

Mycotoxin monitoring results

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AHDB Contaminants Consortium

Partners



AIC – Agricultural Industries Confederation

BOBMA – British Oats and Barley Millers' Association

MAGB – Maltsters' Association of Great Britain

UKFM – UK Flour Millers

Background

For the UK grain supply chain to remain competitive, it needs to maintain its reputation for compliance and quality

- Agrochemical residues, mycotoxins and other major contaminants in cereals and co-products have been monitored independently since the mid-1980s
- A five-year (2016–21) AHDB monitoring contract (21130040) is led by Fera, this has been extended to cover 2022–23 and 2023–24
- Commercial grain samples* from each harvest are tested for key contaminants
- Sampling and sample preparation is key consideration, sample sizes ~1kg
- The results presented show harvest 2023 data for mycotoxins**

*Commercial intake samples have been provided by member companies of AIC, BOBMA, MAGB and UKFM

**Full monitoring results are published on the AHDB project page: ahdb.org.uk/monitoring-of-contaminants-in-uk-cereals-used-for-processing-food-and-animal-feed

Data treatment

- Mycotoxin results are all corrected for recovery determined with each analytical batch
- For statistical summaries (from Fera) all results are calculated using 'lower bound' values
- This means anything $<RL$ is presumed = 0
- This is why some mean values can be calculated as a 'value/number' which is lower than the RL

Sampling plan (harvest samples 2023)

Sample type	Trade Association	Sample number	Core and additional analytes
Milling Wheat	UKFM	50	Trichothecenes, ZON, fungicides, PGRs & glyphosate, 6+6 ergot alkaloids
Malting Barley	MAGB	40	Trichothecenes, ZON, fungicides, 6+6 ergot alkaloids
Food Oats	BOBMA	29	Trichothecenes, ZON, fungicides, PGRs & glyphosate, 6+6 ergot alkaloids
Barley		1	Trichothecenes, ZON, fungicides, PGRs & glyphosate, 6+6 ergot alkaloids
Feed Wheat	AIC	14	Trichothecenes, ZON, glyphosate, 6+6 ergot alkaloids
Wheatfeed		20	Trichothecenes, ZON, 6+6 ergot alkaloids
Feed Barley		14	Trichothecenes, ZON, glyphosate, 6+6 ergot alkaloids
Feed Oats		6	Trichothecenes, ZON, glyphosate, 6+6 ergot alkaloids
Oatfeed		6	Trichothecenes, ZON, 6+6 ergot alkaloids

Analytical method

- In-house method developed at Fera, for analysis of 17 fusarium mycotoxins
- Method uses solvent extraction, followed by SPE clean-up and LC-MS/MS analysis
- Analytes are:

Deoxynivalenol, fusarenon X, 3-acetyl DON, 15-acetyl DON, nivalenol, diacetoxyscirpenol, neosolaniol, T-2 toxin, HT-2 toxin, DON-3-glucoside, T-2 α 3 glucoside, zearalenone, α -zearalenol, β -zearalenol, α -zearalenol glucoside, β -zearalenol glucoside and zearalenone glucoside
- Method is accredited to ISO17025

Deoxynivalenol results (harvest 2023 samples)

DON

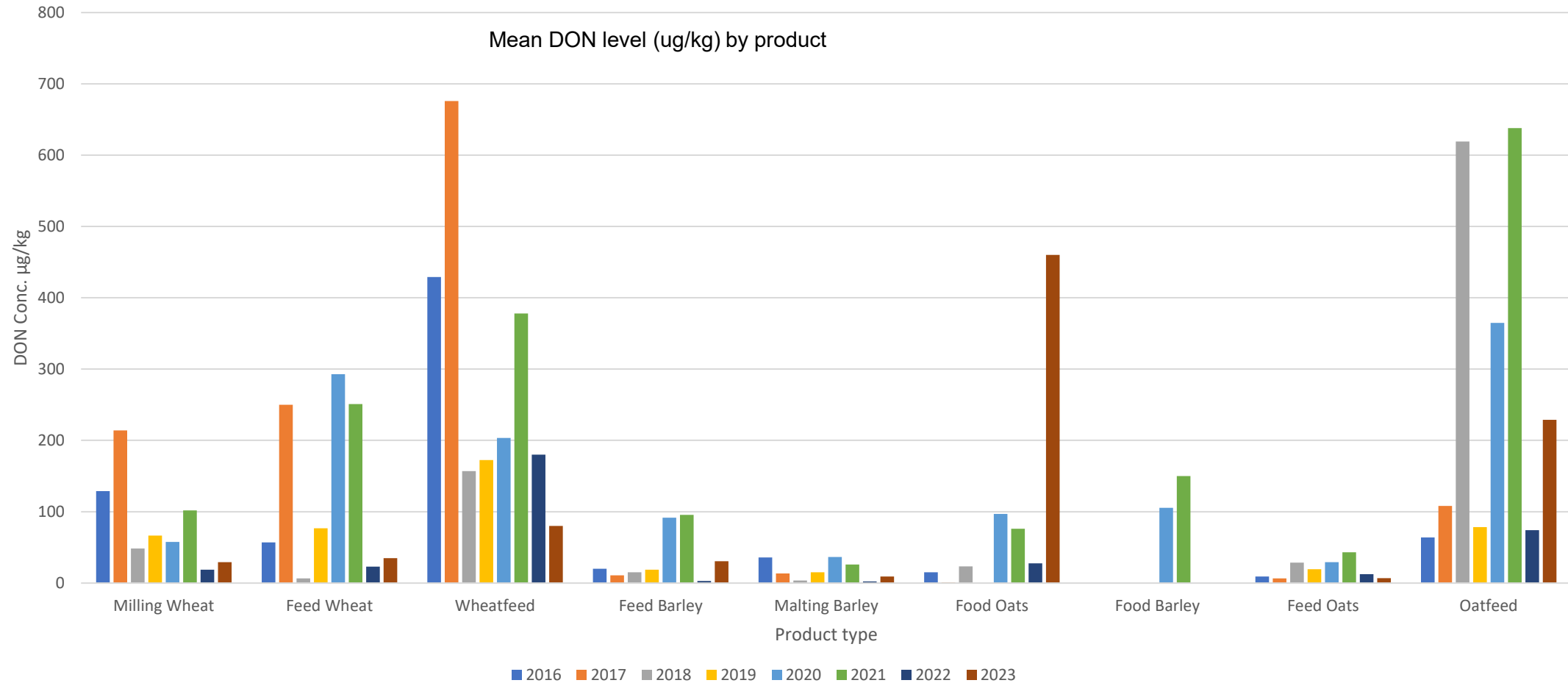
Year 8

Harvest (September 2023)

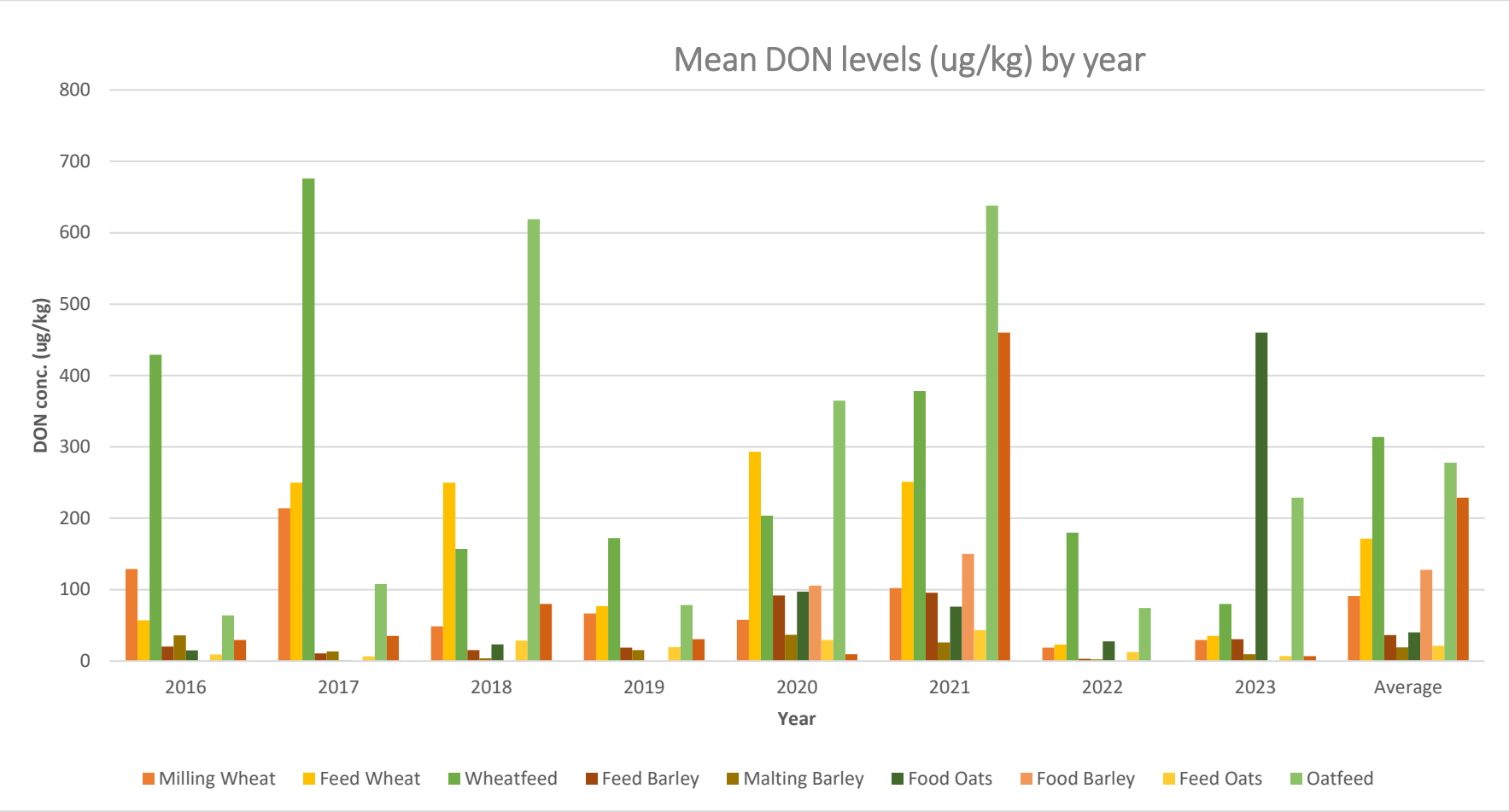
	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	2023 Mean Level µg/kg	2022 Mean Level µg/kg	2021 Mean Level µg/kg	2020 Mean Level µg/kg
Milling Wheat	50	50%	<10	400	29.3	19	102	57.7
Feed Wheat	14	71%	<10	209	35	23	251	293
Wheatfeed	20	100%	22.1	158	80	180	378	203.6
Feed Barley	14	43%	<10	238	30.5	3	95.5	91.7
Malting Barley	40	28%	<10	80.3	9.3	2.3	43.6	36.7
Food Oats	29	45%	<10	6387	460*	27.6	76	97.1
Food Barley	1	0%	<10	<10	<10	<10	150	105.4
Feed Oats	6	50%	<10	16.3	6.7	12.5	43	29.2
Oatfeed	6	100%	20.1	814	229	74	638	364.7

*Two anomalous values of 6386µg/kg and 6053µg/kg are included in this mean. When removed the mean value is **32.9µg/kg** µg/kg

Collated mean DON results by product (2016–2023)



Collated Mean DON results by year (2016–2023)



	2023 Mean ug/kg
Milling Wheat	29.3
Feed Wheat	35
Wheatfeed	80
Feed Barley	30.5
Malting Barley	9.3
Food Oats	460
Food Barley	<10
Feed Oats	6.7
Oatfeed	229

DON-3 Glucoside (harvest 2023 samples)

DON-3-Glc								
Year 8								
Harvest (September 2023)								
	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	2023 Mean Level µg/kg	2022 Mean Level µg/kg	2021 Mean Level µg/kg	2020 Mean Level µg/kg
Milling Wheat	50	12%	<10	43.5	2.7	0.9	11.7	13.3
Feed Wheat	14	29%	<10	34	5	<10	34.4	36.4
Wheatfeed	20	55%	<10	21	8.4	8.3	41.0	29.6
Feed Barley	14	14%	<10	66	6.7	<10	28.8	64.7
Malting Barley	40	15%	<10	39.1	3.0	<20	10.6	14.6
Food Oats	29	24%	<10	2020	125*	8.5	11.9	33.1
Food Barley	1	0%	<10	<10	<10	<10	46.0	42.5
Feed Oats	6	17%	<10	17.7	2.9	<10	5.9	12.1
Oatfeed	6	83%	<10	110	40.5	14	66	117.7

*Two anomalous values of 2020µg/kg and 1456µg/kg are included in this mean. When removed the mean value is **6.3µg/kg**.

Zearalenone (harvest 2023 samples)

ZEN

Year 8

Harvest (September 2023)

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	2023 Mean Level µg/kg	2022 Mean Level µg/kg	2021 Mean Level µg/kg	2020 Mean Level µg/kg
Milling Wheat	50	28%	<2.5	13.4	1.6	0.1	5.9	<2.5
Feed Wheat	14	21%	<2.5	40	4.0	<2.5	36.6	29.0
Wheatfeed	20	80%	<2.5	20	5.0	12.8	19.4	23.5
Feed Barley	14	21%	<2.5	19	1.9	<2.5	3.5	25.8
Malting Barley	40	0%	<2.5	<2.5	<2.5	<2.5	0.9	3.1
Food Oats	29	21%	<2.5	840	33*	2.1	2.4	33.8
Food Barley	1	0%	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Feed Oats	6	0%	<2.5	<2.5	<2.5	<2.5	1.8	1.0
Oatfeed	6	50%	<2.5	24	8	1.1	29.2	40.3

*One anomalous value of 840µg/kg is included in this mean. When removed the mean value is **4.2µg/kg**.

Sum HT-2 and T-2 Toxins (harvest 2023 samples)

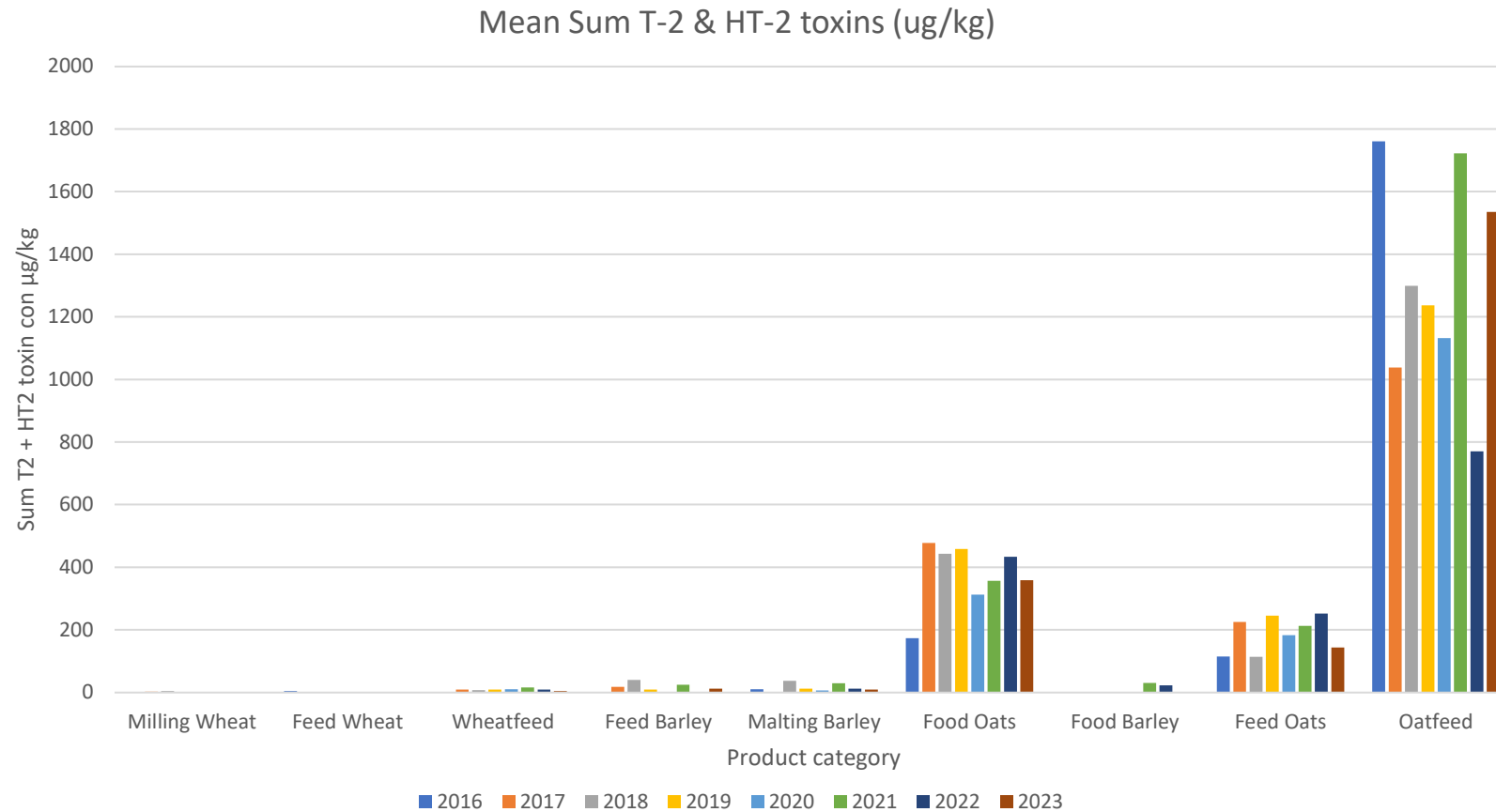
HT-2 + T-2

Year 8

Harvest (September 2023)

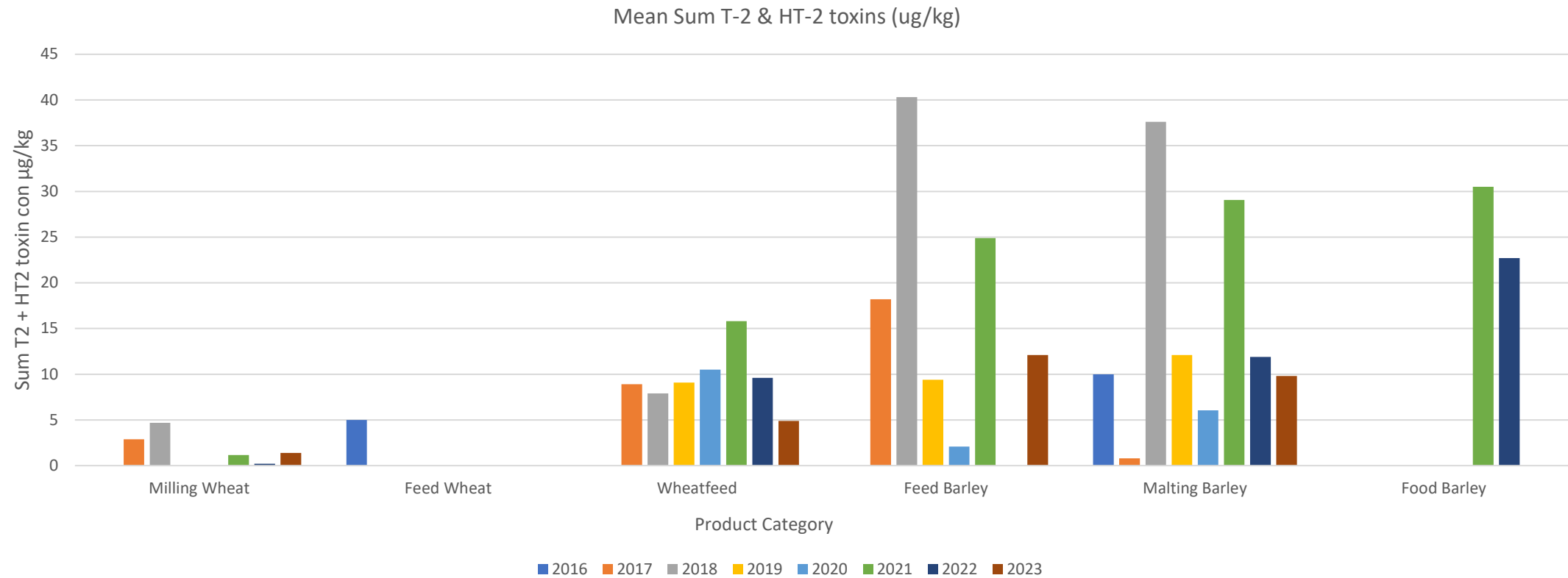
	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	2023 Mean Level µg/kg	2022 Mean Level µg/kg	2021 Mean Level µg/kg	2020 Mean Level µg/kg
Milling Wheat	50	2%	<20	71.6	1.4	0.2	1.2	<20
Feed Wheat	14	0%	<20	<20	<20	<20	<20	<20
Wheatfeed	20	40%	<20	15.6	4.9	9.6	15.8	10.5
Feed Barley	14	14%	<20	120	12.1	<20	24.9	2.1
Malting Barley	40	45%	<20	95.6	9.8	11.9	19.6	6.0
Food Oats	29	93%	<20	1930	359	433	357	313
Food Barley	1	0%	<20	<20	<20	22.7	30.5	<20
Feed Oats	6	100%	22.7	485	144	252	213	183
Oatfeed	6	100%	515	4294	1535	770	1722	1132

Collated results sum T-2 & HT-2 toxin (2016-2023)

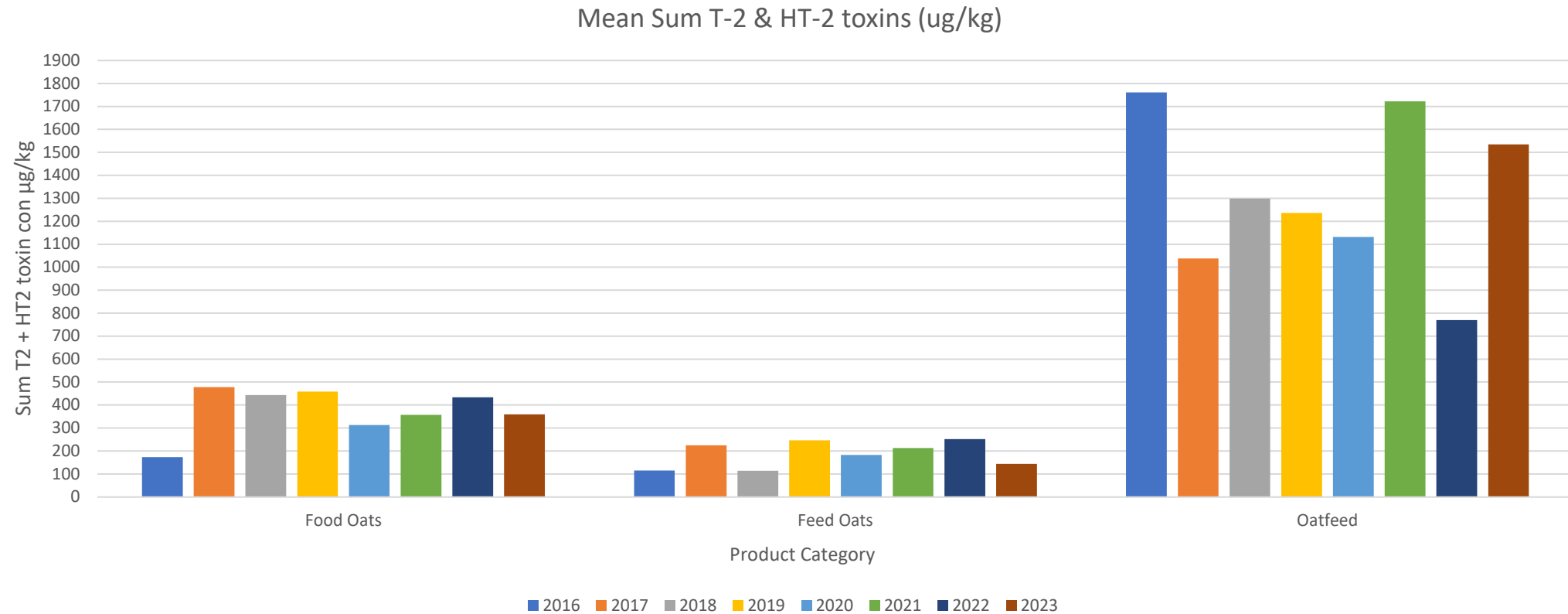


	2023 Mean Level µg/kg
Milling Wheat	1.4
Feed Wheat	<20
Wheatfeed	4.9
Feed Barley	12.1
Malting Barley	9.8
Food Oats	359
Food Barley	<20
Feed Oats	144
Oatfeed	1535

Collated results sum T-2 & HT-2 toxin (2016-2023)

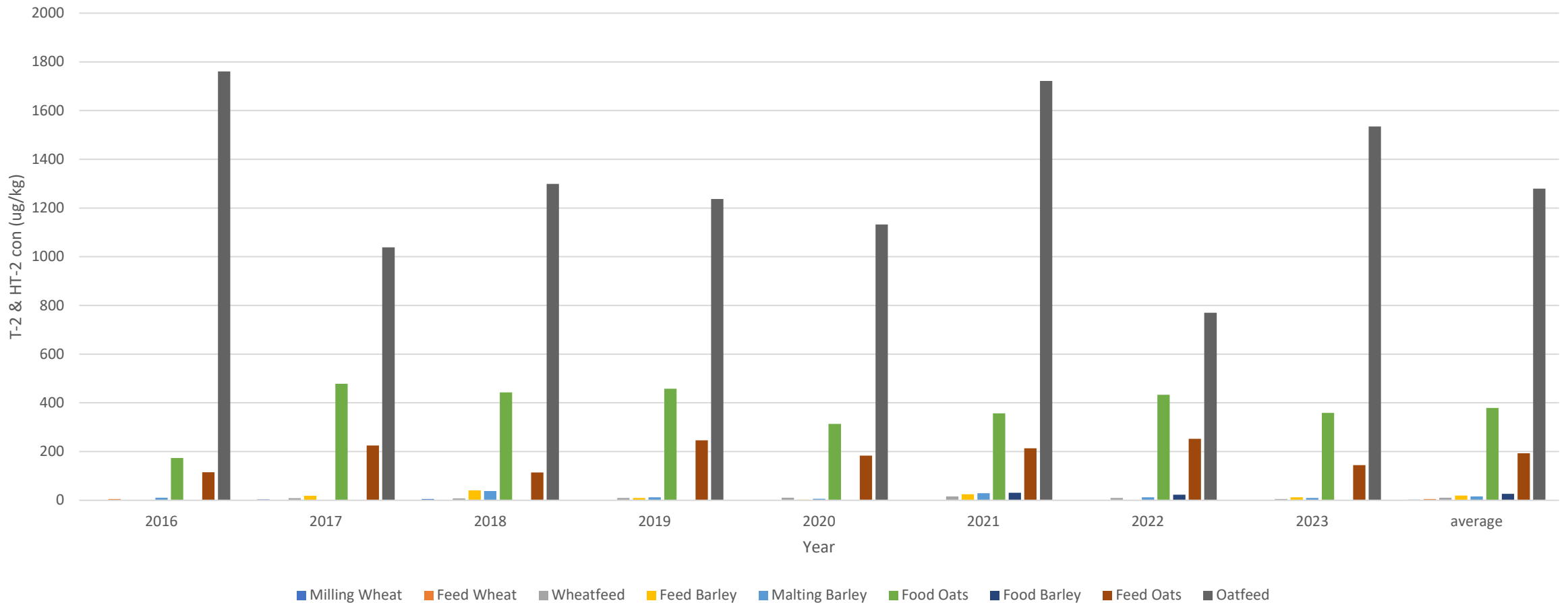


Collated results sum T-2 & HT-2 toxin (2016-2023)



Collated results sum T-2 & HT-2 toxin (2016-2023)

Mean Sum T-2 and HT-2 toxins (ug/kg)



T2-A3-Glucoside (harvest 2023 samples)

T2-A3-Glc

Year 8

Harvest (September 2023)

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	2023 Mean Level µg/kg	2022 Mean Level µg/kg	2021 Mean Level µg/kg	2020 Mean Level µg/kg
Milling Wheat	50	0%	<10	<10	<10	<10	<10	<10
Feed Wheat	14	0%	<10	<10	<10	<10	<10	1.0
Wheatfeed	20	0%	<10	<10	<10	<10	<10	<10
Feed Barley	14	7%	<10	29	2.1	<10	2.1	3.1
Malting Barley	40	5%	<10	<10	<10	0.6	2.3	1.6
Food Oats	29	59%	<10	240	45	8.5	53.5	37.1
Food Barley	1	0%	<10	<10	<10	<10	<10	<10
Feed Oats	6	33%	<10	47	10	7.8	37.7	61.5
Oatfeed	6	100%	37	709	224	83	188	118

Nivalenol (harvest 2023 samples)

Nivalenol

Year 8

Harvest (September 2023)

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	2023 Mean Level µg/kg	2022 Mean Level µg/kg	2021 Mean Level µg/kg	2020 Mean Level µg/kg
Milling Wheat	50	0%	<50	<50	<50	1.3	2.4	<50
Feed Wheat	14	0%	<50	<50	<50	<50	12.1	13.5
Wheatfeed	20	5%	<50	51.7	2.6	115	59.9	43.1
Feed Barley	14	21%	<50	674	103	9	165	131
Malting Barley	40	13%	<50	129	10.9	19.3	98.4	17.7
Food Oats	29	38%	<50	860	73	91	136	100.7
Food Barley	1	0%	<50	<50	<50	<50	850	<50
Feed Oats	6	0%	<50	<50	<50	79	182	406
Oatfeed	6	100%	134	274	197	583	169	215

Other results

- No occurrence of 15 acetyl DON, 3 acetyl DON detected in 5 samples (2 oatfeed samples - 76.2 µg/kg and 38.5 µg/kg and 3 food oat samples – 43.5 µg/kg, 500 µg/kg and 1583.3 µg/kg)
- Fusarenon X not detected
- Diacetoxyscirpenol not detected
- Neosolaniol only found in one malting barley (13 µg/kg) and one feed barley (10.9 µg/kg). For oat products, 45% occurrence in food oats (max level 75 µg/kg, mean 14 µg/kg), 100% incidence in oatfeed (max level 71.8 µg/kg) and 1 feed oats sample (10.9 µg/kg)

Other results

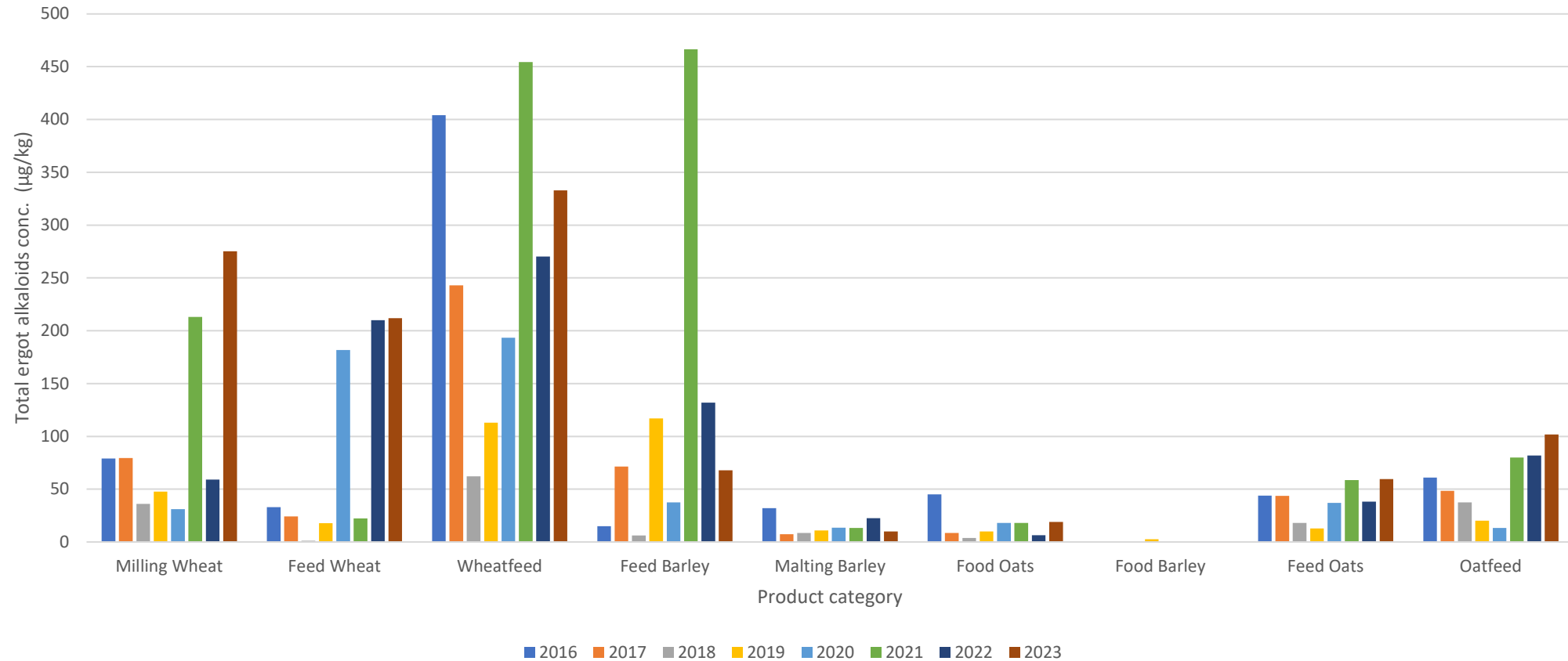
- Alpha-zearalenol was detected in one sample of food oats (7.3 µg/kg). Zearalenone was also detected at high levels in this sample (840 µg/kg)
- Alpha-zearalenol glucoside was not detected in any sample
- Beta-zearalenol was detected in two samples of food oats (4.6 µg/kg and 37.1 µg/kg), both samples also detected zearalenone (100 µg/kg and 840 µg/kg)
- Beta-zearalenone glucoside was not detected in any sample

Total ergot alkaloids (harvest 2023)

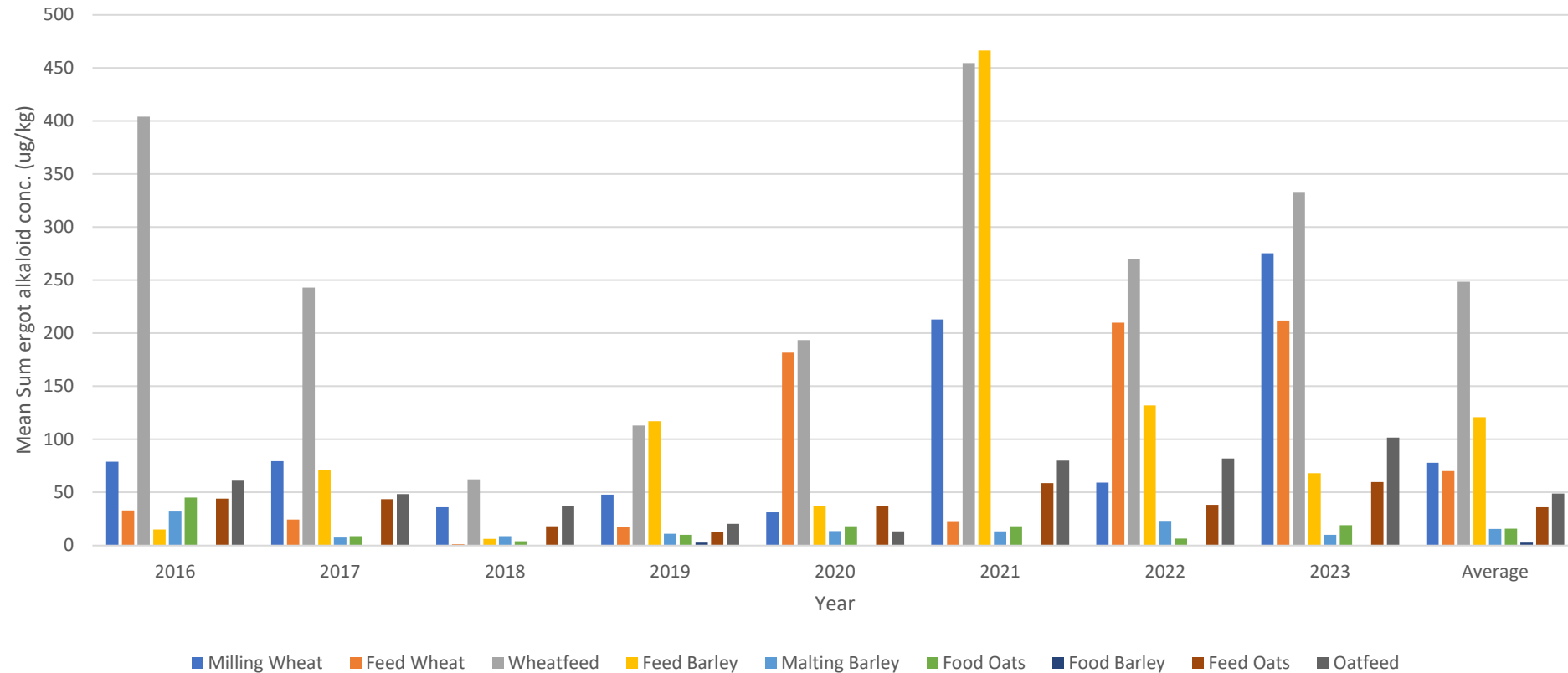
Total Ergot Alkaloids (n=12) [Sum of quantified residues] Harvest (September 2023)						
	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	Mean Level µg/kg (*)	Median Level µg/kg
Milling Wheat	50	72%	<6.0	2967	257.3 (31.1)	19.8
Feed Wheat	14	64%	<6.0	1339	212 (182)	35
Wheatfeed	20	100%	60.8	859	333 (193)	264
Feed Barley	14	64%	<6.0	490	68 (37.6)	12.1
Malting Barley	40	30%	<6.0	111	10 (13.5)	<6.0
Food Oats	29	41%	<6.0	113	19.1 (18.1)	<6.0
Food Barley	1	0%	<6.0	<6.0	<6.0 (<6.0)	<6.0
Feed Oats	6	67%	<6.0	155	59.6 (37)	39.7
Oatfeed	6	100%	21.7	262.1	101.7 (13.2)	79.7

(*) 2022 mean level in brackets

Collated ergot alkaloid results by product (2016–2023)



Collated ergot alkaloid results by year (2016–2023)



Summary of project (2016-2023)

Year	No. Samples harvest	Fusarium toxins	Ergot Alkaloids	Alternaria Toxins	Pesticides	Glyphosate	Metals	Beauvericin & Enniatins	Chlorate	Aflatoxins	PGRs	Total No. Analyses
2016-17	181	181	181	70	120	150					80	782
2017-18	185	185	185		120	150					80	720
2018-19	185	185	185	30	120	150	50				80	800
2019-20	180	180	180		120	110		35			80	705
2020-21	176	176	176		120	120	25		30		80	727
2021-22	181	181	181		120	114	45			10	80	731
2022-23	180	180	180		120	114	85				80	759
2023-24	180	180	180		120	114					80	674
Totals	1448	1448	1448	100	960	1022	205	35	30	10	640	5898
No. analytes		17	12	5	33	1	7	5	2	4	3	89
Total No. results		24616	17376	500	31680	1022	1435	175	60	40	1920	78824

Year	No. Samples Stored	Fusarium toxins	OTA	STG	Pesticides	Metals	Dioxins	PAHs	Acrylamide	Chlorate	Aflatoxins	PGRs	Total No. Analyses
2016-17	220	40	220	30	220	150	80	80				40	860
2017-18	220	40	220		220	40		25				40	585
2018-19	220	40	220		220				20			40	540
2019-20	220	40	220		220							40	520
2020-21	220	40	220		220					40		40	560
2021-22	220	40	220		220					40	10	40	570
2022-23	220	40	220		220				20			40	540
2023-24	220	40	220		220							40	520
Totals	1760	320	1760	30	1760	190	80	105	40	80	10	320	4695
No. analytes		17	1	1	33	7	34	28	1	2	4	3	131
Total No. results		5440	1760	30	58080	1330	2720	2940	40	160	40	960	73500

Conclusions

DON – Very low across the board. 2022 saw some of the lowest DON results on record for this project and for some products (wheatfeed and feed oats) 2023 results were even lower still.

Only food oats returned a 'high' mean value for DON, this mean was skewed by two unusually high values. Once removed, the mean was in line with values from previous years (32.9µg/kg).

DON-3-Glc – Very low as expected. As above, two unusually high values in the food oat samples have skewed the data, producing a high mean value for that product (125µg/kg), once removed the value drops to 6.3µg/kg, which is one of the lowest mean values observed throughout this project.

ZEN – Generally low across all product types, with incidence and maximum levels higher than 2022 but broadly in line with previous years. Only one product had an incidence level greater than 50%. Once again, food oats had a skewed mean value, the result of one very high ZEN result of 840µg/kg. Once removed, the mean value is 4.2µg/kg, which is in line with mean values observed in previous years.

SUM T2 and HT-2 – Incidence levels are similar to those observed in 2022 with mean and max values also broadly similar to those seen in previous years. All products had mean values lower than the seven-year average, except oatfeed, which was marginally higher.

Ergot alkaloids – Mean levels observed in 2023 were higher for all products, except malting barley, when compared to 2022. For most products, the increase was only small. However, for oatfeed (13.2µg/kg in 2022 to 101.7µg/kg in 2023) and milling wheat (31.1 µg/kg in 2022 and 257.3 µg/kg in 2023) the increase was significant. Maximum values observed were broadly similar to those seen in previous years.

Exceedances

3 food oats returned values that would be ML exceedances for T2 and HT2, if the proposed limits, as detailed in the Annex of Commission Regulation (EU) 2023/915, were applied within GB. Those values were 1,407 µg/kg, 1,930 µg/kg and 1,563 µg/kg.

2 food oats returned DON values of 6,387 µg/kg and 6,053 µg/kg and 1 food oat returned a ZEN value of 840 µg/kg, all of which are ML exceedances under GB assimilated regulation 1881/2006.