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Survey of current harvesting, drying and storage practices with oilseed rape

by

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ABSTRACT

Telephone interviews with crushers preceded a survey of 101 producers which comprised a face-to-face questionnaire of harvesting, drying and storage practices with a parallel sampling exercise to inform HGCA of the changes of on-farm management and storage practices and future research requirements. On-site sampling was run in parallel to support the results of the questionnaires and to enable assessments of mite infestation, and rapeseed moisture content.

Two-thirds of farmers need to dry rapeseed and most harvest at above 12% which is the critical moisture content threshold for the production of ochratoxin A (OTA). A survey of OTA levels in rapeseed is therefore recommended. Moisture measurement is most commonly relied upon for hot-air dryer settings, yet less than half of the farmers calibrate the meters properly by returning them to the manufacturers. Therefore the importance of proper calibration should be publicised. Only one-quarter of farmers accepted that 7.5% was the safe mc for long-term storage, although this proportion is almost double the response 10 years ago. This recommendation still needs emphasizing. One third of farmers using floor-dryers took over a month to dry the seed. In view of the threat from mycotoxin production; associated advice and improvement to floor drying might well be required. There is no clear consensus on safe drying temperatures for rapeseed when hot-air drying. Clearer advice, resulting from research associating safe drying temperatures with rancidity (FFA levels), is required. About 20% of farmers had difficulties in cooling. The variability in fan running time and the complications of operating ambient air drying systems to cool the grain all indicate the benefit of adapting engineering cooling models to develop faster cooling strategies for rapeseed. Half the farmers used the on-floor drying system to additionally cool the seed. This is the first clear indication we have had of this practice and greater experimental experience as a basis for advice on this practice is clearly needed.

Most rejections were for admixture, which can be best remedied by improvements in weed control and cleaning practice. One-fifth of farmers experienced seed heating which causes rancidity and therefore affects market quality, yet there is no clear indication in the literature of the cause. More than a quarter of farmers had problems with mites; 43 had infestations in excess of 10,000/kg at the surface but only 10 had similar populations beneath, indicating it was a superficial problem. Mites were not a great concern of the crushers and there were few rejections citing mites as a cause. Nevertheless, they clearly cause farmers great concern and a great deal of expense and energy is expended on their behalf. It is therefore recommended that a study be carried out to define market thresholds of mites with regard to effect on FFA and allergen levels. Available remedial treatments for mites are few and one-fifth of farmers expressed discontent with available treatment options. The only other option is fumigation and information on its efficacy against mites is equally limited. Research on these treatment options would also therefore be beneficial. Perhaps because of the limited pesticide options to treat the grain, fabric treatments have doubled since 1995 although there is no indication of their effectiveness in limiting mite numbers. This is another area where objective scientific research would help minimise unnecessary pesticide use and expenditure.

SUMMARY

Introduction

There has been little work on rapeseed storage specific to UK conditions. Effects of mite infestation at 9% and 8% mc were compared in farm-scale rapeseed storage trials in the UK between 1975 and 1978. This approach was updated in HGCA-funded experiments in 2002-4 to provide a basis of recommendations with modern low erucic acid (double zero) varieties. In 1995, a survey was conducted of rapeseed storage practice and mite infestation on arable and mixed farms and central stores.

Since then there have been large changes in practice, not least the withdrawal of admixture pesticides for oilseeds and the widespread introduction of pest monitoring devices or 'insect traps'. In addition, EU regulations relating to food and feed storage have focussed attention on 'due diligence' with regard to food safety issues.

The project resulted in a representative sample of current harvesting, drying and storage methods used as well as an overview of the condition of rapeseed in store at the time of the survey. The aim was to identify reasons for current problems, highlight areas for improvement and pinpoint any future research requirements for harvesting, drying and storage.

Methods

The survey samples were based proportionately on the number of agricultural holdings from Defra arable statistics, shown as growing cereals and/or oilseeds in each of the old MAFF regions.

Distribution of survey samples

Old MAFF 'regions'	No. of holdings	No. farms to be visited	By	No. farms actually visited
East Midlands	2401	22	Velcourt	26
Eastern	2232	21	Velcourt	16
North East	692	7	TFG	5
North West	152	1	TFG	1
South East	1430	13	Velcourt	15
South West	938	9	Velcourt	10
West Midlands	921	9	Velcourt	9
Yorkshire and the Humber	1856	17	TFG	15
Scotland		5	TFG	4

Telephone interviews with crushers preceded a survey of 101 producers which comprised a face-to-face questionnaire of harvesting, drying and storage practices At each site, a fact sheet was completed to collect information on quantities of rapeseed stored, pre-harvest issues such as desiccation and ripening, drying and cooling methods, crop monitoring, pesticide use, problems and rejections. At the same time, five seed

samples from the surface and five from below the surface were taken from the farm. These were examined for arthropod pests and the moisture content was determined by oven method.

Results

Problems perceived by crushers – The two principal crushers in the UK received between 20% and 30% of their total tonnage directly from farm stores. Rejections were in the range of 0.2-0.5% at one crusher, around 1% at the other. Reasons common to both included moisture content (high or low), seed admixture, green seed and burnt seed. Infestation was not regarded as a big issue; there was no known link between mite infestation and rancidity and there was no known issue preventing processing of mite infested rapeseed. Neither crusher was aware of any mycotoxin problems related to rapeseed. One crusher noted high free fatty acid (FFA) due to incorrect dryer use in Scotland as a problem, the other was concerned by green seed caused by uneven growth in difficult years. Future concerns included increase in mite contamination, due to lack of treatment options, green or burnt seed and polyaromatic hydrocarbons (PAH) levels in poorly set dryers. A risk assessment of diatomaceous earth (DE) application was thought necessary and, in conclusion, the key was better avoidance of problems before delivery to the crushers.

Pre-harvest information - The sites covered by the survey harvested 35,140 t of seed representing about 4% stored on farms, of which 88.8% was for normal use, 10.8 % was for set-aside and only 0.4% was for biofuel.

Seventy two farms stored the rapeseed for three months or more, mainly as part of their marketing strategy. Three-quarters was stored on-floor. The long storage periods indicated here suggest recommendations of storage moisture contents should be on the conservative side to minimise mite infestation and deterioration through rancidity.

Of the different methods of desiccation available, glyphosphate was by far the most widely used by over 70% of farms. Nearly 30% of the sites experienced problems with ripening of the seed; of these, the greatest problems were when natural senescence or glyphosphate were relied upon. Pigeons headed the list of other factors predisposing to uneven ripening, particularly on headlands.

Moisture measurement and drying - Harvesting started mainly at 12% mc. This is the critical level for production of Ochratoxin A but there have been no recent surveys of its occurrence in seed, oil or cake, of OTA. All farmers measured the mc as the seed went into store, all but one using a meter. By far the majority, 84, calibrated the meter in the harvest year but only 43 sent the meter back to the manufacturer. Samples for mc measurement were taken from each trailer on over ¾ of farms, mainly to adjust the dryer settings. Nearly half thought 8% mc was safe for storage. All of the farms expected to dry the rapeseed and 33 of them used ambient-air drying. Of these, 18 dried the seed at half the depth they would employ for cereals. Most expected to dry in a fortnight. However, 11 out of 35 thought a month or more was reasonable for drying and

14 out of 35 found this period was necessary in practice, indicating that about of a third of the ambient-air drying systems were not operating to specification.

Sixty five of the farms used hot-air drying. Thirteen of the 62 that answered had experienced a fire in the dryer and although 14 did not check the temperature of seed in the dryer there was no statistically significant connection between this and the fires. Only ten of the farms using hot-air drying did not know the safe drying temperature settings although the range of values indicates that practice varied widely.

Maximum hot-air drying temperatures

°C	30	35	40	45	50	55	60	65	70	73	75	80	85	90	100	140	150
Sites	1	0	4	5	9	5	6	2	0	1	1	5	1	4	0	1	1

Cooling- Only 17 of the 101 stores did not use aeration to cool the grain but 75 of the 84 that did had systems designed for cereals, not oilseed, while 28 of these compensated for the increased resistance of oilseed by storing the rapeseed at a lesser depth than for cereals. However, 46 used the bulk drying system to cool the grain which complicates things slightly. This is the first indication we have had that nearly half of farmers use their ambient-air drying fans to cool. In this case, the considerably higher airflow probably means that the compensation for higher resistance by reducing bed depth is unnecessary, but considerably lower cooling times would be necessary as drying flow rates are 20x higher than for cooling.

Seventeen farmers aimed to get to 5°C or below and 54 aimed to get between 10 and 5°C. Most estimated it would take 1-3 months to reach their temperature targets but while only three reckoned it was reasonable to take more that three months to cool, in practice 19 took longer than that. A sizeable proportion of farmers therefore are not satisfied with cooling speeds and these could certainly be improved by simple thermostats and by monitoring hours of aeration more carefully. Only four sites did not measure the temperature of rape during storage and of the remainder, 88 used hand-held probes. Seventy three farmers only measured the temperature at one depth. Forty-three farmers did not record the hours or had not run the fans and of the remainder, hours run ranged from 80 to 1440. Some answers indicated the fans had been running for weeks. Hours of fan operation are critical for assessing whether or not the cooling system is working properly and this aspect of record keeping needs to be tightened up.

Storage problems- Just 17 farmers used no detection methods for pest problems during storage and most of them used pitfall-cone (PC) traps. In 1995, no farmers used PC traps. The increase in the use of traps to monitor pests can be attributed to their being a requirement of assurance schemes. Problems with seed heating had occurred on 22 sites and although fungi and admixture were the most common assumed culprits, there was no clear consensus on the reasons for heating. Mites were the greatest problem, noted on 27 sites, against which pesticides and cooling were most likely to be employed. Of the varied remedies, only hygiene was thought to have failed.

Problems in store

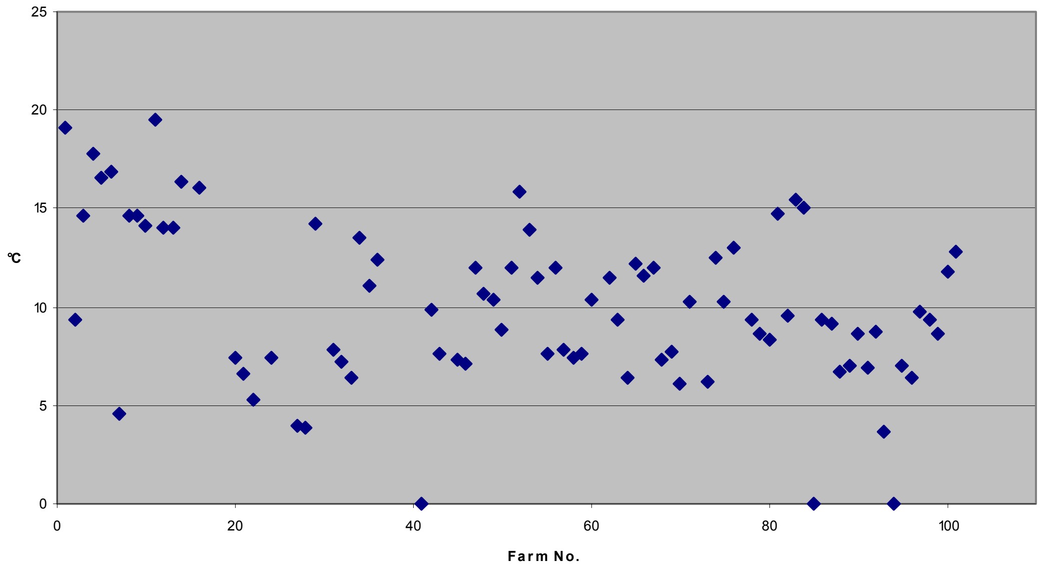
Problem	Sites	Reasons for heating	Sites	Pest remedy	Sites
Mite	27	Admix	5	Cooling	4
Mite, beetle	1	Admix, fungal,	1	Clean	1
Mite, rodent	1	Admix, roof leak	1	Cool, clean	1
Beetle	0	Fungal	5	Hygiene	1
Mice	2	Fungal, mite	1	Pesticide, cool	1
Seed heating	22	Immature seed	2	Pesticide	5
		Insect, mite	2	DE	2
		Opico drying systems ?	1	Pesticide-Actellic surface	1
		Other-blend wet seed	1	Convey, aspiration	1
		Insect/mite caused by dust	1	Rake surface	1
		Operator error	1	Turned	1
		No answer	1	Cold air	1
				Sorex (Contractor)	1

Rejections were admitted by 15 sites; usually only one load was involved and nearly all for admixture. Since the rapeseed was cleaned by only 39 of the farmers, most of whom used an aspirated sieve, it may be that greater attention should be paid to this aspect Although mites are perceived by farmers as a problem, it is interesting to note that they caused no rejections.

Pesticides- Fabric treatment using pesticides were not carried out by 14 farmers but 87 did and of these only 14 used contractors; the remaining farmers carryied out the treatment themselves. Less than 10 used anything other than pirimiphos-methyl (Actellic). Three sites used some form of treatment of the seed, two using diatomaceous earths (which do not require approval and work by physical means) and one using Actellic liquid (which is not an approved use). All these treatments were rated as ‘very effective’. One-fifth of farmers were not content with the available pest control options.

On-farm sampling - Few bulks of seed were below 5°C or above 15°C; 39 were between 6 and 10 and 30 between 10 and 15°C.

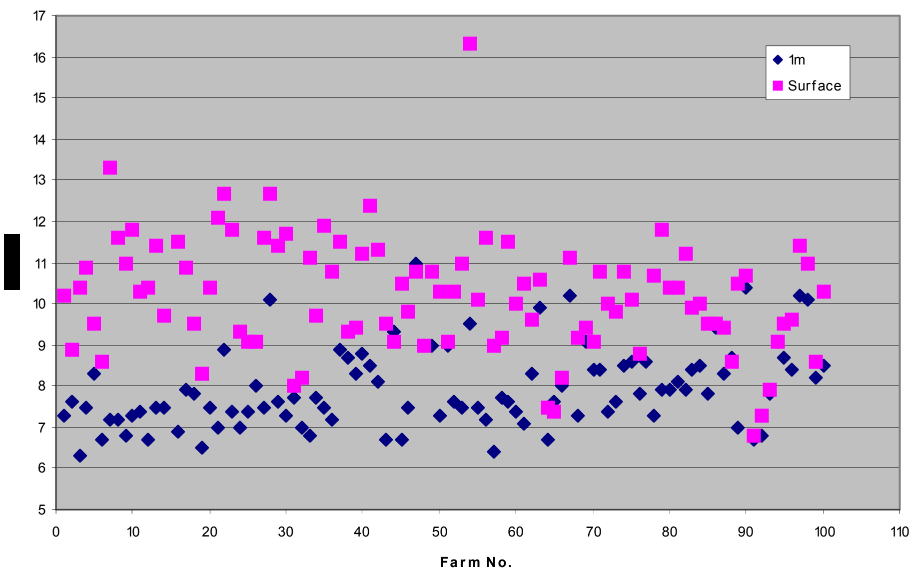
Distribution of mean temperatures



Just one farm was found to have insects in the seed and here there was a serious of infestation of *Cryptolestes ferrugineus* (Stephens) of about 100/kg beneath the surface and several hundred/kg at the seed surface.

Moisture contents measured at the surface (16 sites below 9% mc) were much higher than those beneath (86 sites below 9% mc). The surface mc increases firstly due to condensation of moisture in hot air as it meets cold seed at the surface during the early stages of cooling or if the seed is stored without cooling. The second reason is due to the uptake of moisture from the atmosphere throughout the winter.

Mean moisture contents at and beneath the surface



Forty-three farms had surface mite infestations above 10,000/kg compared to only 10 above this population level beneath the surface, indicating mites to be generally a superficial problem. Significant correlations were obtained between mite numbers and moisture content both at the surface and beneath. In addition, *Acarus* was significantly more frequent than *Lepidoglyphus* in damper seed

Dominant mite genera and the infestation level in samples from the farms

Mites per kg	< 10	10-100	100-1,000	1,000-10,000	10,000-100,000	100,000-1,000,000	>1,000,000
a. Surface							
Acarus	0	3	3	10	22	10	1
Lepidoglyphus	1	2*	7	8	4	4	0
Tyrophagus	2	2	0	5	2	0	0
Cheyletus	0	3*	2	2	0	0	0
Gamasid	1	4	0	2	0	0	0
b. 1 metre							
Acarus	5**	7	3	7	5	3	0
Lepidoglyphus	2	11	6	3	2	0	0
Tyrophagus	2	2	0	4	0	0	0
Cheyletus	3*	15	6	2	0	0	0
Gamasid	3*	7	1	0	0	0	0

* 2 spp co-dominant

<u>Conclusions and recommendations</u>

1. Two-thirds of farms need to dry rapeseed and most harvest above 12% which is in equilibrium with the critical mc threshold for the production of ochratoxin A (OTA). A survey of OTA levels in rapeseed is therefore recommended.

2. Moisture measurement is most commonly relied upon for hot-air dryer settings yet less than half of the farmers calibrate the meters properly by returning them to the manufacturers. This is the only way to ensure accuracy across the mc scale so it is therefore recommended that the importance of manufacturer calibration is publicised.

3. Only one-quarter of farmers accepted that 7.5% was the safe mc for long-term harvest and this recommendation needs emphasizing.

4. One third of farms using floor-dryers took over a month to dry the seed. In view of the threat from mycotoxin production detailed above; improvements to floor drying are required.

5. There is no clear consensus on safe drying temperatures for rapeseed when hot-air drying. Research needs to associate safe drying temperatures with FFA levels, particularly since quality problems associated with hot-air drying were a concern of end-users.

6. About 20% of farmers admitted to difficulties in cooling and about the same proportion did not compensate for the increased resistance to airflow of rapeseed compared with cereals. The variability in fan running time additionally indicates the benefit of adapting engineering cooling models to better understand cooling strategies for rapeseed.

7. Half of the farmers used the on-floor drying system to cool the seed and there is likely to be a similar frequency doing so with cereals. This is the first clear indication we have had of this practice and greater experimental experience as a basis for advice on this practice is called for.

8. Most rejections were for admixture which can be best remedied by improvements in weed control and cleaning practice.

9. One-fifth of farmers experienced seed heating which causes rancidity and therefore affects market quality, yet there is no clear understanding of the cause (when it is not the obvious fungal-initiated heating of damp seed). Research is required to clarify this.

10. Mite infestations in excess of 10,000/kg at the surface occurred on 43 farms but only 10 had similar populations beneath, indicating it was a superficial problem caused by uptake of mc at the surface during the winter. Mites were not a great concern of the crushers and there were no rejections citing mites as a cause. Nevertheless a great deal of effort is expended on their behalf. It is therefore recommended that a study be carried out to define market thresholds of mites with regard to effect on FFA and allergen levels.

11. Available remedial treatments for mites are few. No pesticides can be admixed and the only alternatives remedies, diatomaceous earths, can only be top-dressed. The only other option is fumigation and information on their efficacy against mites is equally limited. Research on these treatment options is required.

12. Fabric treatments have doubled since 2005 although there is no indication of their effectiveness in limiting mite numbers. Objective scientific research would be beneficial in minimising unnecessary pesticide use and expenditure.

TECHNICAL DETAIL

INTRODUCTION

It is often claimed by farm managers that rapeseed is very difficult, if not impossible, to store beyond September. It is necessary to determine whether this is because current advice is out-of-date or whether it is because the correct advice is not applied (or has not been received). This project was as a direct response to an HGCA request for 'expressions of interest' on a survey of rapeseed storage.

There has been little work on rapeseed storage, specifically under UK conditions. The only description of changes in farm-scale rapeseed storage in the UK was between 1975 and 1978 (Armitage, 1981) when mite infestation at 9% and 8% mc was compared and this approach was updated in HGCA experiments in 2002-4 (Armitage, 2005) to provide a basis of recommendations with modern low erucic acid (double zero) varieties. In 1995 a survey was conducted of rapeseed storage practice and mite infestation on arable, mixed and central storages (Prickett, 1997) but this was largely a vehicle for collection and resistance testing of mites. Since then there have been large changes in practice, not least the withdrawal of admixture pesticides for oilseed and the widespread introduction of pest monitoring devices or 'insect traps'. In addition, EU regulations relating to food and feed storage have focussed attention on 'due diligence' with regard to food safety issues.

The project was intended to result in a representative sample of current harvesting, drying and storage methods used as well as an overview of the condition of rapeseed in store at the time of the survey. The aim was to identify the reasons for current problems, highlight areas for improvement and pinpoint any research requirements for harvesting, drying and storage of rapeseed that may be needed in the future.

The aims of the project were:-

- To quantify and define the practical problems of harvesting, drying and storage OSR on farm and to provide recommendations to improve storage safety.
- To determine problems of quality as perceived by crushers
- To conduct a stratified survey of 100 farms based on a face-to-face questionnaire and on-farm sampling
- To define changes in on-farm practice since the CSL survey published in 1997 and recommend changes to future practices and research to address major unresolved problems.

METHODS

Problems perceived by crushers and commercial storages.

CSL and Velcourt conducted telephone interviews with United Oilseeds and Cargills, two of the largest crushers in the UK, based on the questions in Appendix 1.

Selection of farms

The survey samples were based proportionately on the number of agricultural holdings from Defra arable statistics, shown as growing cereals and/or oilseeds in each of the old MAFF regions. The lists from Defra were compared to the similar data from the HGCA database and as there was over 80% consistency, it was concluded that the HGCA data was good enough to be used and had the advantage of containing more information such as contact details. The farms randomly selected for visits were first phoned to explain the survey and its benefits, check suitability such as the existence of rapeseed still in store and offer inducements such as feedback of sampling and free advice. Appointments for a visit with a face-to-face interview and sampling of a rape store were then made. The number of holdings interviewed for each region differed from the original plan as some farms had already sold their entire crop (Table 1).

Table 1. Distribution of survey samples

Old MAFF 'regions'	No. of holdings	No. farms to be visited	By	No. farms actually visited
East Midlands	2401	22	Velcourt	26
Eastern	2232	21	Velcourt	17
North East	692	7	TFG	5
North West	152	1	TFG	1
South East	1430	13	Velcourt	14
South West	938	9	Velcourt	10
West Midlands	921	9	Velcourt	9
Yorkshire and the Humber	1856	17	TFG	15
Scotland		5	TFG	4

Site visits

Out of the 101 sites visited by experienced storage consultants 25 were visited by TFG and 76 by Velcourt farm managers between November and March. At each site, a fact sheet (Appendix 2) was completed in consultation with the farm manager or owner. This was designed to collect information on quantities of rapeseed stored, pre-harvest issues such as desiccation and ripening, drying methods, cooling methods, crop monitoring, pesticide use, problems and rejections. Five equidistant seed samples from the surface and five from below the surface were taken for arthropod contamination and moisture content determination at the time of the store visit using a recommended protocol (Appendix 3).

Laboratory examination of samples

The samples were then posted or hand-delivered to CSL and assessed for arthropod pests by sieving through a 2mm mesh and examining the dust under a binocular microscope. Where numbers were very high, the dust was coned and quartered and a disc divided into areas was used (Solomon, 1962). Numbers of the different mite genera were noted. Moisture content were determined using the ISO oven method, by drying whole seed in a ventilated oven for 5h @ 103°C. Individual samples from about half the farms were analysed but for the latter half, the individual samples from the surface and from beneath were combined so effectively just two samples were examined as early appraisal indicated little variance.

RESULTS

Problems perceived by crushers

The two crushers received between 20 and 30% of loads from farm stores as opposed to central stores and although one felt the mc and admixture from central stores was more consistent than from farms, the other saw no differences. Rejections were in the range of 0.2-0.5% for one crusher, around 1% for the other, the reasons common to both included moisture content (high or low), admixture, green seed and burnt seed. Chlorophyll-contaminated seed is difficult to rectify in the crushing process and burnt seed has high free fatty acid (FFA) levels which degrade the oil after processing. The first two rejection reasons were also the commonest reason for price deductions.

Infestation was not regarded as big issue, there was no known link between mite infestation and rancidity but while one crusher thought this unlikely, the other thought it logical and there was no known issue preventing processing of mite infested rapeseed. However, one crusher noted allergies due to handling infested seed as a Health and Safety concern and the other cited dust. Neither crusher was aware of any mycotoxin problems related to rapeseed. One crusher noted high FFA due to incorrect dryer use in Scotland as a problem, the other was concerned by green seed caused by uneven growth in difficult years.

On arrival at the crushers, inspection was mainly visual, although one carried out tailgate inspections of farm loads. Contaminated loads were dealt with according to Federation of Oils, seeds and fats association (FOSFA) recommendations, blended where possible and rejected where the conditions could not be rectified. Normally rapeseed spent only a few days at the crushers before processing, reliance being largely on the contractor for the condition of seed on one site and temperature and visual assessment of pests were carried out at the other.

Future concerns included increase in mite contamination, due to lack of treatment options, green or burnt seed and polyaromatic hydrocarbons (PAH) levels in poorly-set dryers. The second crusher was concerned with extraction efficiency and preferred a larger proportion of large seed since small seed was lost in crushing. A risk assessment of diatomaceous earth (DE) application was thought necessary and, in conclusion, the key was better avoidance of problems before delivery to the crushers.

Pre-harvest information

The sites covered by the survey harvested 35,140 t of seed of which 31,193 t (88.8%) was for normal use, 3,787 t (10.8) % was for set aside and only 160 t (0.4%) was for biofuel. As oil prices continue to soar through lack of global production, most in the industry are forecasting a significant increase in the use of rapeseed as a biofuel.

The length of intended storage varied but most (ca. 72%) was stored for 3 months or more (Table 2). The sampled farms represented about 3.7% of the rape stored on farms at the time of the most recent survey (Dawson et al., 2005).

The 1995 survey did not detail lengths of storage so this survey has given us the first idea. The implications of the long storage periods indicated here are that recommendations of storage moisture contents should be on the conservative side to minimise mite infestation and deterioration through rancidity.

Table 2. Planned periods of storage

Storage time (months)	0	1	1-3	3-6	>6
Tonnes	2359	2493	3893	10693	11403
%	7.6	8.1	12.6	34.7	37.0

The reasons for the period for storage were scored 1-4 with 4 being the highest. Market strategy and cash flow were the main reasons given, with storage difficulties ranking much lower (Table 3). Other reasons given included contract storage (2) and market prices (1) and how well the seed stored (1).

Table 3. Number of sites and their reasons for choosing the period of storage

Score	Cash Flow	Market Strategy	Other uses For Store	Difficulties in Handling	Difficulties in Storing	No appropriate store	Other
1	14	1	27	31	28	34	1
2	17	6	4	10	10	3	0
3	16	15	5	0	4	2	1
4	12	73	16	1	5	1	2
0	42	5	49	59	54	61	95

Over three-quarters of the seed was stored on-floor (Table 4). The 1995 survey found that the percentage of capacity represented by external bins varied widely; 2 % for arable farms, 7% for mixed farms but nearly 60% for central stores.

Table 4. Mode of storage

	Floor	Internal bins	External bins
Tonnes	24774	5824	740
%	78.8	18.5	2.4

Of the different methods of desiccation available, glyphosphate was by far the most widely used, with natural senescence being the next most popular (Table 5). Reglone is not a favoured choice because it makes the pod too brittle and vulnerable to storm damage.

Table 5. Number of sites using different methods of desiccation

Glyphosphate	Reglone	Swathing	Senescence	Challenge	Desiccation	No answer
72	6	24	20	0	1	1

Nearly 30% of the sites experienced problems with ripening of the seed and of these, the greatest problems were when natural senescence or glyphosphate were relied on for desiccation (Table 6).

Table 6. Problems with ripening and associated desiccation methods

Problems with ripening	Yes	No
No. of sites	29	71
Glyphosphate	7	1
Reglone	1	1
Natural senescence	8	1
Swathing	3	3

Pigeons headed the list of other factors predisposing to uneven ripening (Table 7). Other reasons included game birds including pheasants (2), slugs (3), length of straws, drainage and early swathing.

Table 7 Other factors predisposing to uneven ripening

Score	Pigeon	Headland	Hedges	Rabbit	Uneven Establishment	Soil	Weather	Other
4	39	5	17	5	15	6	5	2
3	33	28	26	11	15	19	10	1
2	12	22	15	26	26	14	14	0
1	10	19	16	24	17	24	28	2
0	7	27	27	35	28	38	44	96

Harvesting started mainly between 9% and 16% mc with by far the greatest number of respondents starting at 12% mc (Table 8). No similar information was collected in 2005. The significance of the mc at harvest is that 12% is the critical level for production of Ochratoxin A, in equilibrium with 85% erh (Armitage, 2005) and this emphasises the importance for well-managed drying. However to date there have been no surveys of the occurrence in seed, oil or cake, of OTA.

Table 8. Number of sites starting to harvest at different moisture contents (mcs)

Mc	7	8	9	10	11	11.5	12	12.5	13	13.5	14	15	16	17	18	19	20	30
Sites	0	0	6	14	12	1	35	1	6	1	13	6	3	0	1	0	0	1

The rapeseed was cleaned by 39 of the farmers and 34 of these cleaned ALL of the seed (Table 9). The reasons given were to remove weed (18) or seed (5), because it was part of the drying or conveying system (4) removing pods (3) removing cereals (1) and habit (1). Most (22) used an aspirated sieve, 5 used aspiration alone and 11 used a sieve alone.

Moisture measurement and sampling

All farmers measured the mc as the seed went into store, all but one using a meter (Table 9). By far the majority, 84, calibrated the meter in the harvest year and 15 the previous year. However the definition of calibration varied, 43 sent the meter back to the manufacturer but 47 calibrated by comparison with another meter and 17 by measurement of a sample of known mc.

In 1995, only 40% were calibrated the same year, which suggests an improvement but in that year only 47% calibrated by sending back to the manufacturer compared with a similar 43% in this survey. Most of the others 'calibrated' by comparison with other meters or using a sample of known mc which depends on the accuracy of other (usually merchants') meters and means the check would only ensure agreement at the mc range tested. Since meters are vital, not just to check the mc meets the market requirement at sale, but to make decisions during drying, it is essential calibration covers the full range of the mc scale.

Table 9. Measurement of moisture content

Mc method		Calibration frequency		Calibration method	
Meter	100	This year	84	Manufacturer	43
Spear	1	Last year	15	Comparison	47
		More often	2	Known sample	17
				Cell	1
				Clinic	1

Samples for mc measurement were taken from each trailer on over ¾ of farms (Table 10) but the frequency varied- other responses included every half hour, every day, every 15 t and in store (2). The use of the information also varied but the commonest reason was to adjust the dryer settings although a sizeable proportion used the information to segregate the seed, blend or choose how deep to load the store.

Table 10. Sampling details

Trailers sampled		Use of sampling information	
Each	77	Segregation within different stores	19
1 in 2	2	Segregation within same store	12
1 in 3	2	Blending	17
1 in 5	10	Loading height	17
1 in10	4	Dryer settings	36
Other	7	Dryer decisions	7
		Other	5

Nearly half the farmers thought that 8% mc was the safe mc level for rapeseed storage (Table 11). Only 12 had different targets for short and long term storage of seed, 8-9% mc being the usual for short term and 7-8% mc for long-term storage. Only 26% thought the seed needed to be at the recommended 7.5% or below for safe storage and this is probably why mites are so prevalent in rapeseed stores. (This is an improvement in the 13 out of 94 sites that intended the grain mc to be below 7.5% in 1995.) The importance of small differences in seed mc on the equilibrium moisture and the limited accuracy of meters compounds the difficult of managing mc to eliminate mites.

Table 11. Perceptions of safe moisture levels for storage

Safe mc for long-term storage	Sites	Long and short term storage mc targets long	short	Sites
7	11	12	9	1
7.2	1	9.9	8	1
7.5	14	9.25	8.5	1
8	48	9	8	1
8.5	12	9	7.5	2
		9	7	1
		8.5	7.5	3
		8	7	2

Seed drying

All of the farms expected to dry the rapeseed and 33 of them used ambient-air drying. Of these, only two thought the systems were specifically designed for both rapeseed and cereals but 18 dried the seed at half the depth they would employ for cereals (Table 12). Most expected to dry in a fortnight. Other responses on drying times ranges from 10 days to 2 months as being reasonable and 10 days (1 response), 3 weeks (4) 2 months (3).

In 1995, about 80% of farms dried the seed and about one quarter (35% of arable and 15% of mixed) dried on-floor, so there had been little change here. In 1995, 44% dried the rapeseed at lower depth, to account for the greater resistance and ensure equivalent airflow to cereals which is a higher proportion than observed in the current survey. This may indicate a greater pressure on space. The 11 out of 35 that thought a month or more was reasonable for drying and 14 out of 35 that found this period was necessary in practice, indicate that about of a third of the ambient-air drying systems were not operating to specification as the airflow is calculated to pass a drying front through a bulk in 10 days.

Table 12. Details of ambient-air drying practice

Designed for		Height (compared to cereals)		Time to dry	Thought Reasonable	Found in practice
Cereal	33	Higher	1	Week	7	6
Oilseed	2	Lower	18	Fortnight	18	15
		Same	15	Month	8	6
				Other	3	8

Sixty five of the farms used hot-air drying, 61 serviced annually, one biannually and one never ! Thirteen of the 62 that answered had experienced a fire in the dryer and although 14 out of the 62 that replied did not check the temperature of seed in the dryer there was no connection between this and the fires; 25 % of those that checked and 8% of those that didn't had fires. This could be one reason why the crushers are getting more wary of PAH's in OSR .

Only ten of the farms using hot-air drying did not know the safe drying temperature settings although the range of values indicates that practice varied widely (Table 13). Clearer guidance on this issue seems required and it is noted that the information contained in the 'HGCA Grain Storage Guide' and the 'HGCA Oilseed rape guide' comes from Canadian sources. Determination by experiment of safe drying times with regard to market requirements of FFA levels may be advantageous.

Table 13. Maximum hot-air drying temperatures

°C	30	35	40	45	50	55	60	65	70	73	75	80	85	90	100	140	150
Sites	1	0	4	5	9	5	6	2	0	1	1	5	1	4	0	1	1

Seed cooling

Only 17 of the 101 stores did not use aeration to cool the grain but 75 of the 84 that did had systems designed for cereals, not oilseed, while 28 of these compensated for the increased resistance of oilseed by storing the rapeseed at a lesser depth than for cereals. However, 46 used the bulk drying system to cool the grain. This is the first indication we have had that nearly half of farmers use their ambient-air drying fans to cool.

It is interesting to note that in 1995, considerably fewer central stores compensated for the higher resistance to airflow of rapeseed (6%) than did the farmers (25%), presumably due to pressure on space or because the seed was already cool on intake but the proportion compensating this way has not increased greatly in the interim. It may not be so important to cool rapeseed as quickly as cereals as insects have difficulty in establishing in the oilseed and the rate of cooling in cereals is matched to breaking the life-cycle of the storage beetles. Practical scale tests have indicated that cooling of rapeseed at full depth may in any case be just as fast as with cereals as the fans operate for twice as long over the same time period (Armitage, 2005). The fact that 46 of the farmers used the floor dryers to cool complicates things slightly. In this case, the considerably higher airflow probably means that the compensation for higher resistance by reducing bed depth is unnecessary although there was no significant difference in crop depth between those that used the drying system to cool and those that did not (Chisquare= 0.29 df= 1, p= 0.59).

Considerably shorter cooling times would be necessary as drying flow rates are 20x higher than for cooling. The fans would only need to run for 20-30 h (or 40-60h using a cereals drying system) to cool below 10°C, compared with 200-300 (400-600h using a cereals cooling system) at cooling rates.

Seventeen farmers aimed to get to 5°C or below and 54 aimed to get between 10 and 5°C (Table 14). In 1995, only 7 sites intended to get below 5°C and 25 aimed to get below 10°C, so there has been a doubling in those expecting to reach the recommended storage targets in the interim. Most estimated it would take 1-3 months to reach their temperature targets but while only 3 reckoned it was reasonable to take more that 3 months to cool, in practice 19 took longer than that and the same number admitted to finding difficulty in cooling (Table 15).

A sizeable proportion of farmers therefore are not satisfied with cooling speeds and these could certainly be improved by simple thermostats and by monitoring hours of aeration more carefully. As with cereals, modeling new cooling strategies remains a priority to cope with warmer harvests and milder winters.

Table 14. Cooling temperature targets

°C	3	4	5	6	7	7.5	8	9	10	11	12	13	13.5	14	15	16	17	17.5	18	19	20
Sites	1	1	15	7	7	1	8	3	28	0	7	0	1	0	3	0	0	1	0	0	2

Table 15. Comparison of what is considered a reasonable cooling time with normal practice

Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Reasonable	2	5	0	21	0	1	0	3	0	0	0	37	0	0	0	1	0	0	0	2
Actual	2	7	1	7	1	5	0	7	0	1	1	25	2	1	1	7	0	1	0	7

Only four sites did not measure the temperature of rape during storage and of the remainder, 88 used hand-held probes and of the seven that had permanent installations, rhree of these additionally used hand probes. Seventy-three farmers only measured the temperature at one depth but 23 checked at more than one depth. Most measured temperatures, weekly, fortnightly or monthly but there were a variety of approaches (Table 16). Often measurement frequency was increased with length of storage and the answers to this question probably mainly apply to the initial period of storage. Other answers indicated one respondent using continuous automatic temperature recording, and frequencies ranging from 'hardly ever' to 'twice since harvest'. No such detailed questions about temperature measurement were asked previously.

Table 16. Frequency of temperature measurement

Frequency	week	fortnight	month	week 1st month 2nd	fortnight 1st month 2nd	week 1st fortnight 2nd month 3rd
Sites	15	34	31	7	1	1

Storage problems

Just 17 farmers used no detection methods for pest problems during storage and by far the most (51) used pitfall-cone (PC) traps (Table 17). Only 20 used the traditional methods of sieving and/or sieving samples. It is probably worth noting that many of the farms did not actually place the traps in the seed !

In 1995, no farms used PC traps and about 20% of sites sampled and sieved. At that time, the greatest reliance (64% of sites) was on visual assessment of the seed condition. The increase in the use of traps to monitor pests can be attributed to their being a requirement of assurance schemes but the likelihood of finding insects is minimal since few species develop on rapeseed. However, Defra commissioned work has shown that they are the most sensitive way of detecting low infestations of mites (Dunn, CSL, Personal Communication).

Table 17. Detection methods

Method	Sites
spear	17
vacuum	0
sieve	3
probe	12
pit	51
PCtrap	12
Bugpit	1
baitbag	15
PCfloor	0
BTmite	2
sticky-roach	1
visual	13
smell	1
heat	1
none	17

Problems with seed heating occurred on 22 sites, although fungi and admixture were the most common assumed culprits, there was no clear consensus on the reasons for heating (Table 18). Mites were the greatest problem, noted on 27 sites against which pesticides and cooling were most likely to be employed. Of the varied remedies, only hygiene was thought to have failed.

Rejections were admitted by 15 sites, usually only one load was involved and by far the commonest cause was admixture (Table 19). However, there was no significant difference between the proportion that cleaned seed and were rejected and those rejections that did not clean the seed (Chisquare=0.64, df=1, p=0.43).

Table 18. Problems in store

Problem	Sites	Reasons for heating	Sites	Pest remedy	Sites
mite	27	Admix	5	Cooling	4
mite, beetle	1	Admix, fungal,	1	Clean	1
mite, rodent	1	Admix, roof leak	1	Cool, clean	1
beetle	0	Fungal	5	Hygiene	1
mice	2	Fungal, mite	1	Pesticide, cool	1
Seed heating	22	Immature seed	2	Pesticide	5
		Insect, mite	2	DE	2
		Opico drying systems ?	1	Pesticide-Actellic surface	1
		Other-blend wet seed	1	Convey, aspiration	1
		Insect/mite caused by dust	1	Rake surface	1
		Operator error	1	Turned	1
		No answer	1	Cold air	1
				Contractor	1

Table 19. Rejections, reasons, quantities and storage time

Rejection 1			Rejection 2		
Tonnes	Months	Cause	Tonnes	Months	Cause
30	2	Mite			
8	1	Cleavers			
30	0	Cleavers			
30	3	Admixture			
30	5	Heating			
20	2	Admixture	-	-	Green seed
25	4	Admixture			
28	1	Admixture			
60	-	Charlock seed			
29	2	Cleavers			
26	6	Too dry			
20	0	Admixture	20	-	Admixture
30	5	Taint			
25		Admixture			

Although mites are perceived by farmers as a problem, it is interesting to note that they caused only one rejection. Conveying usually kills the soft-bodied mites and crushers do not hold rapeseed for long before processing which limits their build-up. Nevertheless the products of their contamination, such as allergens will endure. It is therefore important to establish a tolerance threshold since they are invariably present. Research to correlate mite numbers with increasing FFA levels would be a sensible way of doing so. Seed heating which invariably causes changes in FFA was almost as great a threat as mites. This was also noted by a third of commercial stores in the 1995 survey. However, the exact cause of heating in seed that is apparently too dry for serious fungal heating, characterised by some merchants as ‘immature seed heating’, is unclear. This may be due to oxidation or hydrolysis of the oil but research to clarify this point would be helpful.

Pesticide use

Fabric treatment using pesticides were not carried out by 14 farmers but 87 did and of these only 14 used contractors, the remaining carrying out the treatment themselves. Most used pirimiphos-methyl (Actellic), either on its own or combined with a smoke bomb (Table 20). Three sites used some form of treatment, two using diatomaceous earths (which do not require approval and work by physical means) and one using Actellic liquid (which is not an approved use). All these treatments were rated as ‘very effective’. Contentment with the available pesticide options was expressed by 63 farmers but a sizeable minority (21) demurred.

In 1995 about 30% of farmers did not fabric treat and 20% admixed the seed with chemicals. Since then, approval of admixture of pesticides to seed has been withdrawn, so it could be argued that this accounts for the slight increase in fabric treatments. Only two sites used the alternative treatment, surface admixture with DE and it could be that knowledge of this option is not yet very widespread. However, it is not recommended as a total admixture and this may be why a fifth are not satisfied with the control options. Clearly this area would benefit from further research to satisfy the need.

Table 20. Pesticides used

Pesticide	Sites
Actellic -liquid	45
Actellic-liquid, Actellic-smoke	30
Reldan-liquid	6
Reldan-liquid, Acellic-smoke	3
Actellic-smoke	2
No answer	1

On-farm sampling of the 2004-5 harvest

Samples were taken from 71 floor stores, 25 internal bins and five external bins holding respectively 14,293, 2,821 and 317 t of rapeseed. Eighty-three of these had received fabric treatment, usually Actellic although 8 had used Reldan. Only 3 had treated the seed, one had top-dressed with Actellic, one had sprayed the surface with liquid and the third did not specify.

Very little seed was harvested at or below 9% mc; most was 12.5% mc (Table 21).

Table 21. Moisture content at harvest

% mc	8	9	9.5	10	11	11.5	12	12.5	12.8	13	13.5	14	14.5	15	16	17	18	20	22	30
Sites	2	1	2	5	1	15	2	24	1	6	1	8	2	4	6	2	3	5	1	2

There was relatively close agreement between what the farmer thought the mc was and the oven measurements at CSL: 60 sites had mcs below 8% compared to 72 that thought it was (Table 22). This difference nevertheless stresses the narrow margin for error when measuring rapeseed mcs. As expected, the moisture contents measured at the surface (16 sites below 9% mc) were much higher than those beneath (86 sites below 9% mc). The mean difference was 2.2% mc (SE=0.16) but there was no significant correlation between surface and 1m mcs (correlation coefficient=0.19, df=96, p=0.061). The high surface mc is due, firstly, to condensation of moisture in hot air from the freshly harvested seed on the grain surface during the early stages of cooling or particularly if the seed is stored without cooling and secondly, to the uptake of moisture from damp air throughout the winter. This explains the preponderance of mites at the surface compared with their infrequent occurrence in the bulk (see below).

Table 22. Comparison of sampled mcs with farmers' expectations

MC range from (%)	to (%)	MC surface	1m	estimated
6.1	6.5	0	2	4
6.6	7	1	13	5
7.1	7.5	3	25	22
7.6	8	2	20	41
8.1	8.5	3	15	19
8.6	9	7	11	7
9.1	9.5	19	6	0
9.6	10	10	1	2
10.1	10.5	15	5	0
10.6	11	13	1	0
11.1	11.5	11	0	0
11.6	12	8	0	0
12.1	12.5	2	0	0
12.6	13	2	0	0
13.1	13.5	1	0	0
16.1	16.5	1	0	0

Eighty-two sites had aerated the seed during the storage season, 43 hadn't recorded the hours or run the fans and of the remainder, hours run ranged from 80 to 1440, with mean of 215 and a median of 80 (Table 23).

Table 23. Hours run by the aeration fans (where they were recorded)

Hours	Sites
up to 24	2
25 - 48	14
49 - 72	12
73-96	5
97-200	13
201-400	4
401-1000	2
1000-1500	5

Some answers indicated the fans had been running for weeks, but it is possible they may have been switched intermittently, without records being kept. Hours of fan operation are critical for assessing whether or not the cooling system is working properly and the information recorded in this survey, which probably also applies to cereals storage, indicates that this aspect of record keeping needs to be tightened up.

Considerably fewer hours of fan running were recorded where a bulk dryer was used to cool compared to conventional cooling systems (Table 24: t test on means of log. hours; t=2.58, df=48, p=0.013).

Table 24. Means and 95% confidence limits for fan hours

Hours		Bulk	Conventional
	mean	75.3	171.7
	lower95%CI	55.4	82.4
	upper95%CI	102.3	357.8

While only 26 farmers thought their seed was above 10°C, over 39 were found to be so which indicates that recording accuracy, frequency or record keeping could be improved (Table 25). If 43 farmers managed to get their seed below 10°C, then it implies that the remaining 39 should also be able to do with improved techniques.

Table 25. Comparison of mean temperatures at 1m with farmers' expectations

° C	No. sites	
	Expected	Observed*
0-5	6	4
6-10	59	39
11-15	22	30
16-20	4	9
> 20	1	0

* Temperature measurement was omitted at a number of farms

Just one farm was found to have insects in the seed and here there was a serious of infestation of *Cryptolestes ferrugineus* (Stephens) of about 100/kg beneath the surface and several hundred / kg at the seed surface. This was associated with, but probably not the cause of local areas of warm grain at 23°C in December when the rest of the seed was 10-14°C.

Acarus spp were found to be the commonest mite genus at the surface of rapeseed, 32 farms having infestations in excess of 10,000/kg compared with only 8 farms with *Lepidoglyphus* above this threshold (Table 26). Below the threshold of 10,000 / Kg neither *Acarus* (16 farms) or *Lepidoglyphus* (17 farms) dominated. Beneath the surface, 8 farms had *Acarus* exceeding 10,000/kg compared to only 2 where *Lepidoglyphus* dominated. Below this threshold, dominance was approximately equal with *Acarus* predominating on 20 farms, compared to 22 with *Lepidoglyphus* predominant.

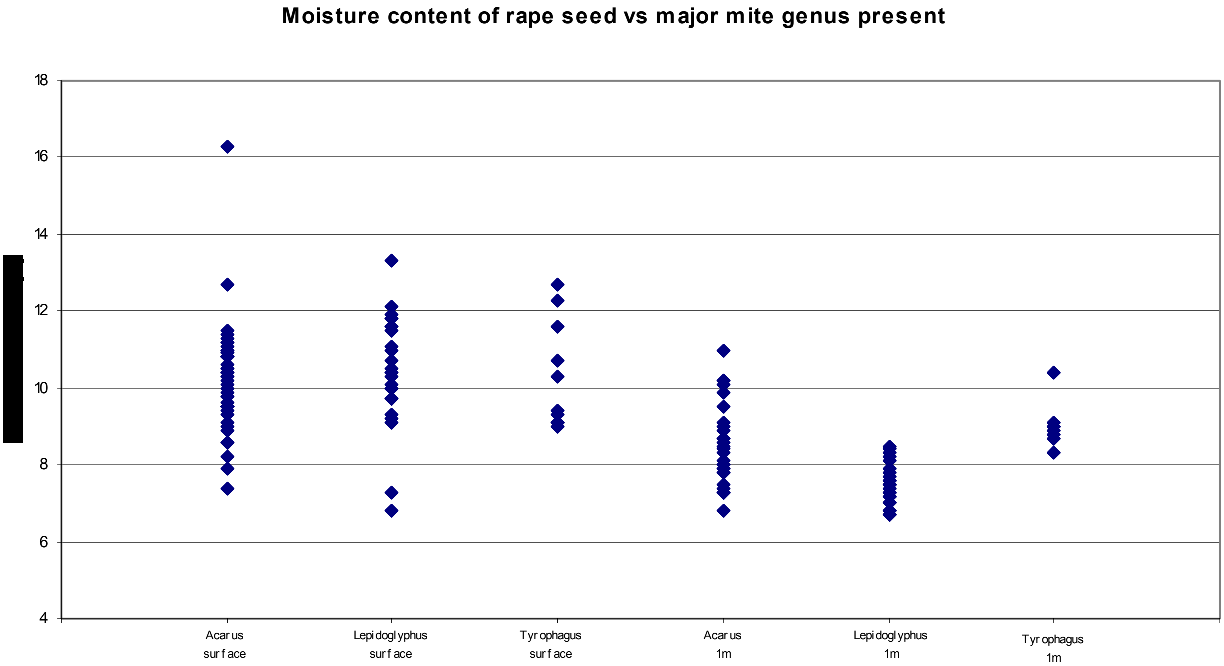
Table 26. Dominant mite genera and the infestation level in samples from the farms

Mites per kg	< 10	10-100	100-1,000	1,000-10,000	10,000-100,000	100,000-1,000,000	>1,000,000
a. Surface							
Acarus	0	3	3	10	22	10	1
Lepidoglyphus	1	2*	7	8	4	4	0
Tyrophagus	2	2	0	5	2	0	0
Cheyletus	0	3*	2	2	0	0	0
Gamasid	1	4	0	2	0	0	0
b. 1 metre							
Acarus	5**	7	3	7	5	3	0
Lepidoglyphus	2	11	6	3	2	0	0
Tyrophagus	2	2	0	4	0	0	0
Cheyletus	3*	15	6	2	0	0	0
Gamasid	3*	7	1	0	0	0	0

* 2 spp co-dominant

To establish if there was a dominance of one mite over another at different mcs (Fig.1), non-parametric Kruskal-Wallis ANOVA, using ranking rather than values was used, as the variances differed greatly. This showed there was no significant difference between the occurrence of different genera at different mcs at the surface ($H = 1.79$, $p = 0.41$) but there was beneath ($H = 22.91$, $p < 0.001$). Using Mann-Whitney U tests, beneath the surface, there was a significant dominance of *Acarus* over *Lepidoglyphus* at higher mcs ($U = 135$, $p = < 0.001$) and a dominance of *Tyrophagus* over *Lepidoglyphus* at higher mcs ($U = 2.5$, $p = < 0.001$) but no significant dominance relationship between *Acarus* and *Tyrophagus* ($U = 64.5$, $p = 0.071$).

Fig. 1.



In 1995, there was no quantitative estimation of mites and no comparison of superficial problems at the surface with deeper-seated infestations in the bulk. However *Acarus* was most commonly encountered, in 89% of stores and it remains the mite that one encounters in higher densities in damper seed. Mites inevitably exist in all commodities at most moisture contents and are conspicuous at the surface where they may reach high populations, however carefully the bulk is dried, because the mc increases throughout the winter due to moisture translocation and/or uptake of atmospheric moisture. However it is important to avoid unnecessary treatments which are not cost-effective if the end-user is not concerned and if there is no health issue attached. For this reason, it is a definite requirement to establish sensible market thresholds for mites by associating population levels with damage to market quality, in this case ffa levels and to health hazards, the most sensitive of which would be allergen levels in seed, cake and the pressed oils.

There were significant correlations between the number of mites at the surface and those beneath (r=0.63, df=97, p<0.001) (Fig 2), between the surface mc and the number of mites there (r=0.36, df=96, p<0.001) (Fig 3) and the mc at 1m and the number of mites there (r=0.62, df=93, p<0.001) (Fig 4).

Fig 2.

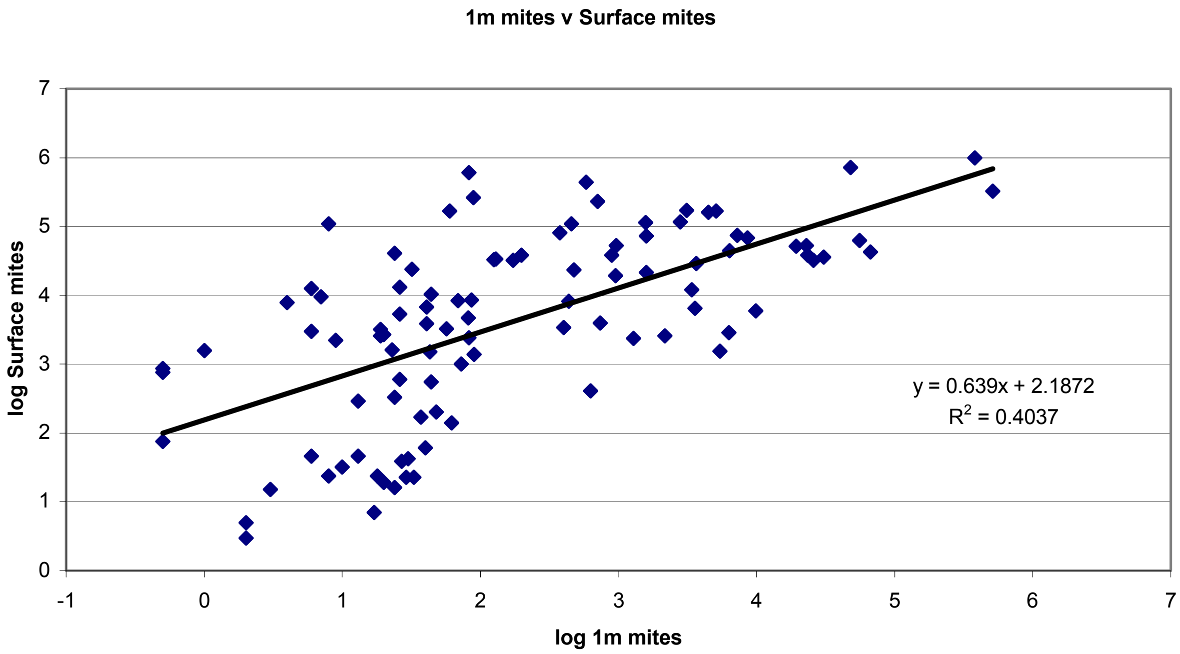


Fig 3.

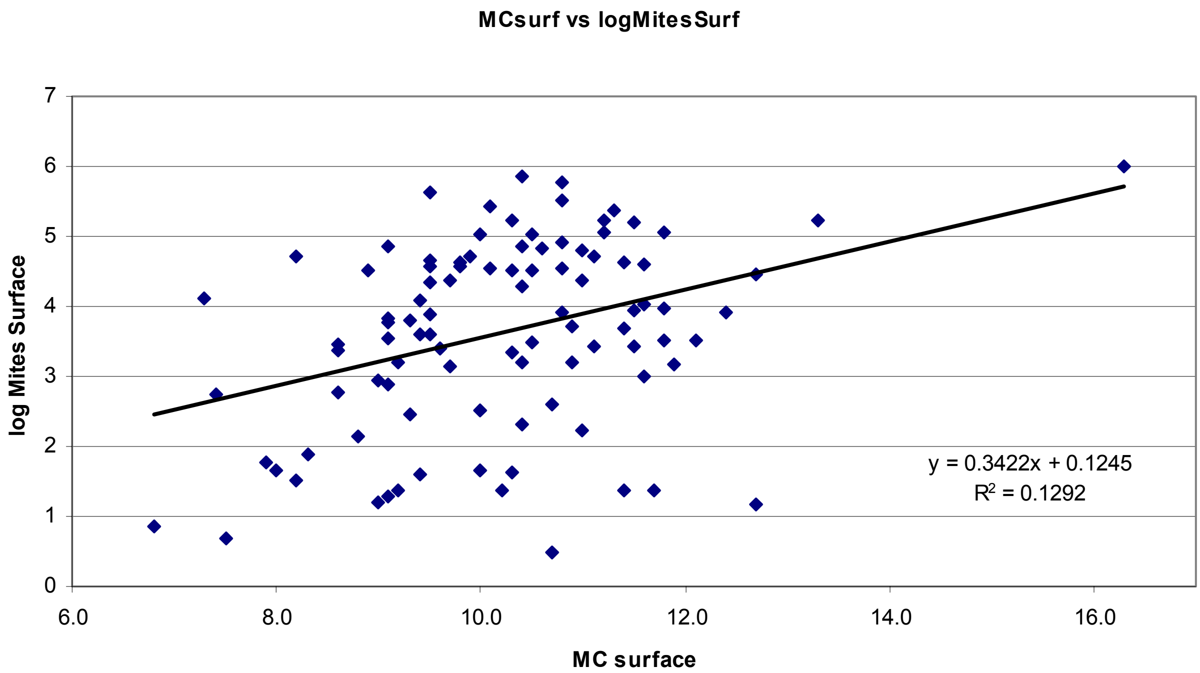
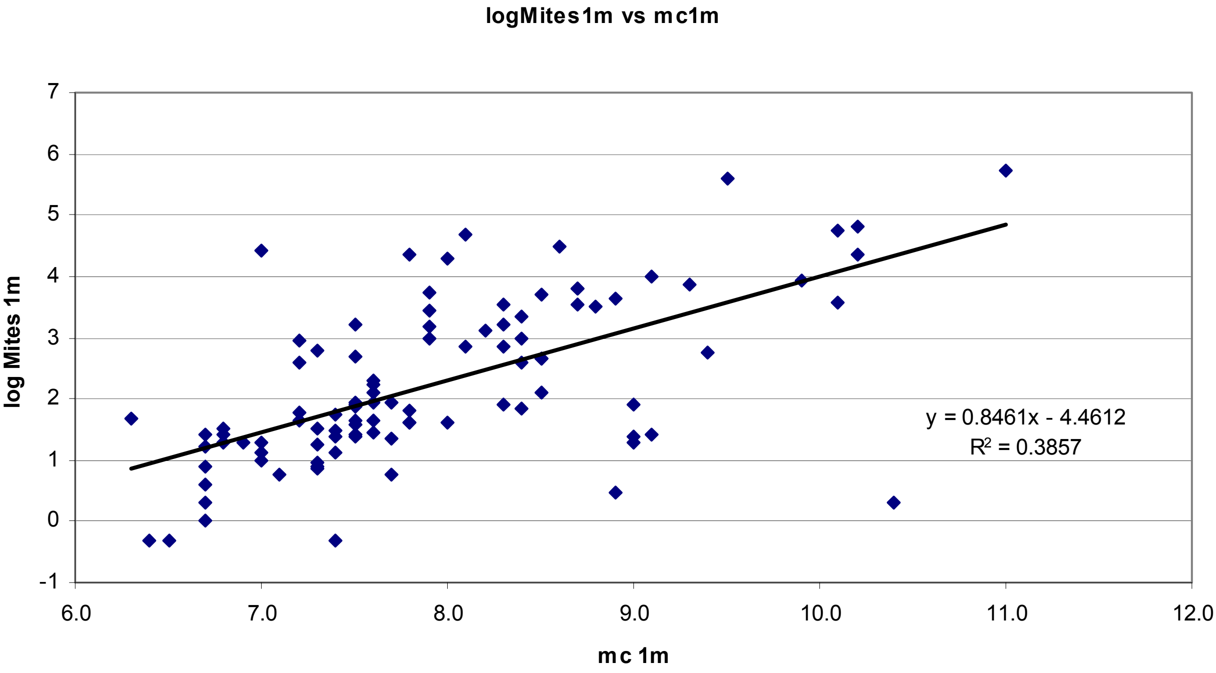


Fig. 4.


logMites1m vs mc1m
log Mites 1m
7
6
5
4
3
2
1
0
-1
6.0
7.0
8.0
9.0
10.0
11.0
12.0
mc 1m
y = 0.8461x - 4.4612
R² = 0.3857

CONCLUSIONS AND RECOMMENDATIONS

Two-thirds of farms need to dry rapeseed and most harvest above 12% which is in equilibrium with the critical mc threshold for the production of ochratoxin A (OTA). OTA is not denatured by heat and may remain therefore in the oil or the cake. EU regulations demand that industries exercise due diligence with respect to regulatory levels of mycotoxins. A survey of OTA levels in rapeseed is therefore recommended since most oil is still used for human consumption.

Moisture measurement is most commonly relied upon for hot-air dryer settings yet less than half of the farmers calibrate the meters properly by returning them for calibration to the manufacturers. This is the only way to ensure accuracy across the mc scale and is critical for safe storage and it is therefore recommended that the importance of manufacturer calibration is publicised. It may be argued that since there were no rejections for mc, measurement accuracy is not an issue. However, this is easily explained by the fact that crushers accept up to 10% mc. In this condition, the seed is open to a variety of quality deterioration.

Only one-quarter of farmers accepted that 7.5% was the safe mc for long-term harvest and although this frequency is an improvement (almost double) the response 10 years ago, this recommendation still needs emphasising.

One third of farms using floor-dryers took over a month to dry the seed. In view of the threat from mycotoxin production detailed above; associated advice and improvement to floor drying might well be required.

There is no clear consensus on safe drying temperatures for rapeseed when hot-air drying. Clearer advice, resulting from research associating safe drying temperatures with FFA levels is required, particularly since quality problems associated with hot-air drying were a concern of end-users.

About 20% of farmers admitted to difficulties in cooling which is unsurprising since about the same proportion did not compensate for the increased resistance to airflow of rapeseed compared with cereals, although nearly half overcame the problem by using the higher airflows of the floor dryer to cool. There is likely to be a similar frequency doing so with cereals. This is the first clear indication we have had of this practice and greater experimental experience as a basis for advice on this practice is clearly called for in association with the models above. It could be argued that research is not required to catch up with what farmers are already doing in practice but the variability in fan running time and the complications of operating ambient air drying systems to cool the grain all indicate the benefit of adapting engineering cooling models to develop faster cooling strategies for rapeseed.

Most rejections were for seed admixture which can be best remedied by improvements in weed control and cleaning practice.

One-fifth of farmers experienced seed heating which causes rancidity and therefore affects market quality, yet there is no clear indication in the literature of the cause when it is not the obvious fungal-initiated heating of damp seed. The phenomenon is colloquially known as 'immature or green seed heating', sometimes (probably erroneously) attributed to admixture and it is not clear whether this is some process of oxidation or hydrolysis. Research is required to clarify this.

More than a quarter of farmers had problems with mites; 43 had infestations in excess of 10,000/kg at the surface but only 10 had similar populations beneath, indicating it was a superficial problem caused by uptake of mc at the surface during the winter. Mites were not a great concern of the crushers and there were few rejections citing mites as a cause. Nevertheless, they clearly cause farmers great concern and a great deal of expense and energy is expended on their behalf. In addition, EU food and feed regulations demand due diligence and that 'action thresholds' for contaminants are set. The US FDA catagorise mites as chemical contaminants and a Level 1 risk to health. It would be all too easy to use mite incidence in British produce as a tariff barrier. It is therefore recommended that a study be carried out to define market thresholds of mites with regard to effect on FFA and allergen levels.

Available remedial treatments for mites are few. No pesticides can be admixed and the only available remedies, diatomaceous earths, can only be top-dressed and there is limited practical experience of their efficacy. Perhaps as a result one-fifth of farmers expressed discontent with available treatment options. The only other option is fumigation and information on its efficacy against mites is equally limited. Research on these treatment options would also therefore be beneficial.

Perhaps because of the limited pesticide options to treat the grain, fabric treatments have doubled since 2005 although there is no indication of their effectiveness in limiting mite numbers (the same is true for cereals storage). This is another area where objective scientific research would be beneficial in minimising unnecessary pesticide use and expenditure.

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APPENDIX 1 – CRUSHER QUESTIONNAIRE

OSR HGCA SURVEY, CSL AND VELCOURT LTD.

1. What percentage of OSR is received direct from farm stores as compared with a centralised store?
2. Are there any perceived or actual differences in the quality and/or condition of OSR received directly from farm stores v's centralised stores?
3. What percentage loads, if any are rejected?
4. Why would they be rejected?
5. For what reasons would price deductions be made?
6. Are all loads of OSR routinely inspected for mites and other storage pests on arrival? If not, what other factors present in a particular load would make sampling take place?
7. What mechanisms are in place to deal with contaminated loads?
8. Are contaminated loads stored separately prior to crushing?
9. What are the tolerance levels/ thresholds for mite/pest infestation?
10. If mite infested OSR is crushed, does the mite presence in the oil cause any other problems further up the process?
11. Is rancidity in a sample considered to be related to mite infestation?
12. Are there any health and safety issues at the crushing plant specifically related to OSR?
13. What is the average length of time OSR will be stored on site before crushing.
14. What sampling for temperature, mc rise, pest infestation etc. take place in the store on site?.
15. Are there any geographic locations that could be pinpointed where specific problems arise with OSR samples?
16. Are there any climatic conditions that could be pinpointed which result in specific problems with OSR samples?
17. How common an occurrence is a mixed colour rape sample, how does this affect the crushing process and is there any adverse effect on oil % or quality?
18. Are mycotoxins considered to be a problem?
19. Are loads of rape with mixed colour treated any differently on intake i.e. more moisture content surveillance?
20. Are there any specific problems with storage and/or crushing of different types or varieties of OSR?

APPENDIX 2 – FARMER QUESTIONAIRE

HGCA-FUNDED OSR STORAGE PROJECT ON FARM RAPESEED STORES – 2004-2005

1. Reference number: (Leave Blank) ....

2. Farmers Name: ....

3. Farm Name: ....

4. Farm Address: ....

....

....

5. County: ....

6. Post Code: ....

7. CSL/Velcourt Adviser: ....

8. Date of Visit: ....

SITE DESCRIPTION

9. How much rapeseed was harvested (tonnes)?

10. How much of the total tonnage was:-

Normal regime	
Set aside	
High Erucic Acid	
Grown for biofuel	

11. How long do you normally plan to store your rapeseed? (ie what is your marketing strategy/sales plan)

Time after harvest	**Tonnes**
Sold directly off farm	
1 month	
1-3 months	
3-6 months	
> 6 months	

12. What determines how long you store rapeseed? (score 1-4 where 4=highest)

a. Cash flow	
b. Marketing strategy	
c. Other uses for store	
d. Difficulty handling rapeseed	
e. Difficulty storing rapeseed	
f. Don't have appropriate store for rapeseed	
g. Other (specify)	

13. What type of store do you use for OSR ?

	(*tonnes*)
Floor-store	
Internal bins	
External bins	
Other	
Total	

HARVESTING

14. What methods of desiccation do you normally carry out:

a. Glyphosate	
b. Reglone	
c. Swathing	
d. Natural senescence	
e. 'Challenge'	

15. Do you have problems with uneven ripening (red/green/immature seed).

☐ Yes ☐ No*

* If no, go to 17

16. In your experience, is there a method of desiccation that predisposes towards this problem?

a. Glyphosate	
b. Reglone	
c. Swathing	
d. Natural senescence	

17. What other factors predispose towards uneven ripening? (score 1-4 where 4= highest)

a. Pigeon damage	
b. Headland effect	
c. Adjacent woodland or hedges	
d. Rabbit damage	
e. Uneven establishment	
f. Varying soil type	
g Weather	
h. Other – please specify	

18. What moisture content would you normally start harvesting OSR?

% mc

19. Do you clean rapeseed before it goes into store?

☐ Yes ☐ No *

* If no, go to 23

20. If so what proportion?

%

21. On what basis do you decide to clean?

Weed admixture (cleavers, volunteer cereals etc.	
Broken seed	
Other (state)	

22. How do you clean?

Sieve	
Aspiration	
Aspirated sieve	
Other (specify below)	

……
…………………………………………………………………………………………

23. Have you had loads of OSR rejected or penalized because of admix of weed seed, or other grain contamination,.

☐ Yes* ☐ No

24**.** If Yes to the above, please give details
If no go to 25.

STORAGE

25. Is the moisture content of the **rape seed** normally measured as it goes into store?

☐ Yes* ☐ No

If No go to 34

26 If 'Yes':
How is the moisture content measured?

Meter: ☐ Yes* ☐ No

Other method (specify):..

....

27. If a meter is used,

a) When was it last calibrated?

This year	
Last year	
More than a year ago	
Never	

b) How was it calibrated?

a. By manufacturer	
b. By comparison with another meter (eg merchant/ end-user)	
c. Using a sample of known mc	
d. Using a calibration cell	
e. Other (specify below)	

……………………………………………………………………………………………

28. Do you sample from:

a. Each trailer load	
b. 1 in 5 trailer loads	
c. 1 in 10 trailer loads	
d. Never	
e. Other (specify below)	

……………………………………………………………………………………………………
………………………………………………………………………………………

29. How do you use this moisture content information to manage the rapeseed in store?

a. Segregation into separate stores	
b. Segregation within same store	
c. Blending	
d. Height of loading into store	
e. Other (specify below)	

…………………………………………………………………………………

30. What do you consider to be the safe moisture content for long term storage of rapeseed?

% mc

31. Do you have a different moisture content target for short term (1-3 months) and long term (>3 months) storage?

☐ Yes ☐ No*

If No go to 34

If Yes to the above:-

32. What is your moisture content target for short term **rape seed** storage?

% mc

33. What is your moisture content target for long term **rape seed** storage?

% mc

34. Is the **rape seed** normally dried for storage?

☐ Yes* ☐ No

*If 'Yes', is it by:

Hot-air drier ☐ Yes ☐ No
Ambient/near-ambient on-floor drier ☐ Yes* ☐ No

If Hot Air Drier only, skip to: 38

ON-FLOOR/ AMBIENT AIR DRYING (for hot air drying systems, go to 38)

35. *If 'Yes' to on-floor:
Is the system designed for cereals or specially for oilseeds? ☐ For cereals ☐ For oilseeds
Is oilseed stored to the same height as cereals? ☐ Yes ☐ No*

*If 'No' to same height:
Is oilseed stored higher or lower than cereals? ☐ Higher ☐ Lower

36. What do you consider to be a reasonable length of time to dry your seed on-floor?

a. 1 week	
b. 2 weeks	
c. 1 month	
d. Other (specify)	

37. Typically, how long does it take in practice?

a. 1 week	
b. 2 weeks	
c. 1 month	
d. Other (specify)	

<u>If you do not use a hot-air dryer skip to 42.</u>

HOT AIR DRYERS

38. How often do you have your hot-air grain dryer serviced ?

a. Never	
b. Annual	
c. Every two years	
d. Other (specify below)	

39. Have you ever had a fire in your hot-air grain dryer ?

☐ Yes* ☐ No

If so, specify the cause below

……………………………………………………………………………………………………

………………………………………………………………………………….

40. Do you check the temperature of the OSR during its passage through the grain dryer.

☐ Yes* ☐ No

41. Are you aware of the maximum temperatures that shouldn't be exceeded when drying OSR.

☐ Yes* ☐ No

If Yes enter your temperature here: °C

COOLING

42 Is the **rape seed** normally cooled in store using an aeration system?

☐ Yes* ☐ No

*If 'Yes' :

Is the system designed for cereals or specially for oilseeds	☐	For cereals	☐	For oilseeds
Is oilseed stored to the same height as cereals?	☐	Yes	☐	No*
Do you cool using the bulk drying system ?	☐	Yes	☐	No

*If 'No' to same height:

Is oilseed stored higher or lower than cereals? ☐ Higher ☐ Lower

43. What temperature do you aim to achieve by cooling? .... °C

44. What do you consider to be a reasonable length of time to cool your seed on-floor to this temperature ?

a. 2 weeks	
b. 1 month	
c. 3 months	
d. Other (specify below)	

……………………………………………………………………………………………………
……………………………………………………………………………….

45. Typically, how long does it take in practice?

weeks

46. Do you have difficulty cooling?

☐ Yes* ☐ No

47. Is the temperature normally measured in storage?

☐ Yes* ☐ No

If no go to 51.
*If 'Yes':

48. How frequently?

a. Weekly	
b. Fortnightly	
c. Monthly	
d. Other (specify below)	

49. How is the temperature measured?

a. Hand-held probe	
b. Permanent probes	
c. Other (specify below)	

……………………………………………………………………………………………………
……………………………………………………………………………

50. Where (what depth) is it measured?

a. One depth (eg 1m)	
b. More than one depth (eg 1m intervals)	
c. Other (specify below)	

……
……………………………………………………………………………………

51. Have you experienced any problems due to seed heating?

☐ Yes ☐ No

If Yes state reason:

Admix	
Immature /Red /green seed	
Fungal heating due to high mc	
Insect or mite presence	
Other (state)	

PESTS DETECTED DURING THE YEAR

52. Have there been pest problems in any **rape seed** at this site at any time during the last <u>36 months</u>? (*tick*):

Mites	☐ Yes	☐ No *
Beetles	☐ Yes	☐ No *
Other including rodents	☐ Yes	☐ No *

<u>If no –go to 55.</u>

53. Was control attempted?

☐ Yes* ☐ No

If so, state treatment eg extra drying, conveying, pesticide

………………………………………………………………………………………………

………………………………………………………………………………………………

54. Was control achieved?

☐ Yes* ☐ No

55. What insect/mite detection methods have been used to monitor stored **rape seed** during the last 12 months? (*circle*):

NONE
Sampling methods
Spear & sieve
Vacuum & sieve
Sieve
In-grain monitors
Probe trap (eg Storeguard)
Pitfall trap (eg beer mug)
PC trap/Bugpit
Floor monitors
Baitbag/PC Floor
BT mite trap
Others
Sticky trap - window
Sticky trap - roach
Visual
Other*

- If 'Other', please specify:

……………………………………………………………………………………………

……………………………………………………………………………………………

56. Have you had any **rapeseed** rejected or penalised during the last 36 months

	Yes	No
Immature/green seed		
Insects		
Mites		
Oil		
FFa / Rancidity		
Broken seed		
Seed too wet		
Seed too dry		
Seed too hot		
Smell		
Admix		

*If 'Yes', please give details:

	Tonnes	How long had it been in store?	Cause of rejection	
1.	....	....	....	....
2.	....	....	....	....
3.	....	....	....	....
4.	....	....	....	....
5.	....	....	....	....

PESTICIDE USE ON STRUCTURE

57. Has the fabric or machinery of any **rape seed** store been treated with pesticide in the last 12 months? (*tick*):

☐ Yes ☐ No*

**If 'No', skip to Question 61.*

58. Please specify where the treatments were carried out (*tick*):

Floor-store	
Internal bins	
External bins	
Other	

59. Who carried out the treatments? (*circle*):

Rapeseed store	Own staff	Contractor	Other*

* If 'Other', please specify:........

60. What insecticides or fumigants were used on the store fabric or machinery in the last 12 months? (*Give full commercial product name of insecticide if possible*):

Insecticide & Formulation

i. Actellic liquid........ ....
ii. Reldan liquid........ ....
iii. Crackdown Rapide........ ....
iv. Actellic smoke........ ....
v. Other (details below)........ ....

....

....

TREATMENT OF OILSEED

61. Has any **rapeseed** been treated with pesticide in store in the last 12 months? (*tick*):

☐ Yes ☐ No*

If No skip to 66.

62. If Yes to the above, which ?

Insecticide & Formulation

1. Diatomaceous earth (Demeter, Silicosec) ....
2. Phosphine fumigant..
3. Methyl bromide fumigant..
4. Other (details below)..

....

....

63. Why was the **rapeseed** treated? (*circle*):

Insects:	Infestation	Prophylaxis
Mites:	Infestation	Prophylaxis

64. Detail the treatment (eg top-dressing or total admixture and dose.

Top-dressing	Total admixture	Dose

65. Please rank the apparent effectiveness of treatments on a scale of 1 (no apparent effect) to 4 (very effective): (*circle*):

Against insects:	1	2	3	4
Against mites:	1	2	3	4

66. Are you content with available control options ?

☐ Yes ☐ No

SAMPLE DETAILS
(To be filled in at the time of sampling the seed).

67. Store number
(For additional stores on the same site, use separate Store Assessment Sheets)

68. What sort of store is it? (*tick*):

☐ Floor store ☐ Internal bins
☐ External bins ☐

69. How much rape seed was present?

☐ *tonnes*

70. WAS THE FABRIC OF THE BUILDING BEEN TREATED WITH INSECTICIDE IN THE LAST 12 MONTHS?

☐ Yes* ☐ No

*If 'Yes', what with?..........
(*Give full commercial product name of insecticide if possible*)

71. Has this sample of **rapeseed** been treated with insecticide in the last 12 months?

☐ Yes, admix* ☐ Yes, surface* ☐ No

*If 'Yes', what with?..........
(*Give full commercial product name of insecticide if possible*)

72. HAS THE RAPESEED BEEN DRIED THIS YEAR ?

73. If so what was the initial maximum mc.

74. WHAT DO YOU THINK THE MC IS NOW?

75. Has the rapeseed been cooled this year ?

76. IF SO – FOR HOW MANY HOURS HAS THE FAN RUN ?

77. What do you think the rapeseed temperature is now?

.

POSITION OF SAMPLES

77. Reference number:..

78. Site name:..

79. Store number:.............. ....

80. Sketch a plan showing the position and identifying numbers of the samples:
Note: The identifying numbers are marked on the traps.

*

MITE COUNT AND MOISTURE OF SAMPLES
(To be filled in at CSL when analysing samples)

	Surface		*1m*		
	mites	*mc*	*mites*	*Mc*	*Temps*
Sample 1					
2					
3					
4					
5					

Please return completed fact-sheet to:
D. Armitage, Central Science Laboratory, sand Hutton, York. YO41 1LZ

APPENDIX 3 – PROTOCOLS FOR SAMPLING RAPESEED

Apparatus required:

- Sampling spear (preferably 200g but the same wt can be made up from multiple samples at the same point.)
- Temperature spear
- Sample bags (sealable, preferably snap-lock)
- Indelible pen

1. Choose a representative batch of seed for sampling from the site visited. This may be a bin, a heap on the floor or a floor store.

2. Take five equidistant 200 g gravity spear samples from the surface of the grain and from 1m beneath the sample. (Surface samples are taken by inserting the spear until the lip is JUST beneath the surface and gently agitating until the spear slowly fills up.) Scooped samples will not give a realistic idea of surface mc. You will have 5 surface samples and five from 1m.

3. Take temperature readings at all 1m points and record on the sample bags.

4. Take care to ensure the surface sample comprises grain only from the top layer of grain.

5. Place the samples in sealable plastic bags and label these with the name of farm, date, location of the sample and depth.

6. Make a plan of the store showing the location of the samples, making a note of facilities such as cooling fans or drying floor.

7. Send the separate samples, securely packed (eg in padded bag), to CSL where moisture content and mite counts will be carried out on the bulked samples from each depth.