



b)

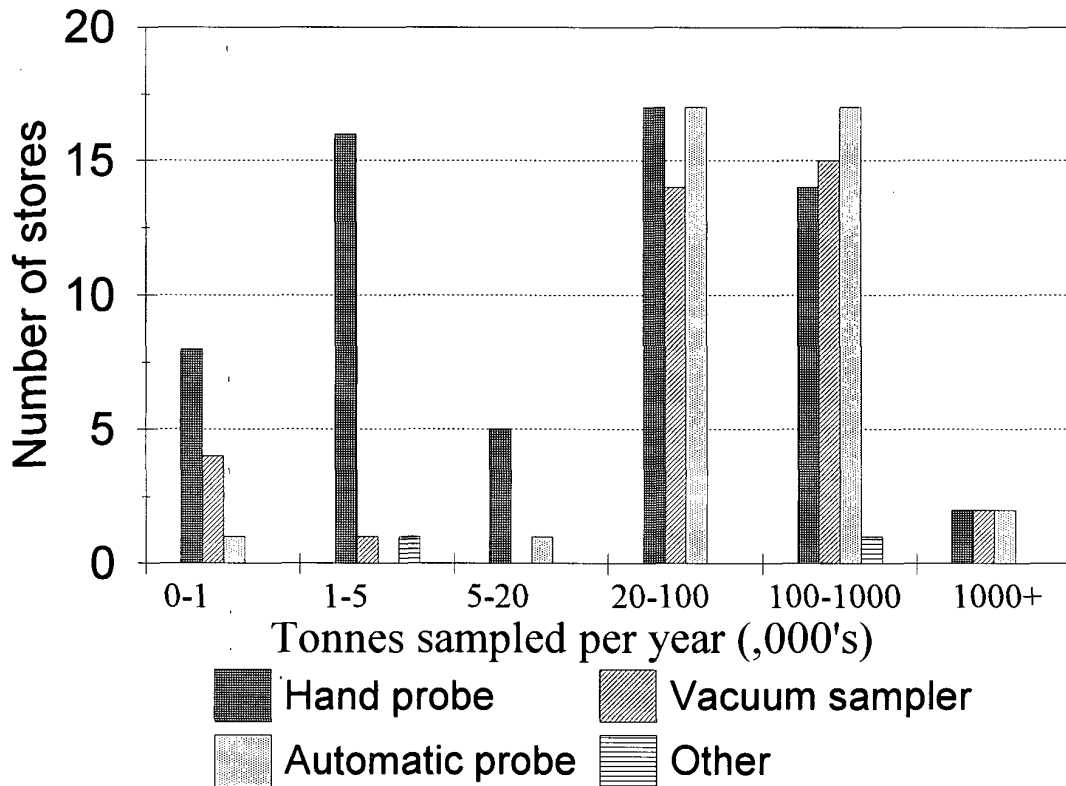
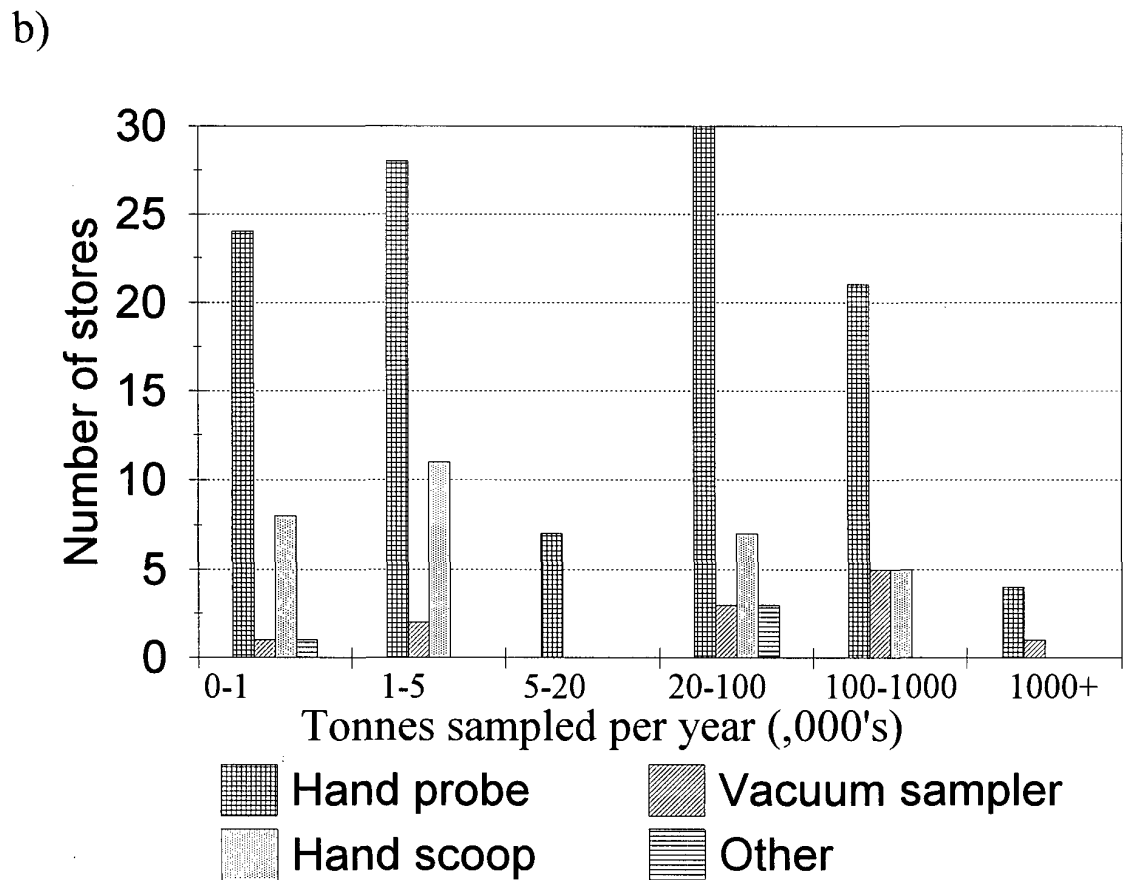
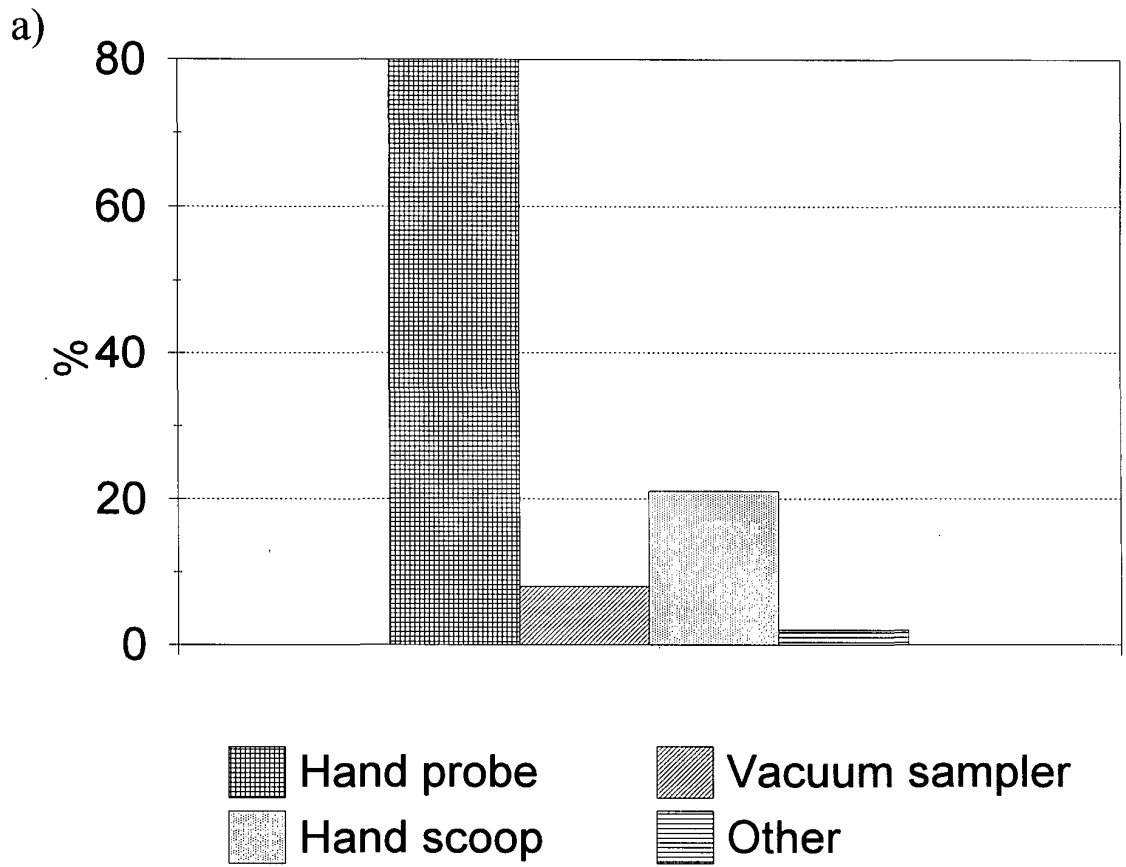


Figure 6. Sampling equipment - stores a) percentage figures for all returns b) split by quantity of grain sampled per annum



operators tended to use samples from a number of depths. Only a few stores used samples drawn from a single depth (see Fig 6).

Table 1. Average number of sampling points, sample size and quantity sampled per lorry load of grain.

	Points sampled			Kg/load			Quantity per load		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
Total	18	6.5	1	20	4.4	1	6	1	0.25
0 - 1000	11	6.3	3	20	4.7	2	2	1.5	0.25
1001 - 5000	8	4.4	1	5	1.4	1	1	0.5	0.25
5001 - 20000	8	7.0	3	10	4.4	2	1	0.7	0.25
20001 - 100000	10	6.8	2	20	5.4	1	5	1.2	0.25
100001 - 1000000	18	6.7	2	10	4.1	1	3	1.1	0.25
1000000+	8	6.7	3	8	5.0	3	6	2.1	0.50

Despite the lack of standardisation in methods, most respondents professed themselves "confident in the quality of their samples and methods but were less confident in the methods used by their suppliers and purchasers (Fig. 7). A large proportion of respondents indicated that they had had disagreements with their suppliers or purchasers over results of sampling and subsequent tests, although only rarely in most cases (see Fig 8). Several respondents indicated that they felt that the provision of only three categories was too restrictive and that another option should have been included between "rarely" and "often".

When identifying problem areas with sampling, peas and beans were identified almost unanimously as difficult commodities (see Fig. 9) and the detection of pests and the measurement of moisture, as the most difficult quality parameters to detect or measure (see Fig. 10).

A considerable number of comments were also provided by the respondents but these are very difficult to analyse and present in the context of this report. However, these did seem to indicate that there was a degree of concern within the industry about the measurement of grain quality and that improvements to sampling might have some role to play in better quality control.

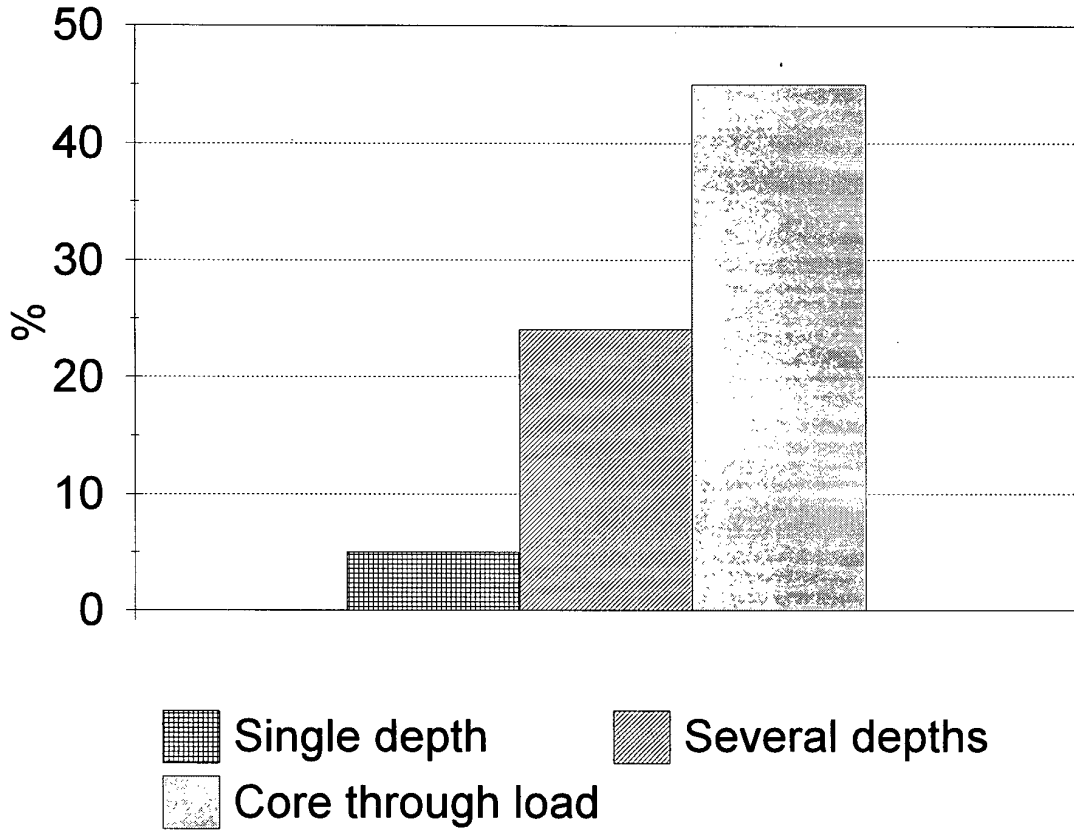
More than a quarter of all respondents felt that they did not have sufficient information on sampling and 30% provided comments relating to the needs for further R&D. One point that was raised frequently was the perception that vacuum samplers collect a disproportionate amount of fine material. The problems of sampling deep bins was also mentioned.

3.2 Preliminary conclusions

The information provided by respondents suggests that sampling bulk commodities and

Figure 7. Type of sample taken - lorries a) percentage figures for all returns b) split by quantity of grain sampled per annum

a)



b)

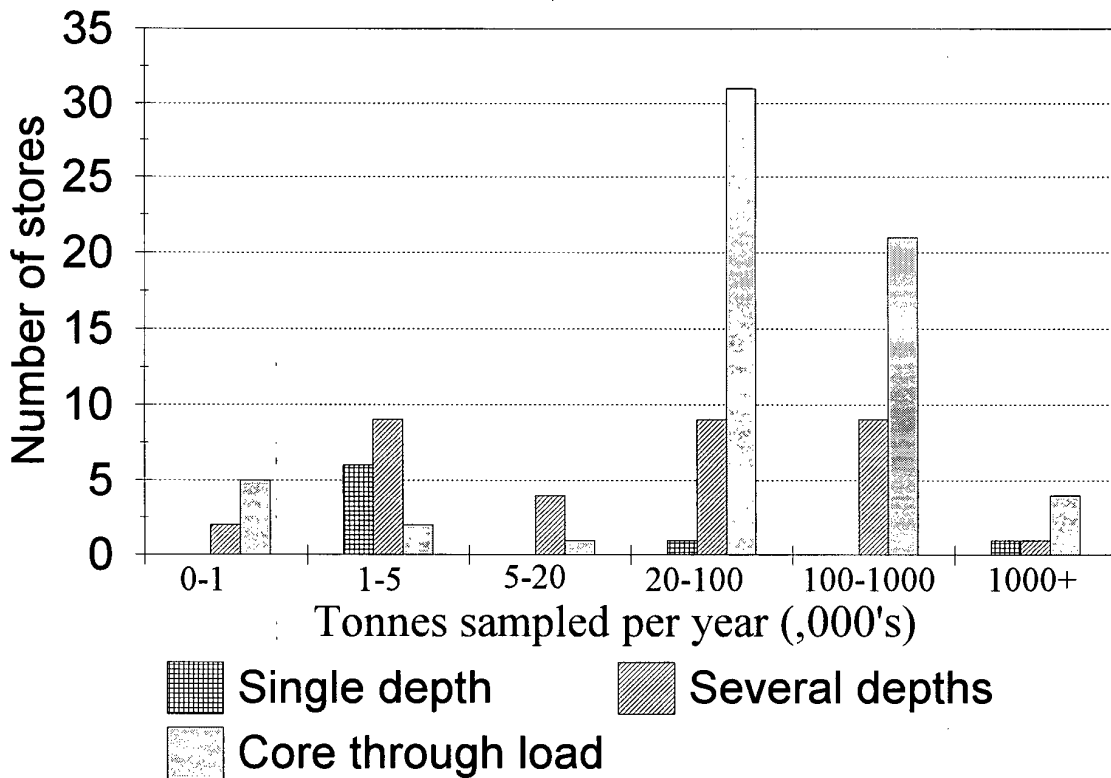


Figure 8. Confidence in sampling method a) percentage figures for all returns b) split by quantity of grain sampled per annum

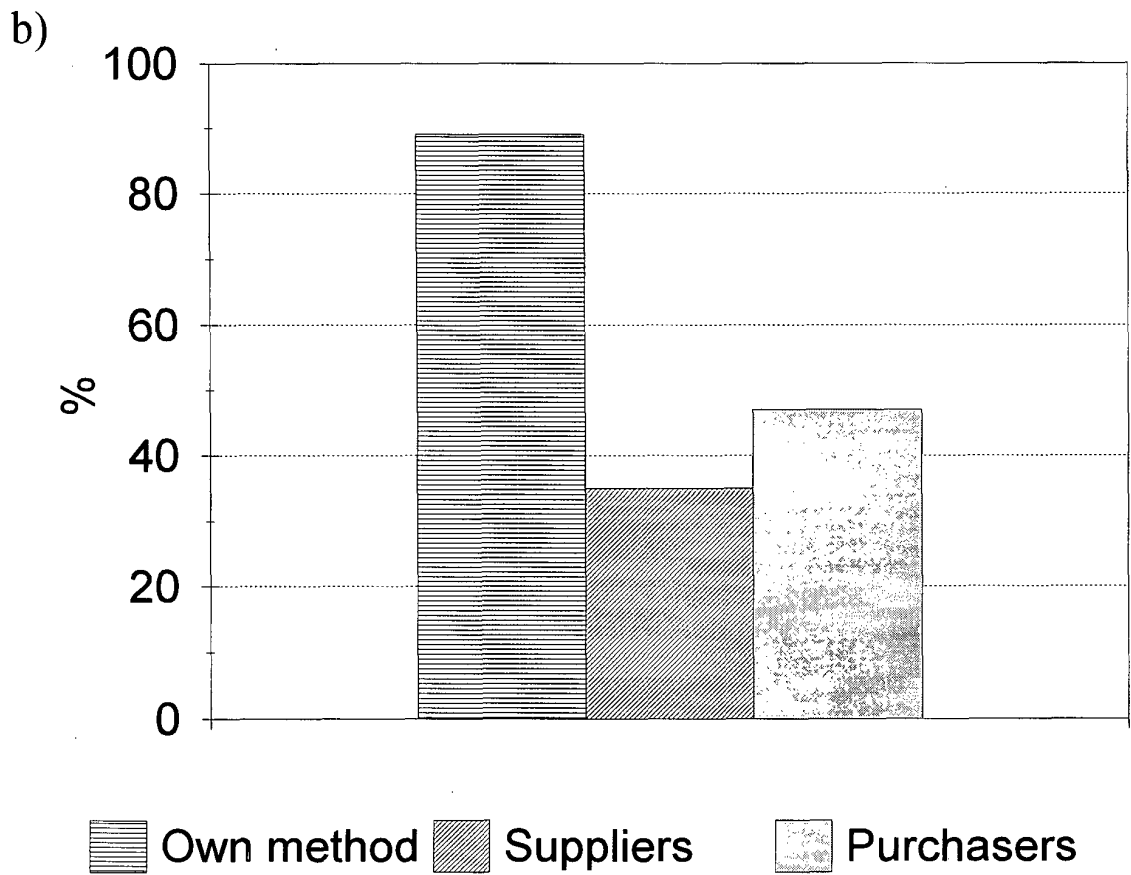
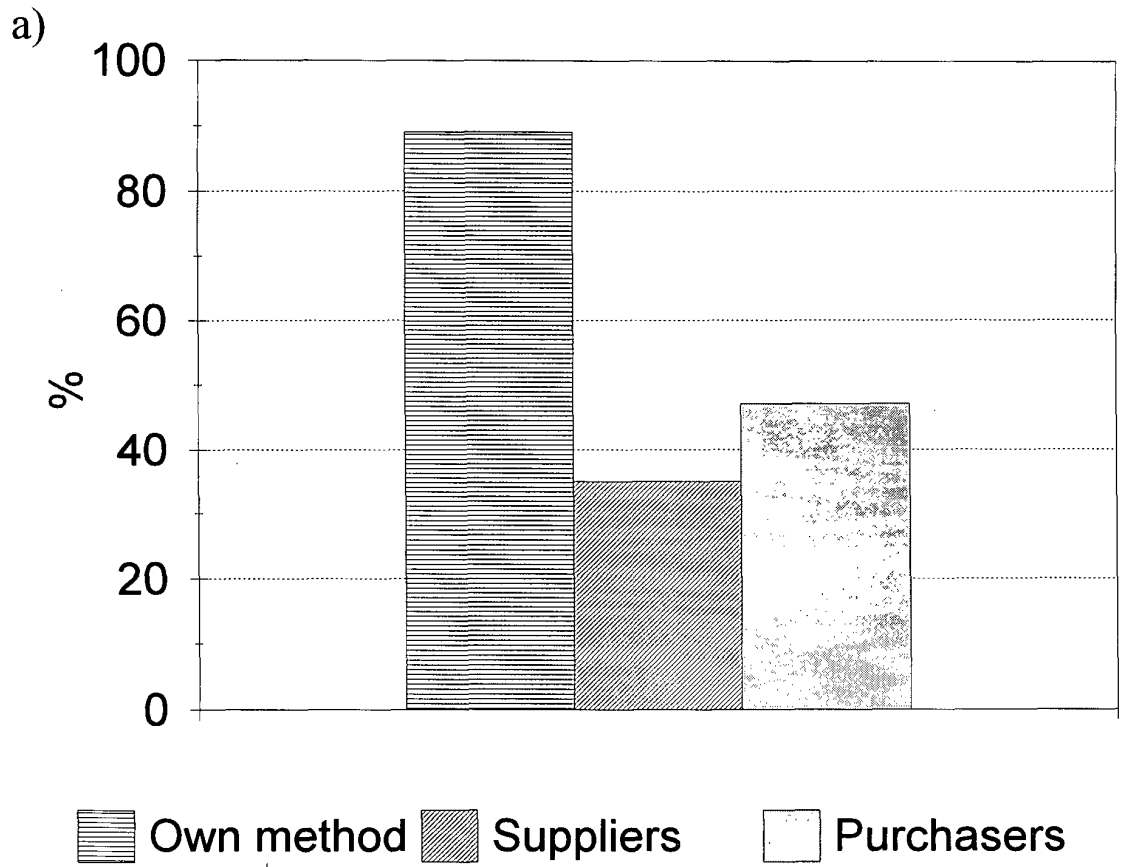


Figure 9. The perceived level of disagreement between suppliers and purchasers as a result of sampling and testing grain a) percentage figures for all returns b) split by quantity of grain sampled per annum

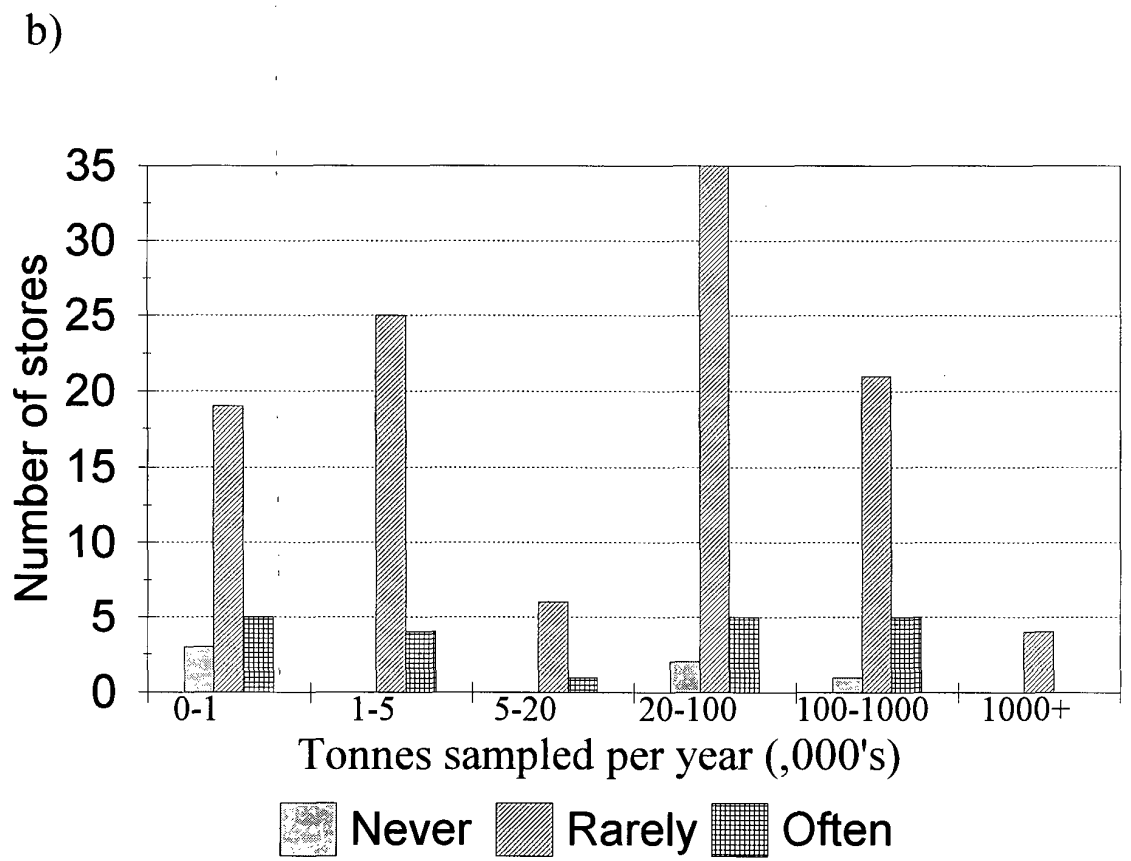
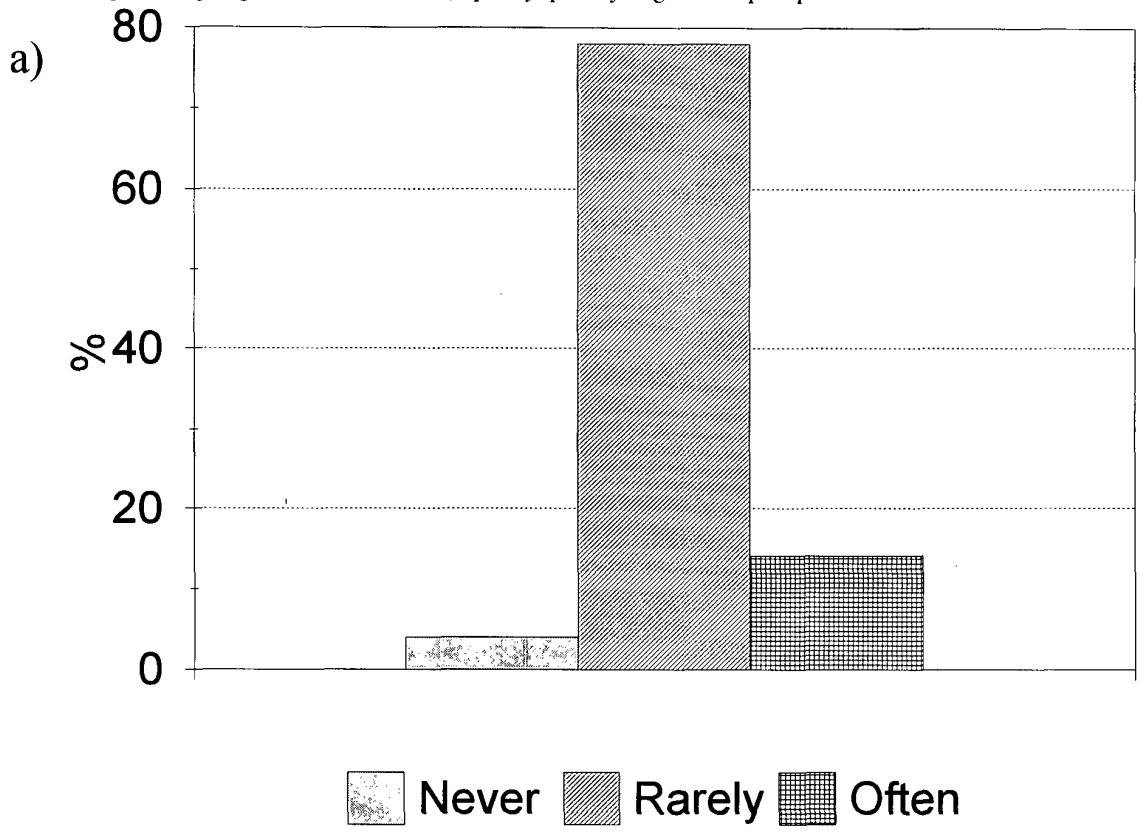


Figure 10. Commodities perceived to be difficult to sample a) percentage of all returns b) split by quantity sampled

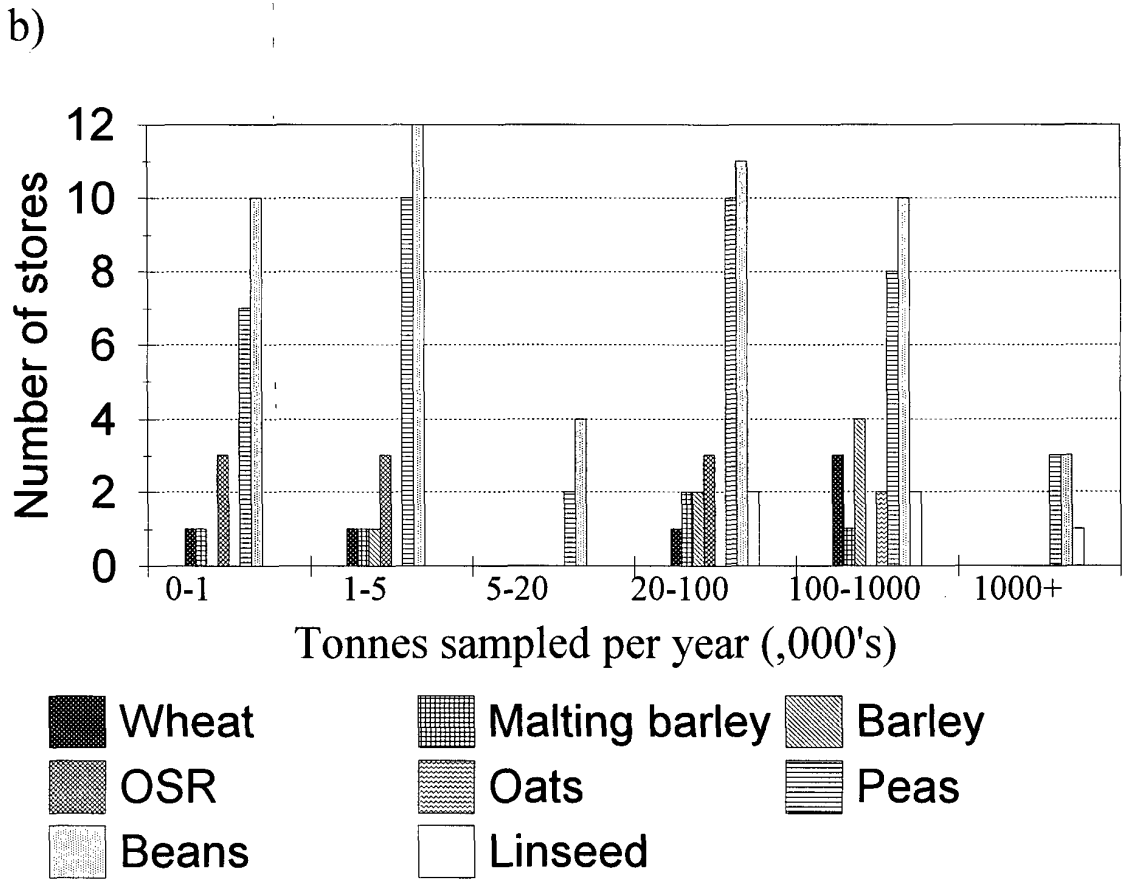
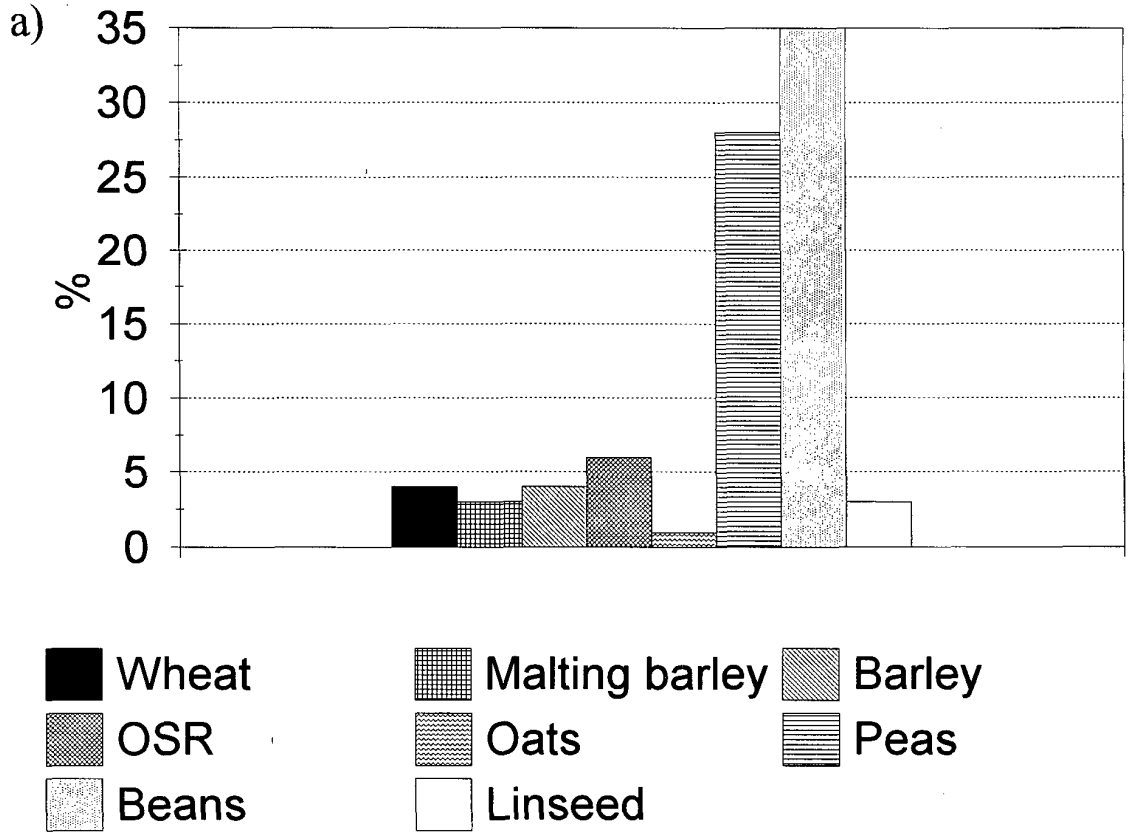
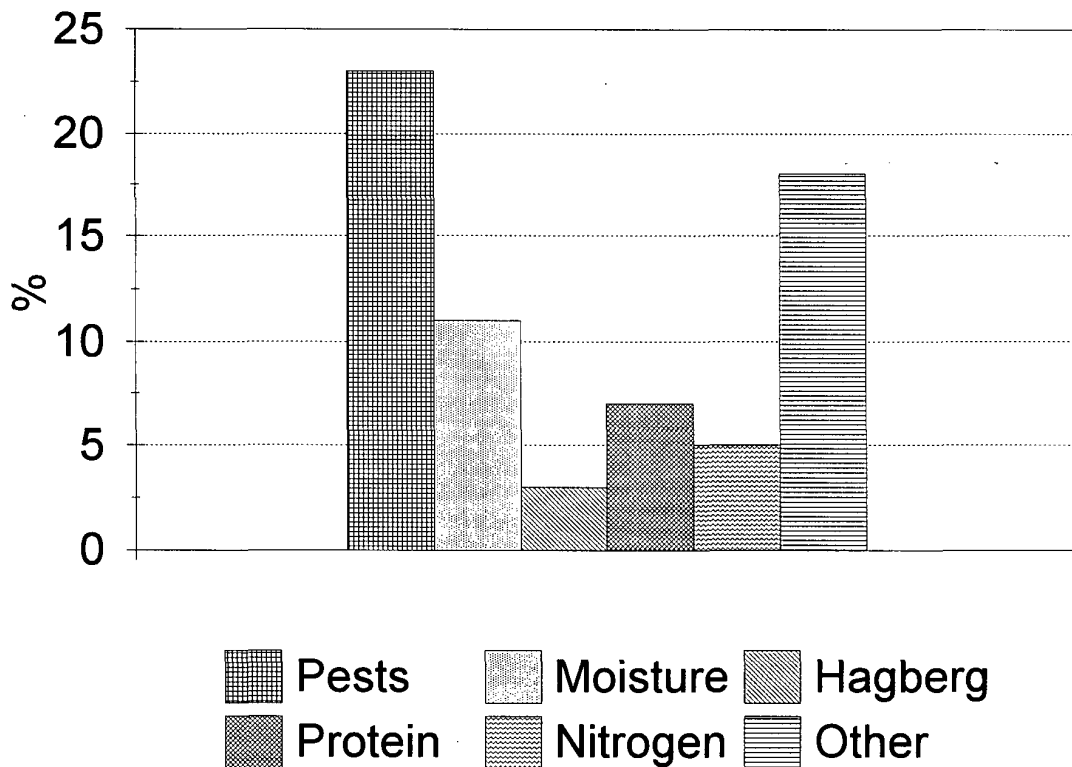
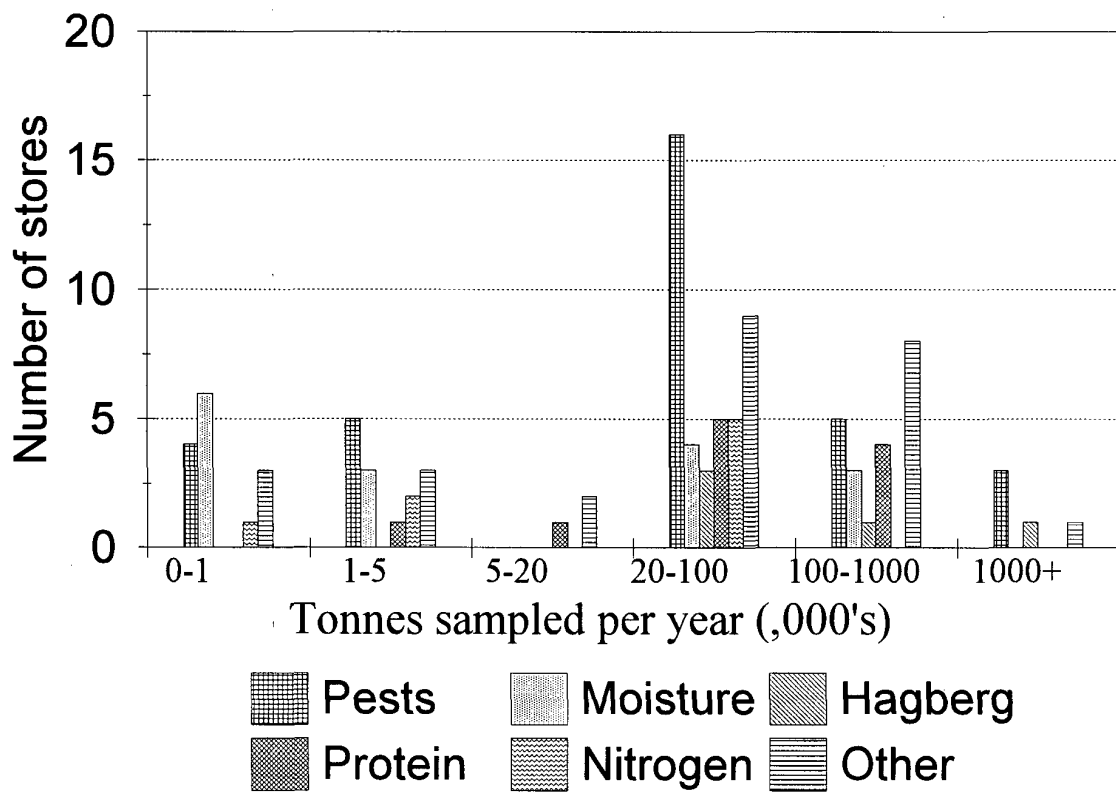


Figure 11. Quality test considered to be most difficult a) percentage of all returns b) split by quantity sampled

a)



b)



measuring quality parameters using samples, still present some problems for the cereal industry. The lack of standardisation in methods, equipment and approaches may contribute to the problem but comments on the forms also suggested that there were basic misunderstandings about the aims and objectives of sampling. The unpopularity of standard methods could be due to the difficulty of adapting these techniques to the changing needs of farm grain and commercial stores or high volume lorry sampling. It is particularly worrying to find that a very large proportion of those with smaller stocks, based their quality assessment on samples taken in the store, rather than from trailers when the store was loaded and/or lorries on out loading.

4. DISCUSSION OF THE INFORMATION COLLECTED AND THE IMPLICATIONS

A meeting was held at the Shuttleworth College on 14 June to discuss the findings and to consider the requirements for further research. Representatives were invited from all the organisations previously mentioned. The meeting was attended by:

Dr Jon Knight, Robin Wilkin and Dr John Mumford, representing Imperial College.

David Wallington (Weston Research), John Shooter (Carrs) and Alex Waugh, representing NABIM.

Ray Beach (Pauls Malt) and Michael Goutsell (IOB), representing the MAGB.

Charles Bolton (Dalgety) representing UKASTA.

Sarah Nightingale and John Bumpstead (SGS), representing GAFTA.

Alan Griffith (Thames Grain), representing UNISTOCK.

Dr Clive Edwards (HGCA) also attended as an observer.

Unfortunately, no representatives from either branch of the NFU were able to attend the meeting.

4.1 Observations and discussions on the data collected

A summary of the analysis of the data was presented and then the meeting discussed the information and implications of the findings. The first part of the open discussion concentrated on the validity of the approach and several important issues were raised. It was agreed that the information collected gave a valid picture of the UK industry but that the farming section was under-represented in the questionnaires returned. However, this was not considered a serious disadvantage as farmers had less direct involvement in sampling. The layout of the form and the type of questions asked were considered reasonable except that it was felt that there may have been some confusion between vacuum samplers and automatic lorry sampling probes. The biggest concern was that the questionnaire did not differentiate effectively between problems caused by sampling or assessment. This is a valid criticism but should be tempered by the consideration that without a representative sample, no assessment will be accurate. Also, far more work has been done to test and validate cereal test methods and equipment than on

methods of sampling.

When discussion of the data began it was clear that there were several different viewpoints of sampling, depending on the section of the industry that was making the comments. Irrespective of the section of the trade, fixed standards are not well thought of unless being used as "methods of last resort" to settle disputes. Various practical requirements and limitations must be allowed to take priority over strict adherence to standard methods and this goes some way to explain the small proportion of respondents who used a standard method.

One of the key sampling problems was identified as the gulf between in-store and lorry sampling. Much discussion took place on this topic and, although the impact of the problem obviously varied depending on the sector of the industry involved, it was generally agreed that this represented one of the more important problem areas in grain sampling. End users rely on results from lorry sampling and any other method used must give comparable results to this. The lack of data comparing store and lorry sampling makes it extremely difficult for the trade to consider alternative approaches. However, grain storage and handling are dynamic and changes in safety and hygiene regulations require changes in approaches to sampling.

Key practical points to emerge from the discussions were the need for scientists to understand that time = money so that the speed of a sampling procedure must be an essential consideration. Secondly, safety of the operator may not have been given sufficient priority in the past and thirdly that walking on grain should be limited because of potential problems with contamination. Finally, the biggest problems with sampling are always associated with confirming premium quality such as malting or milling. Feed quality grain is less of a problem. There was also agreement that it was essential for many storekeepers to use the same sampling methods for a range of different commodities.

Several of those attending the meeting considered that there was a need for information on sampling to be more readily available, particularly to farmers. If this could be coupled with data on the comparisons between lorry and store sampling, it might help farmers to have more realistic ideas of the quality and variability of their grain.

4.2 Conclusions and recommendations

The meeting concluded that the circulation of a questionnaire had been an effective and valid approach to the collection of information about current practices, provide caution was used when interpreting some aspects of the data. There was general agreement that standard methods were not necessarily suitable for the industry and a more flexible approach was likely to be more effective and to gain more widespread approval. Specific sectors of the industry have specific problems in relation to sampling grain and these must be recognised in any research and/or recommendations.

There seemed to be general approval for the method of managing this particular project and all parties agreed to continue to provide input for any continuation of the project.

4.3 Possible options for further R&D on grain sampling

The meeting suggested that there were a number of points arising from the work completed so far which might warrant further input of HGCA Levy funds to support a research project. These were:

- I) The validation of earlier work on lorry sampling with a view to indicating the acceptability of a more flexible approach.
- ii) A comparison of the results from lorry and store sampling. This work should, if possible, make use of IBAP data as well as practical tests.
- iii) The inclusion of an assessment of vacuum samplers in the above work as well as some tests with other commodities.
- iv) Ensuring that an element of information transfer was incorporated into any R&D project.

Acknowledgements

The authors of this report wish to thank the organisations who supported and assisted in this work by providing technical information, distributing the questionnaire and by contributing to the discussions of the information collected. We feel that the method by which this project was controlled with active industry participation, provided significant benefits to the scientists and to the quality of the work.

We would also like to thank all those who completed and returned the questionnaires.

APPENDIX 1

Example of questionnaire distributed



HGCA Levy-funded Research

Collection of Samples from Lorry-Loads of Grain

Background information

The HGCA has provided a grant to allow some further R&D on assessing methods of collecting samples from lorry-loads of grain with the aim of producing practical guidance for farmers, storekeepers and end users. The work is being done by Imperial College, Silwood Park, but it is intended that organisations representing farmers, storekeepers and end users of grain will play an active part in the management and direction of the project.

The first step is to collect information about current practices and equipment. Your co-operation is requested to complete and return the attached questionnaire. Any information will be treated in the strictest confidence and specific contributors will not be identified. All comments are welcome, as are contributions to the direction and management of this and future work on grain sampling.

Although the project is about sampling grain in lorries, comments on other aspects of sampling grain or other commodities would also be welcome.

Please tick the appropriate box or write a value in the space provided.

Please return your completed questionnaire by the end of April '95 to:

**Dr Jon Knight
Grain Sampling Project
Imperial College at Silwood Park
Ascot
Berks
SL5 7PY**

1. Sampling location

1.1 Where do you sample grain

In lorries?

In stores?

Other places?

If in other places please specify where:

2. Equipment used

2.1 What equipment do you use to sample lorry-loads of grain?

Hand probe

Vacuum sampler

If vacuum sampler used:

What is the approximate length of pipe from the probe to the sample collector? (metres)

What type of pipe work is used between the probe and the sample collector?

Automatic lorry probe

Other

Please specify other :

2.2 What equipment do you use to sample grain in store?

Hand probe

Vacuum sampler

Hand scoop

Other

Please specify other :

2.3 What size of store do you sample? (Tonnes)

2.4 Any other comments about sampling equipment:

(Access for sampling, ladders, gantries (size & shape), training and use of equipment, maintenance/reliability of equipment etc)

2.5 What commodities do you sample?

Wheat	<input type="checkbox"/>	Oats	<input type="checkbox"/>
Barley	<input type="checkbox"/>	Oilseed Rape	<input type="checkbox"/>
Peas	<input type="checkbox"/>	Beans	<input type="checkbox"/>
Linseed	<input type="checkbox"/>	Other	<input type="checkbox"/>

Please specify other :

2.6 How many tonnes of grain do you sample in one month?

2.7 How many tonnes of grain do you sample in one year?

3. Collecting samples

3.1 Why do you sample grain?

To obtain a representative sample to determine the general grain quality?

To identify variation within an individual load? (differing quality of grain in a single load)

To detect storage faults? (infestation, moisture etc.)

For other reasons?

If for other reasons please specify :

3.2 Do you always follow the same procedure?

Yes

No

3.3 What method do you use?

IS 950

GAFTA method

Seed regulations method

IOB recommended method

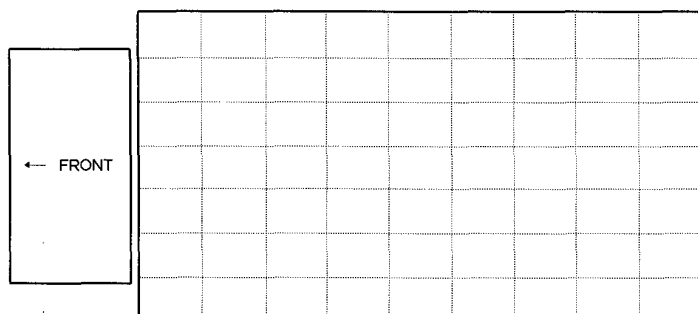
Other

Please specify other method :

4. Sampling lorries:

4.1 How many points do you sample in a 25 tonne load?

4.2 Please indicate position of sample points on diagram below



4.3

At each point do you sample from:

A single depth?

Several depths?

A core from top to bottom?

4.4 How much grain do you collect per load? (kg)

4.5 How much grain do you use as a test sample? (kg)

4.6 On days on which lorries are being sampled
how many lorries do you sample on average?

4.7 What limits the maximum number of lorries you can sample in one day?

Limiting factor:

4.8 How long does it take to sample each lorry load? (minutes)

5. Sample testing

5.1 What method of dividing samples do you use

Manual - coning and quartering

Riffler divider

Boener divider

Other

Please specify other method:

5.2 What quality parameters do you measure in the sample?

Please specify tests:

5.3 Any other comments on testing of samples:

6. Sampling problems

6.1 Do you feel that the samples you collect are
always adequate for your needs? Yes No

6.2 Are you confident in
6.2.1 Your methods? Yes No

6.2.2 The methods used by your suppliers? Yes No

6.2.2 The methods used by your purchasers? Yes No

6.3 How often do the results from your sampling disagree with those
obtained by your purchasers or suppliers?

Never any significant disagreement

Rarely any significant disagreement

Often significant disagreement

6.4 Do you have access to sufficient information on sampling?
Yes No

6.5 Which commodities do you think are the most difficult to sample?

Please list:

6.6 Which type of sample is the most difficult? (moisture, pests, etc)

Please list:

6.7 Any other comments concerning sampling problems:

7. **Suggestions for HGCA funded R&D on grain storage**

APPENDIX 2 - SUMMARY OF KEY INFORMATION FROM QUESTIONNAIRE

Approximately 600 questionnaires were sent out and 142 replies were received. The respondents were responsible for sampling a total of 17.65 million tonnes of grain.

Note: The percentages for each category will not necessarily total to 100 because many answers required more than one response. The results give an indication of the most frequently used methods and equipment.

	Number of respondents	%
Sampling location		
Lorries	101	71
Stores	126	89
Other places	37	26
Equipment used for lorry sampling		
Hand probe	62	43
Vacuum sampler	36	25
Automatic lorry probe	38	26
Other	2	1
Equipment used for store sampling		
Hand probe	114	80
Vacuum sampler	12	8
Hand scoop	31	21
Other	4	2
Commodities stored		
Wheat	114	80
Barley	120	85
OSR	79	56
Oats	51	36
Peas	47	33
Beans	60	42
Linseed	43	30
Other	17	12
Reason for sampling grain		
To determine general quality	128	90
To identify variation within a load	51	36
To detect storage faults	116	82
Other	27	19
Sampling method used		
ISO 950	24	17
GAFTA	14	9
Seed regulations	11	7
IOB	36	25
Other	72	51

Sampling points		
Average number	6.5	
Maximum number	18	
Minimum number	1	
Sampling depth		
Single depth	8	5
Several depths	34	24
Core through load	64	45
Samples collected are adequate for purpose	114	80
Confidence in		
Own methods	126	89
Suppliers methods	50	35
Purchasers methods	67	47
Disagreement between self and purchaser/suppliers		
Never disagree	6	4
Rarely disagree	110	78
Often significant disagreement	20	14