Annual Project Report
August 2022 to June 2023

Project title	Monitoring of mycotoxins and other contaminants in UK cereals used in malting, milling and animal feed		
Project number	21130040		
Start date	August 2016	**End date**	July 2024

Project aim and objectives

To survey the incidence and levels of key contaminants in samples of UK-grown and imported cereals and co-products, destined for milling, malt production, and animal feed to determine that they meet legal and guideline limits and that they are safe for consumption as food and feed.

Key messages emerging from the project

- During the period August 2022 to June 2023, the project focussed on monitoring of harvest and stored grain samples for trichothecenes, zearalenone, ochratoxin A and pesticides. Subsets of samples were also analysed for ergot alkaloids, acrylamide, metals and chlorate/perchlorate. The samples analysed were milling wheat, malting barley, food oats, food barley, feed wheat, wheatfeed, feed barley, feed oats, oatfeed and roasted barley malt. The data is not intended to provide a comprehensive monitoring of the UK grain harvest; the data represents levels likely to be found in each of the sample types within a given year of sampling. The results from the previous 6 years of this study are available on the AHDB website: **ahdb.org.uk/monitoring-of-contaminants-in-uk-cereals-used-for-processing-food-and-animal-feed**. Selected results from this period are presented below.
- Harvest Samples Mycotoxins – The mean DON levels found were very low across the board. For all commodities, excluding wheatfeed and oatfeed, 2022 levels were the lowest recorded throughout the 7 years. No sample exceeded the maximum level (ML). The maximum DON level found was 546 µg/kg in a wheatfeed, 100% of wheatfeed contained DON above the detection or reporting limit (RL). For the other products, incidence above the RL ranged from 10% in malting barley to 83% in oatfeed. Most samples were around the 50% mark. Comparing mean results from 2019 to 2022, in general, DON levels were similar for wheatfeed. However, for all other products mean DON levels were lower. For milling wheat, the mean was 19 µg/kg compared to 101 µg/kg in 2021, for feedwheat the mean was 23 µg/kg compared to 251 µg/kg in 2021 and for oatfeed the mean was 74 µg/kg compared to 638 µg/kg in 2021. A summary of the mean DON levels in fresh harvest samples over the duration of the project is given in Figure 1.
- Incidence of NIV (Table 2) above the RL ranged from 0% (feedwheat and food barley) to 100% (oatfeed). There are no maximum levels for this mycotoxin. Malting barley had incidence level of 15% and a mean of 19 µg/kg. For the other products, the highest mean level (583 µg/kg) was found in

oatfeed. Wheatfeed, food oats and feed oats had similar mean levels of 115, 91 and 79 µg/kg, respectively. The highest maximum level (975 µg/kg) was found in a sample of oatfeed.

- Of the other Type B trichothecenes, 3-acetyl DON was not found above RL in any of the samples. 15-acetyl DON (Table 3) was only found in wheatfeed with instances above RL at 50%, the maximum level found was 55 µg/kg and the mean was 17 µg/kg. Oatfeed had 100% of results above RL for fusarenon X with a mean value of 20 µg/kg, but this mycotoxin was not found any other commodity.
- In 2022, T-2 and HT-2 toxins (Table 4) were detected most frequently in oats (food and feed) and oatfeed, 100% oatfeed and feed oats, 83% food oats, as well as the single food barley sample, contained T-2 and HT-2 above the RL. The highest levels were also found in these products. The maximum levels found were: 1095 µg/kg in oatfeed, 3283 µg/kg in food oats and 615 µg/kg in feed oats. The mean level found in food oats was 433 µg/kg (this level has remained relatively consistent since 2017) and for feed oats was 252 µg/kg. This was similar to 2021 but this is now the highest mean value recorded for feed oats since the project began in 2016. There are no maximum levels in force for T-2 and HT-2, although limits are being discussed in Europe and although the mean values for all products would comply with the levels under discussion, three samples of food oats would be ML exceedances if the proposed limits were adopted by GB (1568, 2425 and 3283 µg/kg) . Over the seven years of the study, there has been little incidence of T-2 and HT-2 toxins above the RL in wheat products, the highest incidence was 83% in wheatfeed in 2021, this has reduced in 2022 to 50%. The maximum level found was 38 µg/kg, this was the same as 2021. Mean levels in these products have generally been below the RL. A summary of the mean T-2 and HT-2 toxins levels in fresh harvest samples over the duration of the project is given in Figure 2.
- For other Type A trichothecenes, neosolaniol was measured above the RL in food oats (38%), feed oats (17%), malting barley (3%) and oatfeed (100%), with mean levels in food oats and oatfeed of 14 and 23 µg/kg, respectively (Table 5). The other products each had a mean of <10 µg/kg. Diacetoxyscirpenol was only found in 2 samples of food oats (13.6 and 10.0 µg/kg, respectively). This is only just over the RL.
- The highest zearalenone (ZEN) level found in any sample was 60 µg/kg in a food oat; however, the incidence in food oats was only 3% (Table 6). The highest incidences of ZEN were in wheatfeed (75%) with a maximum value of 36 µg/kg and a mean value of 13 µg/kg. The only other samples to produce maximum values above the RL were milling wheat (3.2 µg/kg) and oatfeed (3 µg/kg). A summary of the mean ZEN levels in fresh harvest samples over the duration of the project is given in Figure 3.
- Masked (also known as modified) forms of deoxynivalenol, T-2 toxin and zearalenone were also analysed. Deoxynivalenol 3-glucoside (DON3G) was found mainly in oatfeed and wheatfeed samples (Table 7). Incidence above the RL ranged from 83% (oatfeed) to 40% in wheatfeed. DON3G was also

found in milling wheat and food oats with instances of 8% and 17%, respectively. The mean levels in all commodities ranged from less than the reporting limit to 14 µg/kg (food oats). The highest levels found were 99 and 32 µg/kg in food oats and wheatfeed, respectively.

- T-2 glucoside was detected in oats (food and feed) and oatfeed samples plus a small incidence in malting barley samples (Table 8). The mean level found in oatfeed was 83 µg/kg and the maximum level found was 134 µg/kg (compared to 188 µg/kg and 424 µg/kg in 2021). For food oats, the mean value found was 39 µg/kg (compared to 53 µg/kg in 2021) and the maximum value found was 421 µg/kg (compared to 232 µg/kg in 2020).This was the highest maximum level found.
- One sample of wheatfeed contained a low level (3 µg/kg) of a modified form of zearalenone (α-zearalenol). 3 samples (one oatfeed, one malting barley and one milling wheat) contained α-zearalenol-14-glucoside but all at a level just above the RL. Five of the six oatfeed samples analysed contained β-zearalenol-14-glucoside at or marginally above the RL, with a mean value of 6.8 µg/kg.
- Incidence of ergot alkaloids ranged from 23% in malting barley to 100% in wheatfeed (Table 9). The one sample of food barley did not contain ergot alklaoids. The highest maximum level was found in feed wheat (2802 µg/kg), although the mean level was 210 µg/kg. Wheatfeed had the highest mean level (270 µg/kg) but with a maximum level of 865 µg/kg. The next highest maximum level was found in feed barley (1087 µg/kg); however, the mean (132 µg/kg) and median levels (<6.0 µg/kg) were much lower. Milling wheat had a maximum level of 961 µg/kg but the mean (59.1 µg/kg) and median (<6 µg/kg) were much lower. For food oats, the highest maximum level was 108 µg/kg, but the mean level was only 6.4 µg/kg. The mean levels in all other products were low (from 6.4 to 81.9 µg/kg for sum ergot alkaloids). Regulation (EU) 2021/1399 introduced maximum levels for ergot alkaloids in some cereal products for human consumption. These levels came into force in the EU on 1st January 2022, but do not apply in GB. Overall, the lab carried out repeat analysis of 'high values' on 14 samples for ergots with good agreement found between replicates. A summary of the mean sum ergot alkaloid levels in fresh harvest samples over the duration of the project is given in Figure 4.
- Metals analysis – subsets of all commodities were analysed for aluminium, nickel, copper, arsenic, cadmium, mercury and lead (Tables 10-18). Mercury was not detected in any of the samples. Very low levels of arsenic were detected in a number of samples (incidence ranged from 15% to 100%); however, the maximum level found was 0.08 mg/kg in a wheatfeed. Lead was found in almost all commodities where the incidence rate ranged from 16% (milling wheat) to 100% (wheat feed).However, the levels were very low. The maximum value was 0.09 mg/kg (milling wheat). Cadmium was detected in the majority of samples (maximum of 0.09 mg/kg). No sample contained any metal above the maximum level. Data was also obtained for copper, nickel and aluminium, this provided supporting information on the occurrence of these elements in cereals.

- Stored Samples Mycotoxins - Ochratoxin A (OTA) incidence was below 50% for all commodities in 2022, compared to 2021 where wheatfeed and oatfeed had incidences of 92% and 100%, respectively (Table 19). The highest level in 2022, 21.1 µg/kg, was found in a feed barley, but this was atypical as the mean level for feed barley was 0.9 µg/kg and the median was <0.2 µg/kg. A sample of food oats contained 17.6 µg/kg, which exceeded the ML for ochratoxin A (OTA) (after MU was applied). This was one of only two samples of food oats that contained OTA, the other sample contained 1.2 µg/kg. A sample of milling wheat contained 8.7 µg/kg, this was an exceedance of the ML after MU was applied. Malting barley, malt, feed wheat, wheat feed, feed oats and oatfeed had the lowest incidence of OTA. Mean levels across all samples ranged from <0.2 to 0.60 µg/kg. The maximum level for OTA in cereals for direct human consumption is 3 µg/kg.
- 20 samples of malt were analysed for acrylamide (Table 20). Overall incidence of acrylamide was low with only 15% above the RL. Only 3 of 20 samples returned results above the RL (40, 170 and 1521 µg/kg) the most common result was <30 µg/kg. The highest level (1521 µg/kg) was found in a roasted malt. This was an atypical result, most likely as a consequence of the heat used during the roasting process.
- Matched pairs of malting barley and malt were also analysed for *Fusarium* mycotoxins. However, very little was found (Table 21). DON and DON3G were found most frequently, 25% of malting barley and 5% of malt contained DON, and 45% of malting barley and 20% of malt contained DON3G. The maximum levels found were 47.6 µg/kg DON and 35.3 µg/kg DON3G in a malting barley, mean levels of DON and DON3G were <10 µg/kg in malting barley and malt.

Pesticides

- Two samples of milling wheat contained residues of chlorpropham at 0.017 mg/kg and 0.028 mg/kg. The maximum residue level (MRL) is set at 0.01* mg/kg for chlorpropham in wheat. The higher residue is above the MRL and is still an exceedance if measurement uncertainty (±50%) is taken into account.
- One sample of malt contained a residue of 2-phenylphenol at 0.079 mg/kg. The maximum residue level (MRL) is set at 0.02* mg/kg for 2-phenylphenol in barley. The residue is above the MRL and is still an exceedance if measurement uncertainty (±50%) is taken into account.
- One sample of malt contained a residue of biphenyl at 0.18 mg/kg. The maximum residue level (MRL) is set at 0.01* mg/kg for biphenyl in barley. The residue is above the MRL and is still an exceedance if measurement uncertainty (±50%) is taken into account.
- The 2-phenolphenol and biphenyl MRL exceedances were in a single peated malt sample. These compounds are known processing contaminants and their presence is most likely to be contamination as a result of the peating process and not thought to be through use of the products.
- Other than the two samples of milling wheat with chlorpropham residues and the one sample of malt containing both 2-phenylphenol and biphenyl residues above, no other samples contained any residue above their corresponding MRLs.
- A high incidence of residues (105) was found for the fungicide tebuconazole. None of these residues exceeded their corresponding MRLs.
- Other most frequently found residues were for the plant growth regulator chlormequat (86), fungicide fluxapyroxad (80), synergist piperonyl butoxide (69), plant growth regulator mepiquat (42) and herbicide glyphosate (41). None of these residues exceeded their corresponding MRLs. No MRL is set for piperonyl butoxide.
- 211 residues were detected in feed or crops to be used for animal feed. No MRLs are currently applicable for “products or part of products exclusively used for animal feed production”.
- Figure 5 shows the distribution of 572 residues detected in the 374 samples tested. 119 samples (32%) contained no residues and 255 samples (68%) of the samples contained between 1 and 8 residues.

Figure 1. Mean DON levels in harvest samples (µg/kg)

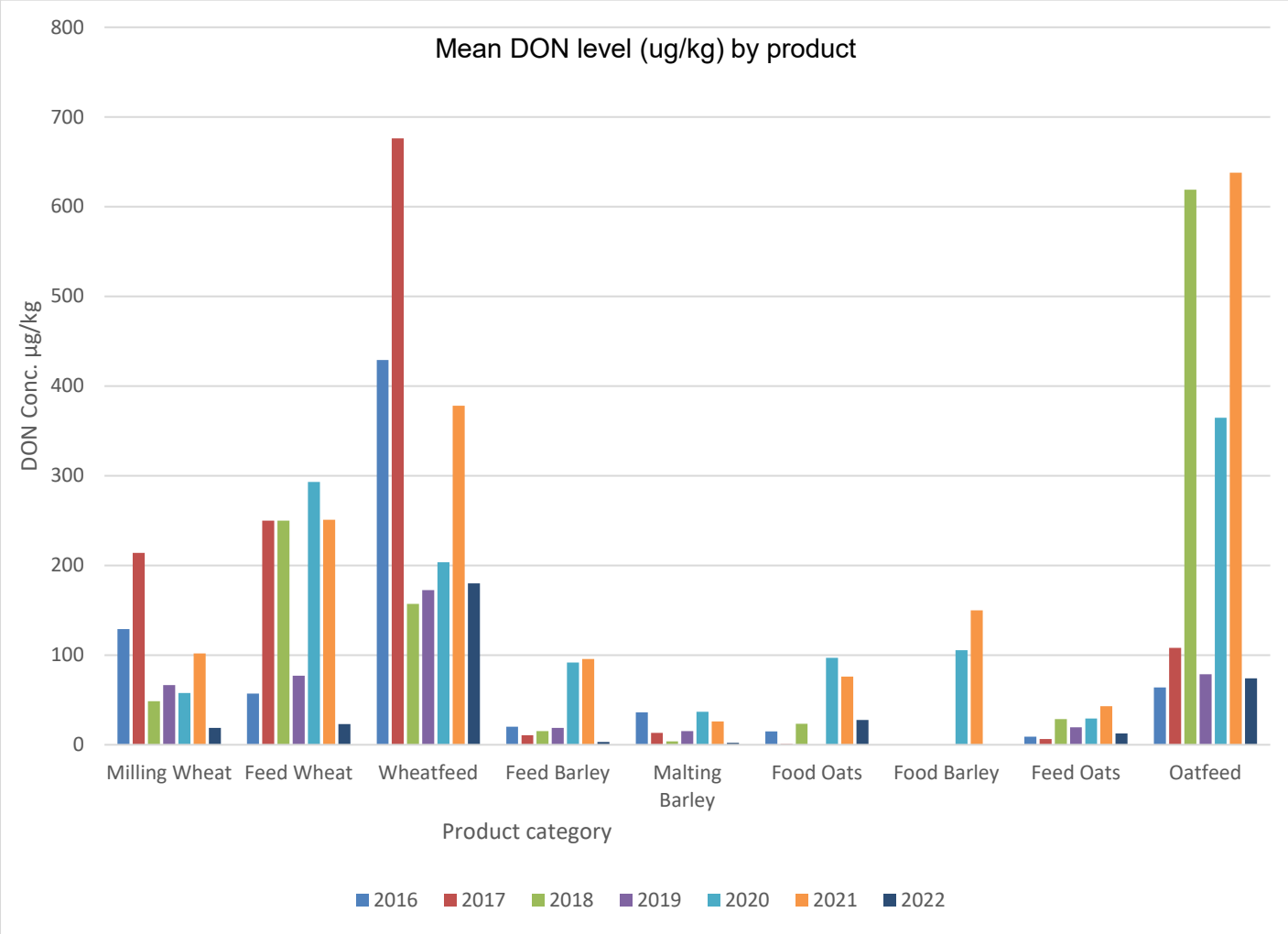
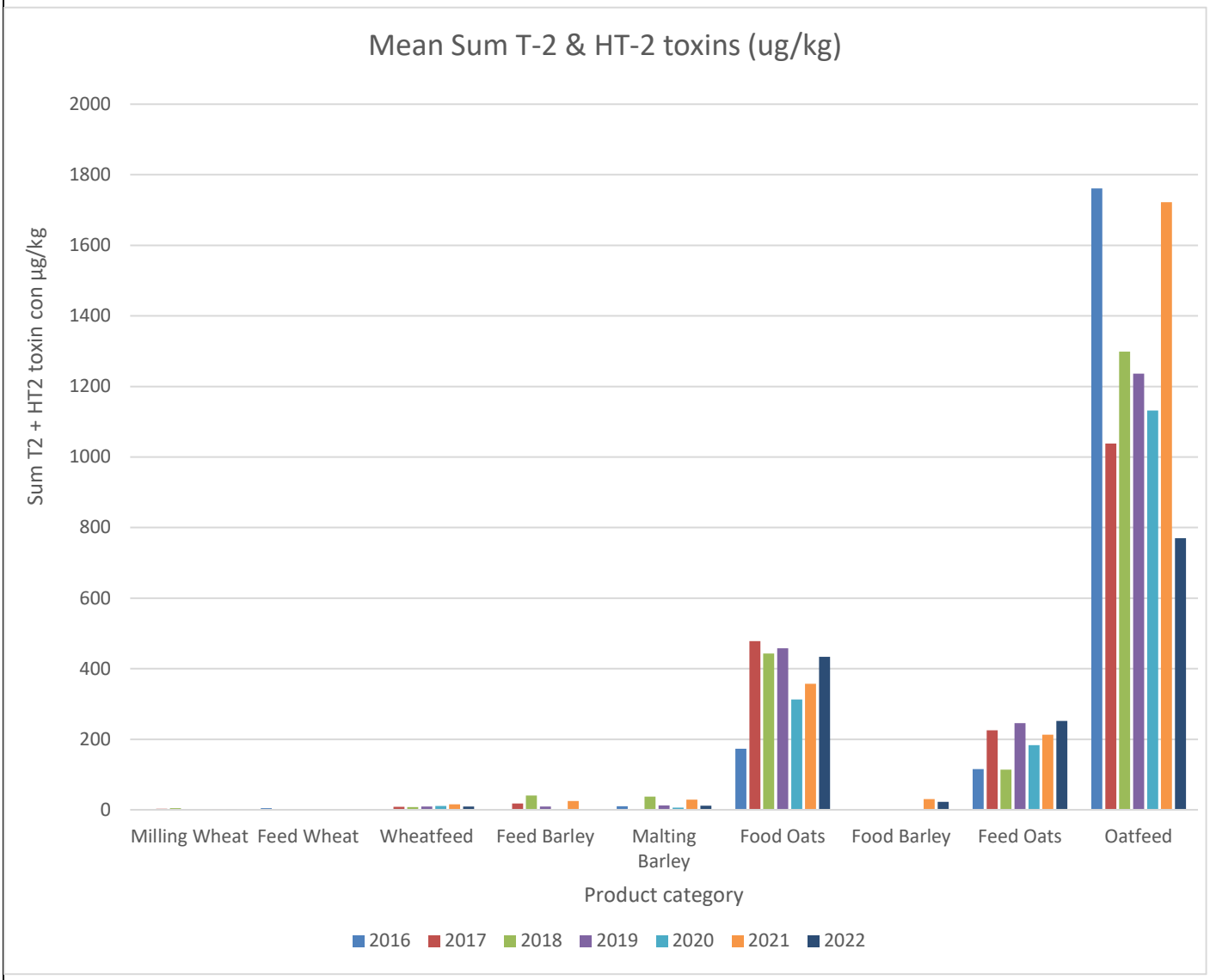


Figure 2. Mean T-2 and HT-2 toxins levels in Harvest samples (µg/kg)



The results described in this summary report are interim and relate to one year, except where stated. In all cases, the reports refer to projects that extend over a number of years.

Figure 3. Mean ZEN levels in harvest samples (µg/kg)

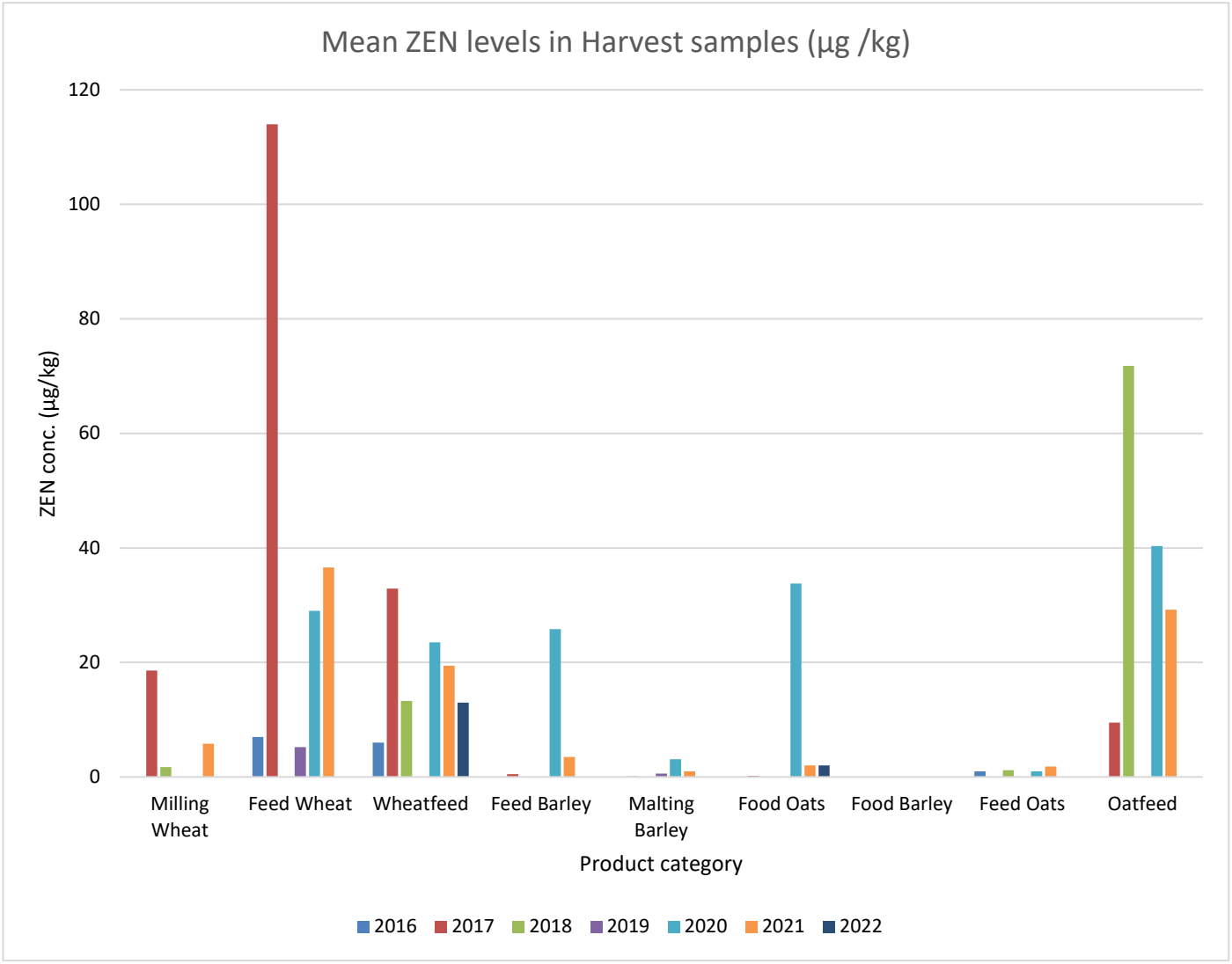


Figure 4. Mean sum ergot alkaloid levels in harvest samples (µg/kg)

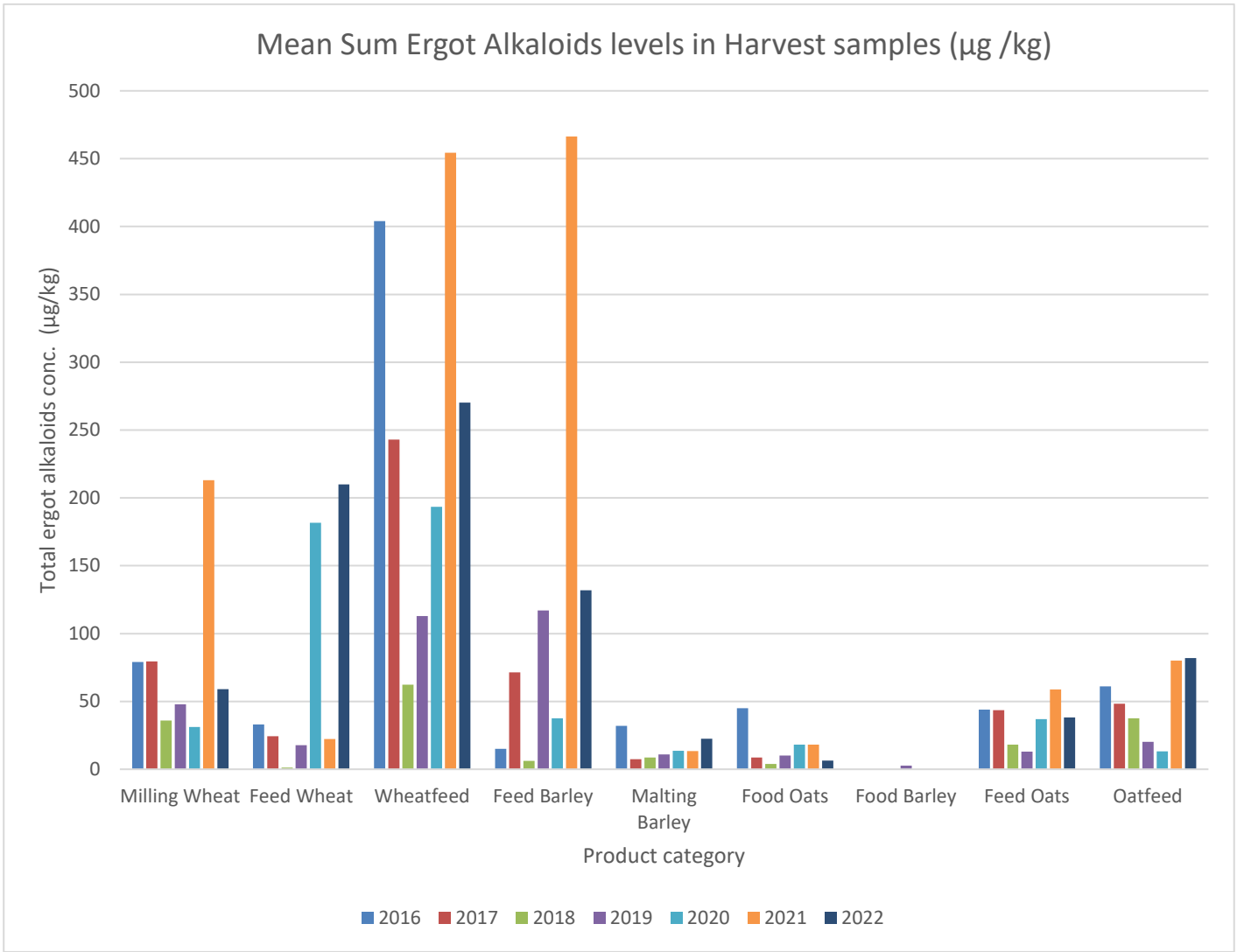
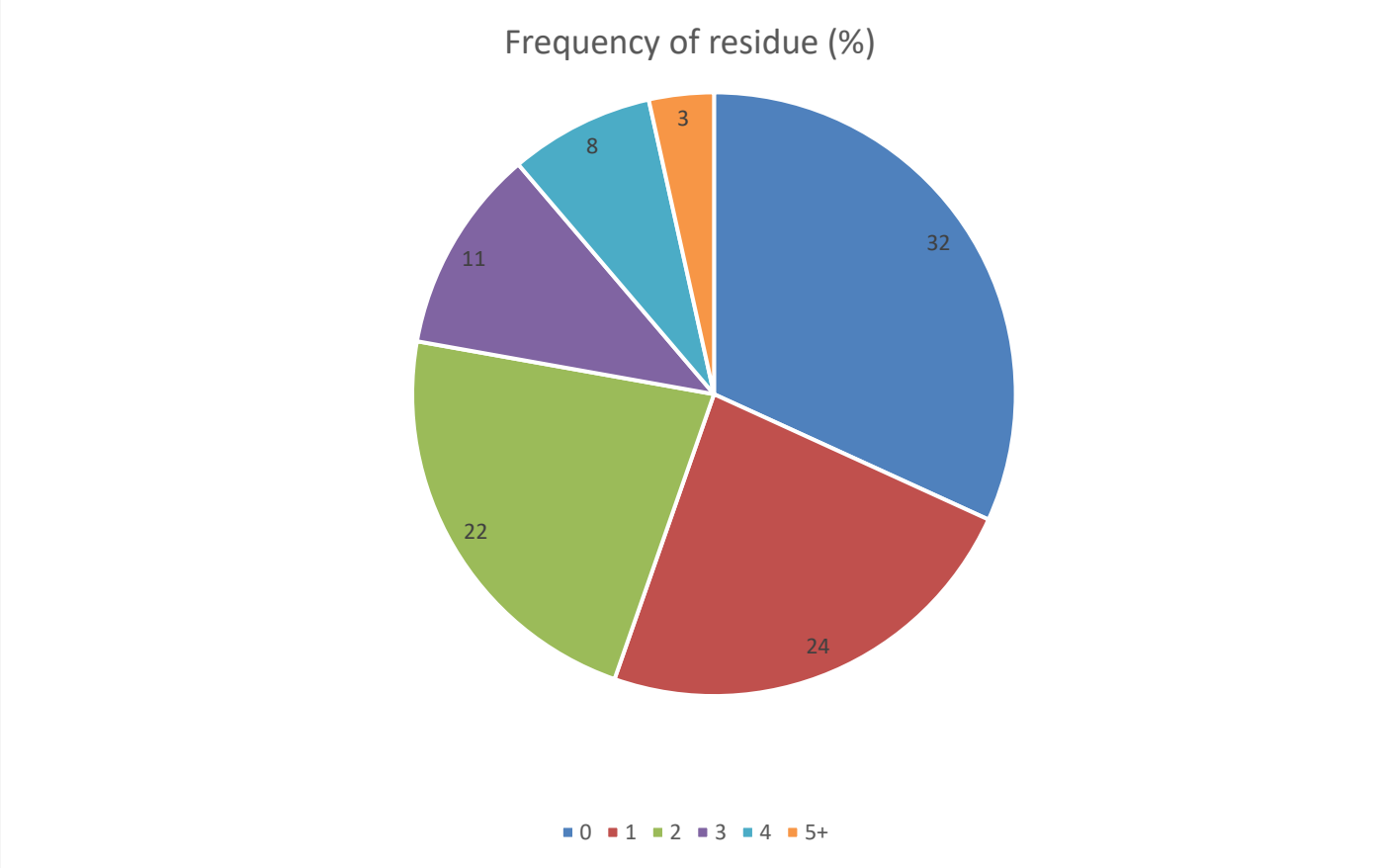


Figure 5. Summary of pesticides residues



Summary of results from the reporting year

All analyses, were carried out using UKAS ISO17025 accredited methods. All data calculations presented in the following tables are reported as 'lower bound' values, i.e. any result less than the reporting limit has been presumed to be zero.

Results for key mycotoxins are shown below.

The minimum level recorded in the tables is the reporting limit, or the lowest measured value where 100% of samples contained a measurable level of analyte.

Table 1. Deoxynivalenol Harvest Results 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	Mean Level µg/kg	Median Level µg/kg
Milling Wheat	50	54%	<10	173	19	11
Feed Wheat	14	43%	<10	127	23	<10
Wheatfeed	20	100%	36	546	180	141
Feed Barley	14	14%	<10	27	3	<10
Malting Barley	40	10%	<10	39	2	<10
Food Oats	29	52%	<10	134	28	12
Food Barley	1	0%	<10	<10	<10	<10
Feed Oats	6	50%	<10	31	12	6
Oatfeed	6	83%	<10	133	74	88

Table 2. Nivalenol Harvest Results 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	Mean Level µg/kg	Median Level µg/kg
Milling Wheat	50	2%	<50	65	1	<50
Feed Wheat	14	0%	<50	<50	<50	<50
Wheatfeed	20	95%	<50	405	115	91
Feed Barley	14	7%	<50	130	9	<50
Malting Barley	40	15%	<50	290	19	<50
Food Oats	29	55%	<50	933	91	55
Food Barley	1	0%	<50	<50	<50	<50
Feed Oats	6	83%	<50	225	79	62
Oatfeed	6	100%	242	975	583	534

Table 3. 15Acetyl-Deoxynivalenol Harvest Results 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	Mean Level µg/kg	Median Level µg/kg
Milling Wheat	50	0%	<20	<20	<20	<20
Feed Wheat	14	0%	<20	<20	<20	<20
Wheatfeed	20	50%	<20	55	17	<20
Feed Barley	14	0%	<20	<20	<20	<20
Malting Barley	40	0%	<20	<20	<20	<20
Food Oats	29	0%	<20	<20	<20	<20
Food Barley	1	0%	<20	<20	<20	<20
Feed Oats	6	0%	<20	<20	<20	<20
Oatfeed	6	0%	<20	<20	<20	<20

Table 4. HT-2 + T-2 Harvest Results 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	Mean Level µg/kg	Median Level µg/kg
Milling Wheat	50	2%	<20	10	0.2	<20
Feed Wheat	14	0%	<20	<20	<20	<20
Wheatfeed	20	50%	<20	38	10	5
Feed Barley	14	0%	<20	<20	<20	<20
Malting Barley	40	23%	<20	129	12	<20
Food Oats	29	83%	<20	3283	433	87
Food Barley	1	100%	23	23	23	23
Feed Oats	6	100%	82	615	252	181
Oatfeed	6	100%	556	1095	770	751

Table 5. Neosolaniol Harvest Results 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	Mean Level µg/kg	Median Level µg/kg
Milling Wheat	50	0%	<10	<10	<10	<10
Feed Wheat	14	0%	<10	<10	<10	<10
Wheatfeed	20	0%	<10	<10	<10	<10
Feed Barley	14	0%	<10	<10	<10	<10
Malting Barley	40	3%	<10	12	0.3	<10
Food Oats	29	38%	<10	145	14	<10
Food Barley	1	0%	<10	<10	<10	<10
Feed Oats	6	17%	<10	15	2.5	<10
Oatfeed	6	100%	16	37	23	22

Table 6. Zearalenone Harvest Results 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	Mean Level µg/kg	Median Level µg/kg
Milling Wheat	50	2%	<2.5	3.2	0.06	<2.5
Feed Wheat	14	0%	<2.5	<2.5	<2.5	<2.5
Wheatfeed	20	75%	<2.5	36	13	11
Feed Barley	14	0%	<2.5	<2.5	<2.5	<2.5
Malting Barley	40	0%	<2.5	<2.5	<2.5	<2.5
Food Oats	29	3%	<2.5	60	2	<2.5
Food Barley	1	0%	<2.5	<2.5	<2.5	<2.5
Feed Oats	6	0%	<2.5	<2.5	<2.5	<2.5
Oatfeed	6	33%	<2.5	3.0	1	<2.5

Table 7. Deoxynivalenol-3-Glucoside Harvest Results 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	Mean Level µg/kg	Median Level µg/kg
Milling Wheat	50	8%	<10	13	0.9	<10
Feed Wheat	14	0%	<10	<10	<10	<10
Wheatfeed	20	40%	<10	32	8	18
Feed Barley	14	0%	<10	<10	<10	<10
Malting Barley	40	0%	<10	<10	<10	<10
Food Oats	29	17%	<10	99	9	<10
Food Barley	1	0%	<10	<10	<10	<10
Feed Oats	6	0%	<10	<10	<10	<10
Oatfeed	6	83%	<10	25	14	14

Table 8. T-2-α3-Glucoside Harvest Results 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	Mean Level µg/kg	Median Level µg/kg
Milling Wheat	50	0%	<10	<10	<10	<10
Feed Wheat	14	0%	<10	<10	<10	<10
Wheatfeed	20	0%	<10	<10	<10	<10
Feed Barley	14	0%	<10	<10	<10	<10
Malting Barley	40	5%	<10	12	1	<10
Food Oats	29	48%	<10	421	39	<10
Food Barley	1	0%	<10	<10	<10	<10
Feed Oats	6	33%	<10	24	8	<10
Oatfeed	6	100%	43	134	83	88

Table 9. Total Ergot Alkaloids (n=12) Harvest Results 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	Mean Level µg/kg	Median Level µg/kg
Milling Wheat	50	42%	<6.0	961	59.1	<6.0
Feed Wheat	14	43%	<6.0	2802	210	N/A
Wheatfeed	20	100%	26.5	865	270	N/A
Feed Barley	15	47%	<6.0	1087	132	<6.0
Malting Barley	40	23%	<6.0	304	22.5	<6.0
Food Oats	29	28%	<6.0	108	6.4	<6.0
Food Barley	1	0%	<6.0	<6.0	<6.0	<6.0
Feed Oats	6	33%	<6.0	49	38.2	<6.0
Oatfeed	6	83%	<6.0	143	81.9	<6.0

** This is a combined value calculated from the sum of the individual 12 alkaloids. The LOQ of each alkaloid is 0.5 µg/kg. Where no residues are detected, the LOQ values are combined to give a sum LOQ, of 6.0 µg/kg. Where individual alkaloids are quantified above the LOQ, the sum is calculated from those values with results below the LOQ presumed to be equal to zero (lower bound result), which can result in values of less than 6.0 µg/kg being reported.

Table 10. Metals in Milling Wheat Results Harvest 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level mg/kg	Maximum Level mg/kg	Mean Level mg/kg	Median Level mg/kg
Aluminium	25	100%	1.30	12.2	3.72	2.8
Nickel	25	100%	0.08	0.44	0.18	0.17
Copper	25	100%	2.40	5.50	3.52	3.50
Arsenic	25	24%	<0.01	0.03	<0.01	<0.01
Cadmium	25	100%	0.02	0.09	0.04	0.04
Mercury	25	0%	<0.01	<0.01	<0.01	<0.01
Lead	25	16%	<0.01	0.09	<0.01	<0.01

Table 11. Metals in Food Oats Results Harvest 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level mg/kg	Maximum Level mg/kg	Mean Level mg/kg	Median Level mg/kg
Aluminium	14	100%	1.20	20.10	5.46	3.65
Nickel	14	100%	3.25	7.75	5.35	5.10
Copper	14	100%	2.80	4.50	3.61	3.60
Arsenic	14	57%	<0.01	0.03	0.01	0.01
Cadmium	14	71%	<0.01	0.03	0.02	0.02
Mercury	14	0%	<0.01	<0.01	<0.01	<0.01
Lead	14	21%	<0.01	0.02	<0.01	<0.01

Table 12. Metals in Food Barley Results Harvest 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level mg/kg	Maximum Level mg/kg	Mean Level mg/kg	Median Level mg/kg
Aluminium	1	100%	8.20	8.20	8.20	8.20
Nickel	1	100%	0.48	0.48	0.48	0.48
Copper	1	100%	3.70	3.70	3.70	3.70
Arsenic	1	0%	<0.01	<0.01	<0.01	<0.01
Cadmium	1	0%	<0.01	<0.01	<0.01	<0.01
Mercury	1	0%	<0.01	<0.01	<0.01	<0.01
Lead	1	0%	<0.01	<0.01	<0.01	<0.01

Table 13. Metals in Malting Barley Results Harvest 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level mg/kg	Maximum Level mg/kg	Mean Level mg/kg	Median Level mg/kg
Aluminium	20	100%	1.50	15.4	5.55	4.70
Nickel	20	100%	0.28	0.96	0.54	0.52
Copper	20	100%	1.90	4.30	3.09	3.20
Arsenic	20	15%	<0.01	0.01	<0.01	<0.01
Cadmium	20	70%	<0.01	0.04	0.0125	0.01
Mercury	20	0%	<0.01	<0.01	<0.01	<0.01
Lead	20	30%	<0.01	0.02	<0.01	<0.01

Table 14. Metals in Feed Wheat Results Harvest 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level mg/kg	Maximum Level mg/kg	Mean Level mg/kg	Median Level mg/kg
Aluminium	5	100%	0.90	12.3	6.40	6.30
Nickel	5	100%	0.08	0.46	0.25	0.19
Copper	5	100%	2.90	4.45	3.68	3.71
Arsenic	5	0%	<0.01	<0.01	<0.01	<0.01
Cadmium	5	100%	0.03	0.04	0.03	0.03
Mercury	5	0%	<0.01	<0.01	<0.01	<0.01
Lead	5	40%	<0.01	0.03	0.01	<0.01

Table 15. Metals in Wheatfeed Results Harvest 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level mg/kg	Maximum Level mg/kg	Mean Level mg/kg	Median Level mg/kg
Aluminium	5	100%	17.9	105	44.6	20.3
Nickel	5	100%	0.68	2.70	1.35	1.20
Copper	5	100%	8.90	10.6	9.70	9.90
Arsenic	5	100%	0.02	0.08	0.04	0.03
Cadmium	5	100%	0.07	0.09	0.08	0.09
Mercury	5	0%	<0.01	<0.01	<0.01	<0.01
Lead	5	100%	0.02	0.06	0.04	0.03

Table 16. Metals in Feed Barley Results Harvest 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level mg/kg	Maximum Level mg/kg	Mean Level mg/kg	Median Level mg/kg
Aluminium	5	100%	1.40	21.5	11.8	12.2
Nickel	5	100%	0.49	0.67	0.59	0.62
Copper	5	100%	3.70	5.40	4.40	3.90
Arsenic	5	0%	<0.01	<0.01	<0.01	<0.01
Cadmium	5	60%	<0.01	0.03	0.01	0.01
Mercury	5	0%	<0.01	<0.01	<0.01	<0.01
Lead	5	60%	<0.01	0.04	0.01	0.02

Table 17. Metals in Feed Oats Results Harvest 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level mg/kg	Maximum Level mg/kg	Mean Level mg/kg	Median Level mg/kg
Aluminium	5	100%	2.40	6.70	3.70	3.20
Nickel	5	100%	3.15	8.01	4.77	3.68
Copper	5	100%	2.80	4.40	3.48	3.00
Arsenic	5	40%	<0.01	0.01	<0.01	<0.01
Cadmium	5	40%	<0.01	0.03	0.008	<0.01
Mercury	5	0%	<0.01	<0.01	<0.01	<0.01
Lead	5	0%	<0.01	<0.01	<0.01	<0.01

Table 18. Metals in Oatfeed Results Harvest 2022

	No. of Samples Analysed	% > Reporting Limit	Minimum Level mg/kg	Maximum Level mg/kg	Mean Level mg/kg	Median Level mg/kg
Aluminium	5	100%	6.40	48.6	28.8	31.7
Nickel	5	100%	9.54	14.1	11.9	11.8
Copper	5	100%	2.20	4.00	2.78	2.7
Arsenic	5	100%	0.02	0.04	0.03	0.03
Cadmium	5	60%	<0.01	0.01	0.01	0.01
Mercury	5	0%	<0.01	<0.01	<0.01	<0.01
Lead	5	80%	<0.01	0.07	0.04	0.05

Table 19. Ochratoxin A Stored Sample Results 2023

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	Mean Level µg/kg	Median Level µg/kg
Malting Barley	20	5%	<0.2	0.3	<0.2	<0.2
Malt	20	45%	<0.2	1.1	0.1	<0.2
Milling Wheat (January)	25	20%	<0.2	8.7	0.60	<0.2
Milling Wheat (March)	25	8%	<0.2	4.0	0.18	<0.2
Feed Wheat	40	40%	<0.2	11.0	0.4	<0.2
Wheat Feed	12	42%	<0.2	2.0	0.5	<0.2
Feed Barley	36	33%	<0.2	21.1	0.9	<0.2
Food Oats	30	7%	<0.2	17.6	0.6	<0.2
Feed Oats	6	0%	<0.2	<0.2	<0.2	<0.2
Oatfeed	6	33%	<0.2	0.5	0.1	<0.2

Table 20. Acrylamide Stored Sample Results 2023

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	Mean Level µg/kg	Median Level µg/kg
Malt	20	15	<30	1521	86.5	<30

Table 21. Field Mycotoxins Malting Barley & Malt Results 2022-2023

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg***	Maximum Level µg/kg	Mean Level µg/kg	Median Level µg/kg
Deoxynivalenol						
Malting Barley	20	25%	<10	47.6	5.2	<10
Malt	20	5%	<10	10.2	0.5	<10
Deoxynivalenol-3-Glucoside						
Malting Barley	20	45%	<10	35.3	7.9	<10
Malt	20	20%	<10	14.7	2.4	<10
3-Acetyl Deoxynivalenol						
Malting Barley	20	0%	<10	<10	<10	<10
Malt	20	0%	<10	<10	<10	<10
15-Acetyl Deoxynivalenol						
Malting Barley	20	0%	<20	<20	<20	<20
Malt	20	0%	<20	<20	<20	<20
T-2-b3-Glucoside						
Malting Barley	20	0%	<10	<10	<10	<10
Malt	20	0%	<10	<10	<10	<10
HT-2 +T2						
Malting Barley	20	15%	<20	14.3*	1.7	<20
Malt	20	5%	<20	24.3	1.2	<20
NIV						
Malting Barley	20	5%	<50	26.2**	1.3	<50
Malt	20	0%	<50	<50	<50	<50

*** Reporting limits vary by toxin due to individual response of each toxin.

** Residue detected so an intermediate STD at half the RL (25µg/kg) was used to quantify this result.

* HT-2 contribution only – no T-2 detected

Table 22. Pesticides Harvest Results 2022

	No. of Samples Analysed	% > LOD	Single Pesticide Incidence % > LOD	Multiple Pesticide Incidence % > LOD
Milling Wheat [1]	50	94	26	68
Malting Barley [2]	40	25	25	0
Food Oats [3]	29	79	41	38
Barley [4]	1	100	100	0
Feed Wheat [5]	14	0	0	
Feed Barely [6]	14	64	64	
Feed Oats [7]	6	0	0	

[1] azoxystrobin (7) 0.017-0.076 mg/kg; chlormequat (46) 0.012-0.82 mg/kg; **chlorpropham (1) 0.028** mg/kg; epoxiconazole (1) 0.011 mg/kg; fluxapyroxad (1) 0.016 mg/kg; glyphosate (9) 0.12-0.55 mg/kg; mepiquat (6) 0.011-0.15 mg/kg; tebuconazole (19) 0.010-0.066 mg/kg. **The MRL for chlorpropham in wheat is set at 0.01*mg/kg.**

[2] bixafen (1) 0.025 mg/kg; boscalid (1) 0.013; fluxapyroxad (8) 0.010-0.057 mg/kg.

[3] azoxystrobin (1) 0.034 mg/kg; chlormequat (17) 0.013-9.6 mg/kg; fluxapyroxad (1) 0.014 mg/kg; glyphosate (8) 0.11-2.4 mg/kg; mepiquat (5) 0.051-0.86 mg/kg; tebuconazole (7) 0.024-0.054 mg/kg.

[4] mepiquat (1) 0.069 mg/kg.

[5] No glyphosate residues detected (not tested for other pesticides).

[6] Glyphosate (9) 1.3-5.3 mg/kg (not tested for other pesticides).

[7] No glyphosate residues detected (not tested for other pesticides).

Table 23. Harvest Results Additional Compounds 2022

	No. of Samples Analysed	% > LOD	Single Pesticide Incidence % > LOD	Multiple Pesticide Incidence % > LOD
Milling Wheat [1]	50	20	14	6
Malting Barley [2]	40	25	15	10
Food Oats [3]	29	7	7	0
Barley [4]	1	0	0	0
Feed Wheat [5]				
Feed Barely [6]				
Feed Oats [7]				

[1] cypermethrin (1) 0.013 mg/kg; deltamethrin (1) 0.13 mg/kg; flonicamid (sum) (1) 0.015 mg/kg; fluopyram (2) 0.011, 0.013; fluroxypyr (1) 0.011 mg/kg; piperonyl butoxide (5) 0.015-0.065; pirimiphos-methyl (3) 0.023-0.13 mg/kg; pyraclostrobin (1) 0.019 mg/kg; TFNG (1) 0.017 mg/kg. Please note that flonicamid parent compound was not detected but flonicamid (sum) is included due to the residue definition: Sum of flonicamid,TFNA and TFNG expressed as flonicamid.

[2] cypermethrin (1) 0.15 mg/kg; deltamethrin (3) 0.015-0.72 mg/kg; fluroxypyr (1) 0.016 mg/kg; MCPA (1) 0.021 mg/kg; piperonyl butoxide (4) 0.073-4.4 mg/kg, pyraclostrobin (4) 0.012-0.034.

[3] piperonyl butoxide (1) 0.013 mg/kg; pyraclostrobin (1) 0.015.

[4] No additional residues detected.

[5] Glyphosate only (Not tested for other pesticides).

[6] Glyphosate only (Not tested for other pesticides).

[7] Glyphosate only (Not tested for other pesticides).

Table 24. Pesticides Malting Barley & Malt Stored Sample Results 2022-2023

	No. of Samples Analysed	% > LOD	Single Pesticide Incidence % > LOD	Multiple Pesticide Incidence % > LOD
Malt [1]	20	90%	15%	75%
Malting Barley [2]	20	95%	25%	70%

[1] chlormequat (13) 0.021-0.44 mg/kg; deltamethrin (4) 0.042-0.089 mg/kg; glyphosate (3) 0.10-0.25mg/kg; mepiquat (16) 0.011-0.18mg/kg.

[2] chlormequat (10) 0.019-0.55 mg/kg; deltamethrin (5) 0.048-0.18mg/kg; glyphosate (12) 0.15-1.5 mg/kg; mepiquat (14) 0.015-0.26mg/kg.

The results described in this summary report are interim and relate to one year, except where stated. In all cases, the reports refer to projects that extend over a number of years.

Table 25. Pesticides Malting Barley & Malt Additional Compounds Results 2022-2023

	No. of Samples Analysed	% > LOD	Single Pesticide Incidence % > LOD	Multiple Pesticide Incidence % > LOD
Malt [1]	20	95%	55%	40%
Malting Barley [2]	20	25%	25%	70%

[1]2-phenylphenol (1) **0.079** mg/kg; biphenyl (1) **0.18** mg/kg; bixafen (1) 0.020 mg/kg; cyprodinil (1) 0.020 mg/kg; fluxapyroxad (18) 0.014-0.15 mg/kg; piperonyl butoxide (7) 0.020-0.22 mg/kg. **The MRL for 2-phenylphenol in barley is set at 0.02* mg/kg. The MRL for biphenyl in barley is set at 0.01* mg/kg.**

[2] bixafen (1) 0.015 mg/kg; cyprodinil (2) 0.011, 0.012 mg/kg; fluroxypyr (1) 0.040 mg/kg; fluxapyroxad (17) 0.020-0.19 mg/kg; piperonyl butoxide (12) 0.013-0.65mg/kg; prothioconazole (2) 0.012, 0.020 mg/kg; pyraclostrobin (1) 0.011 mg/kg; tebuconazole (3) 0.011-0.029 mg/kg.

Table 26. Chlorpropham & Additional Compounds Stored Sample Results 2023

	No. of Samples Analysed	% > LOD	Single Pesticide Incidence % > LOD	Multiple Pesticide Incidence % > LOD
Milling Wheat	25	4	4%	0%
chlorpropham (1) **0.017** mg/kg. **The MRL for chlorpropham in wheat is set at 0.01*mg/kg.**				

	No. of Samples Analysed	% > LOD	Single Pesticide Incidence % > LOD	Multiple Pesticide Incidence % > LOD
Milling Wheat	25	12%	8%	4%
deltamethrin (3) 0.072 – 0.016 mg/kg; pirimiphos-methyl (1) 0.033mg/kg.				

Table 27. Pesticides Stored Sample Results 2023

	No. of Samples Analysed	% > LOD	Single Pesticide Incidence % > LOD	Multiple Pesticide Incidence % > LOD
Food Oats [1]	30	3%	3%	0%
Milling Wheat [2]	25	16%	12%	4%
Feed Wheat [3]	40	2.5%	2.5%	0%
Wheatfeed [4]	12	42%	42%	0%
Feed Barley [5]	36	19%	19%	0%
Feed Oats [6]	6	0%	0%	0%
Oatfeed [7]	6	17%	17%	0%

[1] deltamethrin (1) 0.025 mg/kg.

[2] cypermethrin (2) 0.026, 0.030 mg/kg; deltamethrin (1) 0.13 mg/kg; ; pirimiphos-methyl (2) 0.055, 0.44 mg/kg

[3] deltamethrin (1) 0.033 mg/kg.

[4] deltamethrin (4) 0.014-0.19 mg/kg; pirimiphos-methyl (1) 0.092 mg/kg.

[5] chlorpropham (2) 0.12, 0.14 mg/kg; deltamethrin (5) 0.029-0.18 mg/kg

[7] deltamethrin (1) 0.025 mg/kg.

No MRLs are set for feed or crops meant for animal feed in UK or EU

Table 28. Pesticides Stored Additional Compounds

	No. of Samples Analysed	% > LOD	Single Pesticide Incidence % > LOD	Multiple Pesticide Incidence % > LOD
Food Oats [1]	30	40%	30%	10%
Milling Wheat [2]	25	44%	24%	20%
Feed Wheat [3]	40	97.5%	52.5%	45%
Wheatfeed [4]	12	100%	17%	83%
Feed Barley [5]	36	83%	25%	58%
Feed Oats [6]	6	83%	16.7%	66.7%
Oatfeed [7]	6	100%	16.7%	83.3%

[1] azoxystrobin (2) 0.011, 0.029 mg/kg; fluxapyroxad (1) 0.019 mg/kg; piperonyl butoxide (2) 0.023, 0.20 mg/kg; prothiconazole-desthio (1) 0.021 mg/kg; tebuconazole (9) 0.013-0.21 mg/kg.

[2] azoxystrobin (4) 0.015-0.040 mg/kg; metconazole (1) 0.014mg/kg; piperonyl butoxide (5) 0.016-1.2 mg/kg; pyraclostrobin (1) 0.019 mg/kg; tebuconazole (7) 0.013-0.030 mg/kg.

[3] 2,4-D (1) 0.022 mg/kg; azoxystrobin (4) 0.015-0.045 mg/kg; boscalid (1) 0.036 mg/kg; fluopyram (1) 0.048 mg/kg; fluroxypyr (6) 0.014-0.039 mg/kg; fluxapyroxad (11) 0.010, 0.11 mg/kg; MCPA (2) 0.015, 0.037 mg/kg; piperonyl butoxide (3) 0.013-0.20 mg/kg; prothioconazole-desthio (4) 0.010-0.021 mg/kg; tebuconazole (35) 0.010-0.22 mg/kg.

[4] azoxystrobin (10) 0.011-0.049 mg/kg; fluxapyroxad (3) 0.011-0.016 mg/kg; piperonyl butoxide (12) 0.016-0.41 mg/kg; prothioconazole-desthio (1) 0.011 mg/kg; tebuconazole (12) 0.026-0.13 mg/kg; tri-allate (1) 0.013 mg/kg.

[5] azoxystrobin (4) 0.010-0.015 mg/kg; bixafen (2) 0.013, 0.021 mg/kg; boscalid (1) 0.013 mg/kg; cyprodinil (1) 0.16 mg/kg; fluroxypyr(4) 0.013-0.019 mg/kg; fluxapyroxad (19) 0.010-0.086 mg/kg; isopyrazam (1) 0.053 mg/kg; mecoprop (1) 0.029 mg/kg; piperonyl butoxide (12) 0.016-0.68 mg/kg; prothioconazole-desthio (4) 0.011-0.017 mg/kg; pyraclostrobin (2) 0.017, 0.020 mg/kg; tebuconazole (6) 0.011-0.36 mg/kg.

[6] azoxystrobin (1) 0.012 mg/kg; fluoxastrobin (1) 0.012 mg/kg; prothioconazole-desthio (1) 0.030 mg/kg; tebuconazole (2) 0.029, 0.051 mg/kg.

[7] azoxystrobin (4) 0.014-0.035 mg/kg; cyproconazole (1) 0.015 mg/kg; fluxapyroxad (1) 0.018 mg/kg; piperonyl butoxide (6) 0.013-0.32 mg/kg; propyzamide (1) 0.012 mg/kg; tebuconazole (5) 0.021-0.090 mg/kg; tri-allate (1) 0.010 mg/kg.

No MRLs are set for feed or crops meant for animal feed in UK or EU