

Mycotoxin monitoring results (harvest 2022)

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Original thinking... applied

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
- Commercial grain samples* from each harvest are tested for key contaminants
- Sampling and sample preparation is a key consideration, sample sizes ~1kg
- The results presented show harvest 2022 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 (reporting level) 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 2022

Sample type	Trade Association	Sample number	Core and additional analytes
Milling Wheat	UKFM	50	Trichothecenes, ZON, fungicides, PGRs & glyphosate, 6+6 ergot alkaloids, 25 samples for 7 metals
Malting Barley	MAGB	40	Trichothecenes, ZON, fungicides, 6+6 ergot alkaloids, 20 samples for 7 metals
Food Oats	BOBMA	29	Trichothecenes, ZON, fungicides, PGRs & glyphosate, 6+6 ergot alkaloids, 15 samples for 7 metals – 14 oats
Barley		1	Trichothecenes, ZON, fungicides, PGRs & glyphosate, 6+6 ergot alkaloids, 1 barley for 7 metals
Feed Wheat	AIC	14	Trichothecenes, ZON, glyphosate, 6+6 ergot alkaloids, 5 for metals
Wheatfeed		20	Trichothecenes, ZON, 6+6 ergot alkaloids, 5 for metals
Feed Barley		14	Trichothecenes, ZON, glyphosate, 6+6 ergot alkaloids, 5 for metals
Feed Oats		6	Trichothecenes, ZON, glyphosate, 6+6 ergot alkaloids, 5 for metals
Oatfeed		6	Trichothecenes, ZON, 6+6 ergot alkaloids, 5 for metals

Analytical method: fusarium toxins

- 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 – originally by Flexible Scope, but now on Fixed Schedule

Analytical method: ergot alkaloids

- In-house method developed at Fera, for analysis of 12 ergot alkaloids. Method is the CEN Method EN 17425:2021 - Foodstuffs - Determination of ergot alkaloids in cereals and cereal products by dSPE clean-up and HPLC-MS/MS
- Method uses solvent extraction, followed by dispersive SPE clean-up and LC-MS/MS analysis
- Analytes are: Ergocornine, Ergocorninine, Ergocristine, Ergocristinine, a+b-Ergocryptine, a+b-Ergocryptinine, Ergometrine, Ergometrinine, Ergosine, Ergosinine, Ergotamine, Ergotaminine (12 ergot alkaloids covered by Commission Regulation (EU) 2021/1399)
- Method is accredited to ISO17025 – originally by Flexible Scope, but now on Fixed Schedule

Deoxynivalenol results: harvest 2022 samples

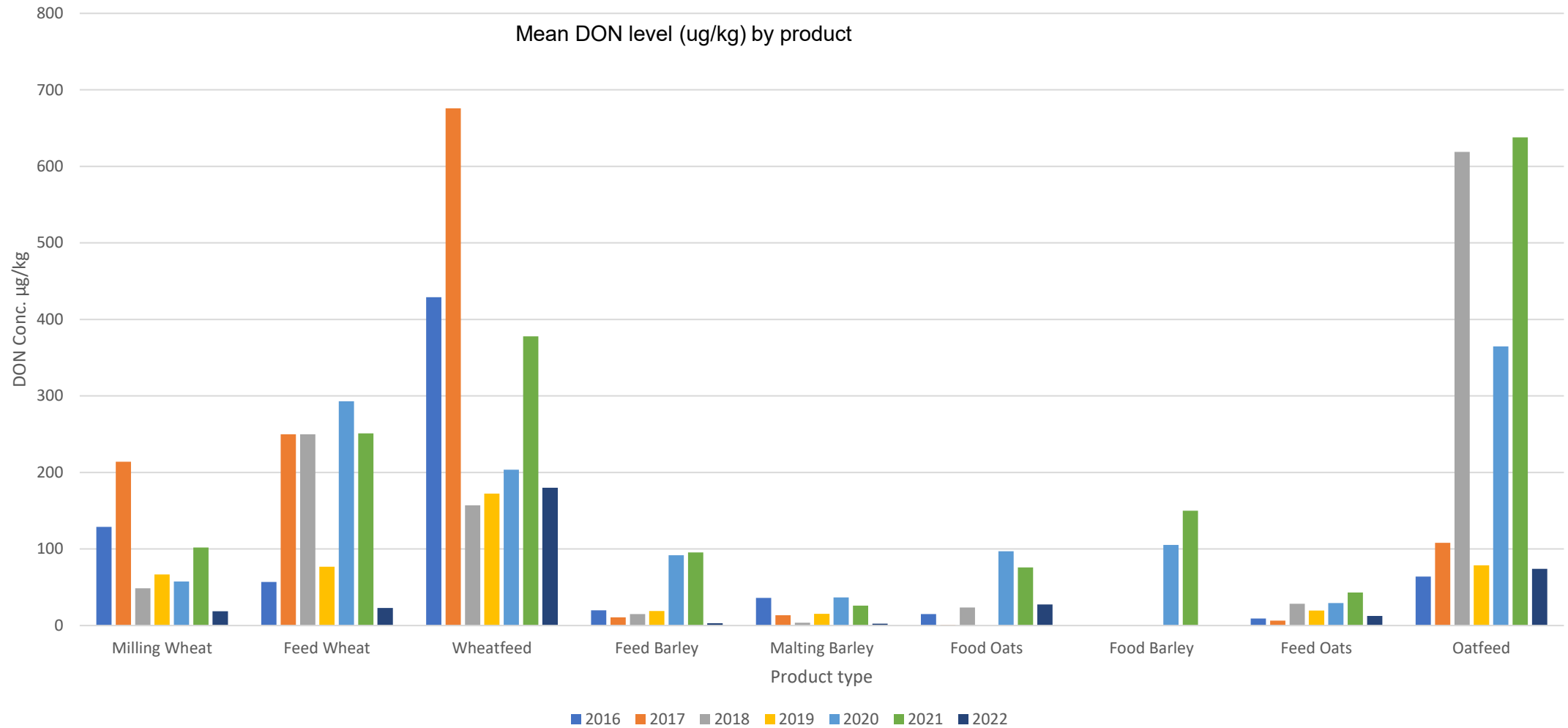
DON

Year 7

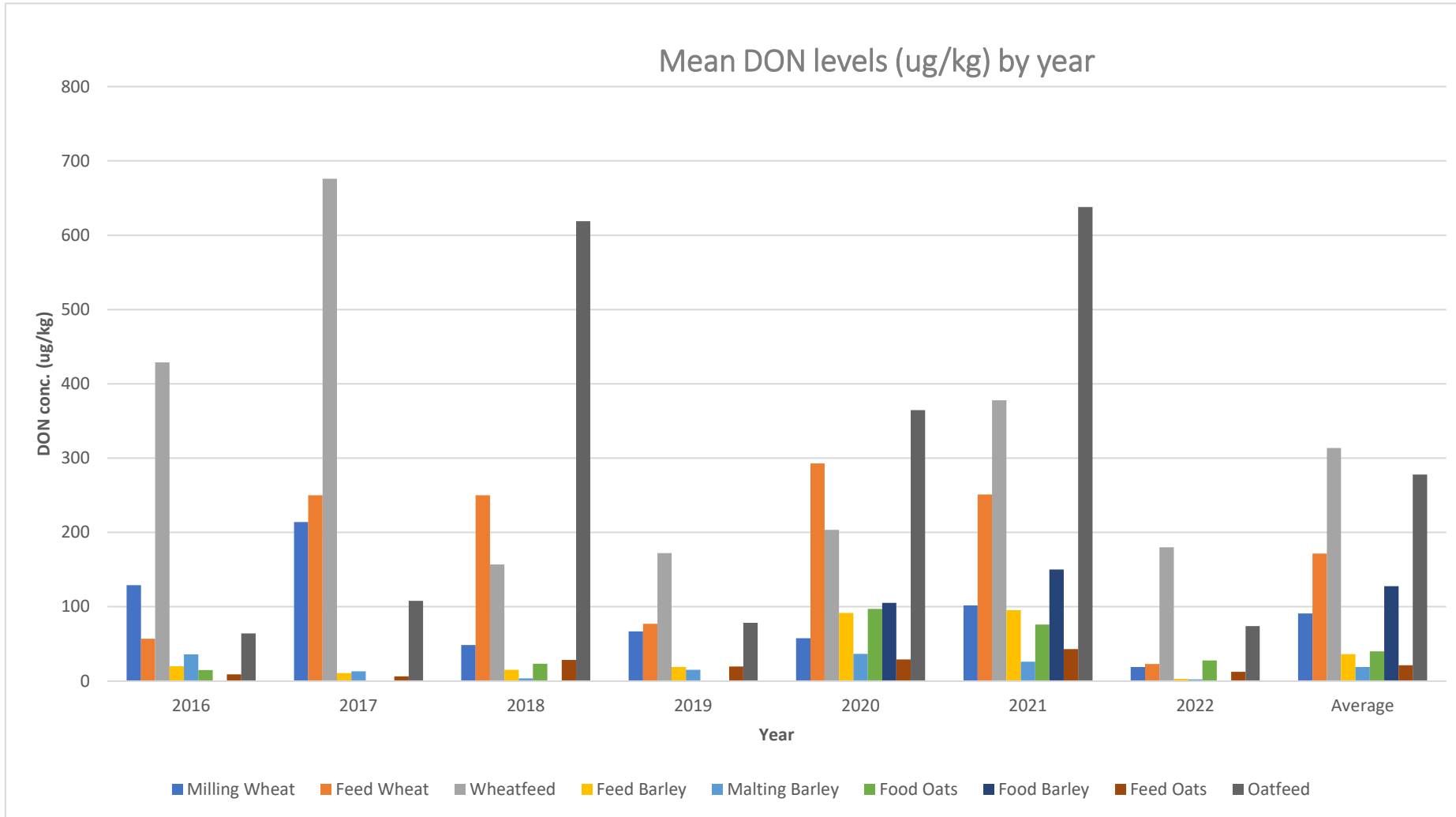
Harvest (September 2022)

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	2022 Mean Level µg/kg	2021 Mean Level µg/kg	2020 Mean Level µg/kg	2019 Mean Level µg/kg
Milling Wheat	50	54%	<10	174	19	102	57.7	66.7
Feed Wheat	14	43%	<10	127	23	251	293.0	76.9
Wheatfeed	20	100%	36	546	180	378	203.6	172
Feed Barley	14	14%	<10	27	3.0	95.5	91.7	18.8
Malting Barley	40	10%	<10	39	2.3	43.6	36.7	15.2
Food Oats	29	52%	<10	134	27.6	76.0	97.1	<10
Food Barley	1	0%	<10	<10	<10	150	105.4	<10
Feed Oats	6	50%	<10	31	12.5	43.0	29.2	19.5
Oatfeed	6	83%	<10	133	74	638	364.7	79

Collated mean DON results by product 2016-22



Collated mean DON results by year 2016-22



	2022 Mean ug/kg
Milling Wheat	19
Feed Wheat	23
Wheatfeed	180
Feed Barley	3.0
Malting Barley	2.3
Food Oats	27.6
Food Barley	<10
Feed Oats	12.5
Oatfeed	74

DON-3 Glucoside: harvest 2022 samples

DON-3-Glc

Year 7

Harvest (September 2022)

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	2022 Mean Level µg/kg	2021 Mean Level µg/kg	2020 Mean Level µg/kg	2019 Mean Level µg/kg
Milling Wheat	50	8%	<10	12.6	0.9	11.7	13.3	<10
Feed Wheat	14	0%	<10	<10	<10	34.4	36.4	11.2
Wheatfeed	20	40%	<10	32	8.3	41.0	29.6	18.9
Feed Barley	14	0%	<10	<10	<10	28.8	64.7	4.9
Malting Barley	40	0%	<20	<20	<20	10.6	14.6	4.6
Food Oats	29	17%	<20	99	8.5	11.9	33.1	<10
Food Barley	1	0%	<10	<10	<10	46.0	42.5	<10
Feed Oats	6	0%	<10	<10	<10	5.9	12.1	<10
Oatfeed	6	83%	<10	25	14	66	117.7	22

Zearalenone: harvest 2022 samples

ZON

Year 7

Harvest (September 2022)

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	2022 Mean Level µg/kg	2021 Mean Level µg/kg	2020 Mean Level µg/kg	2019 Mean Level µg/kg
Milling Wheat	50	2%	<2.5	3	0.1	5.9	<2.5	<2.5
Feed Wheat	14	0%	<2.5	<2.5	<2.5	36.6	29.0	5.2
Wheatfeed	20	75%	<2.5	36	12.8	19.4	23.5	<2.5
Feed Barley	14	0%	<2.5	<2.5	<2.5	3.5	25.8	<2.5
Malting Barley	40	0%	<2.5	<2.5	<2.5	0.9	3.1	0.6
Food Oats	29	3%	<2.5	60	2.1	2.4	33.8	<5
Food Barley	1	0%	<2.5	<2.5	<2.5	<2.5	<2.5	<5
Feed Oats	6	0%	<2.5	<2.5	<2.5	1.8	1.0	<2.5
Oatfeed	6	33%	<2.5	3	1.1	29.2	40.3	<2.5

Sum HT-2 and T-2 toxins: harvest 2022 samples

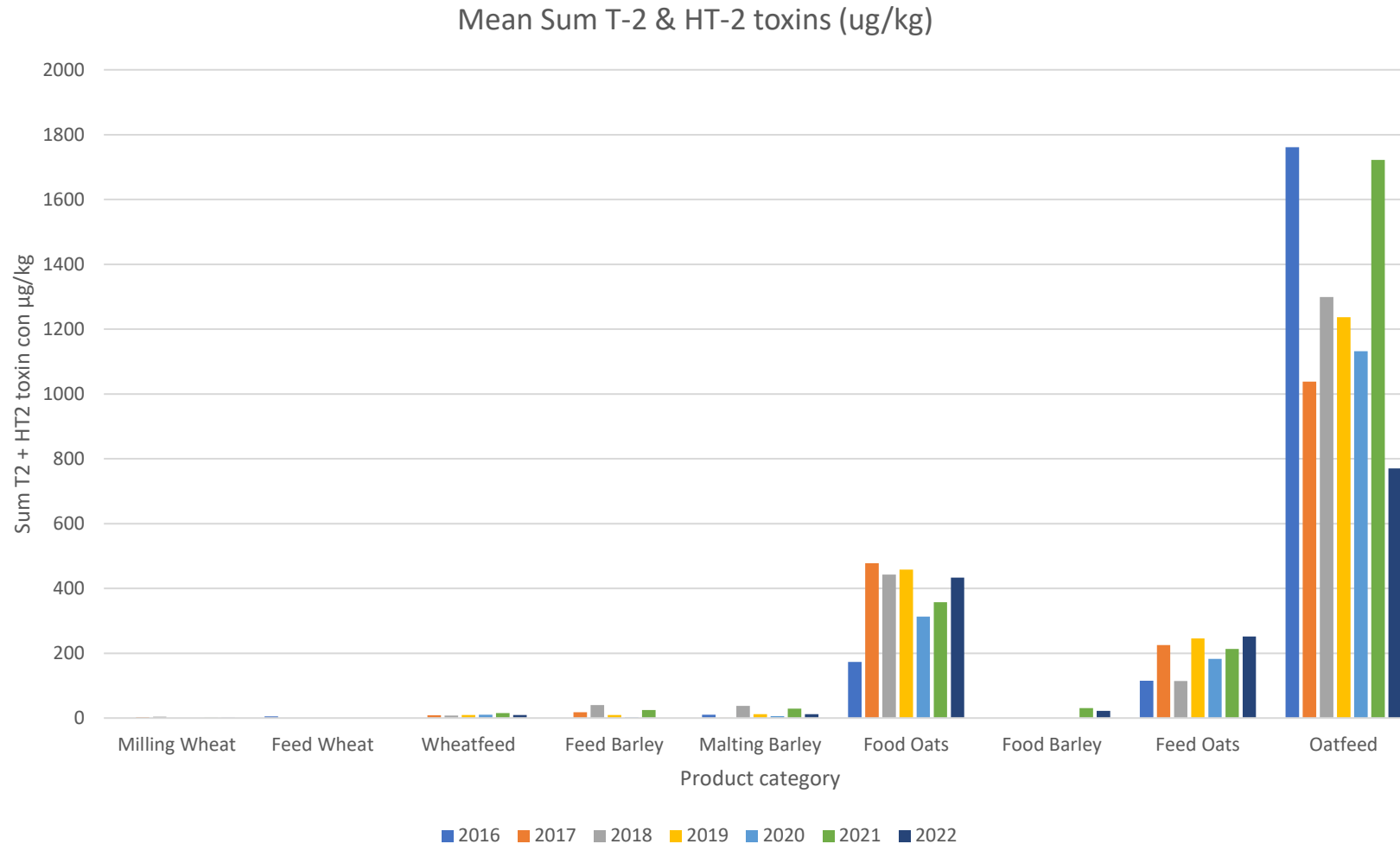
HT-2 + T-2

Year 7

Harvest (September 2022)

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	2022 Mean Level µg/kg	2021 Mean Level µg/kg	2020 Mean Level µg/kg	2019 Mean Level µg/kg
Milling Wheat	50	2%	<20	10.3	0.2	1.2	<20	<20
Feed Wheat	14	0%	<20	<20	<20	<20	<20	<20
Wheatfeed	20	50%	<20	37.9	9.6	15.8	10.5	9.1
Feed Barley	14	0%	<20	<20	<20	24.9	2.1	9.4
Malting Barley	40	23%	<20	129	11.9	19.6	6.0	12.1
Food Oats	29	83%	0.0	3283	433	357	313	458
Food Barley	1	100%	22.7	22.7	22.7	30.5	<20	<20
Feed Oats	6	100%	82.0	615	252	213	183	246
Oatfeed	6	100%	556	1095	770	1722	1132	1237

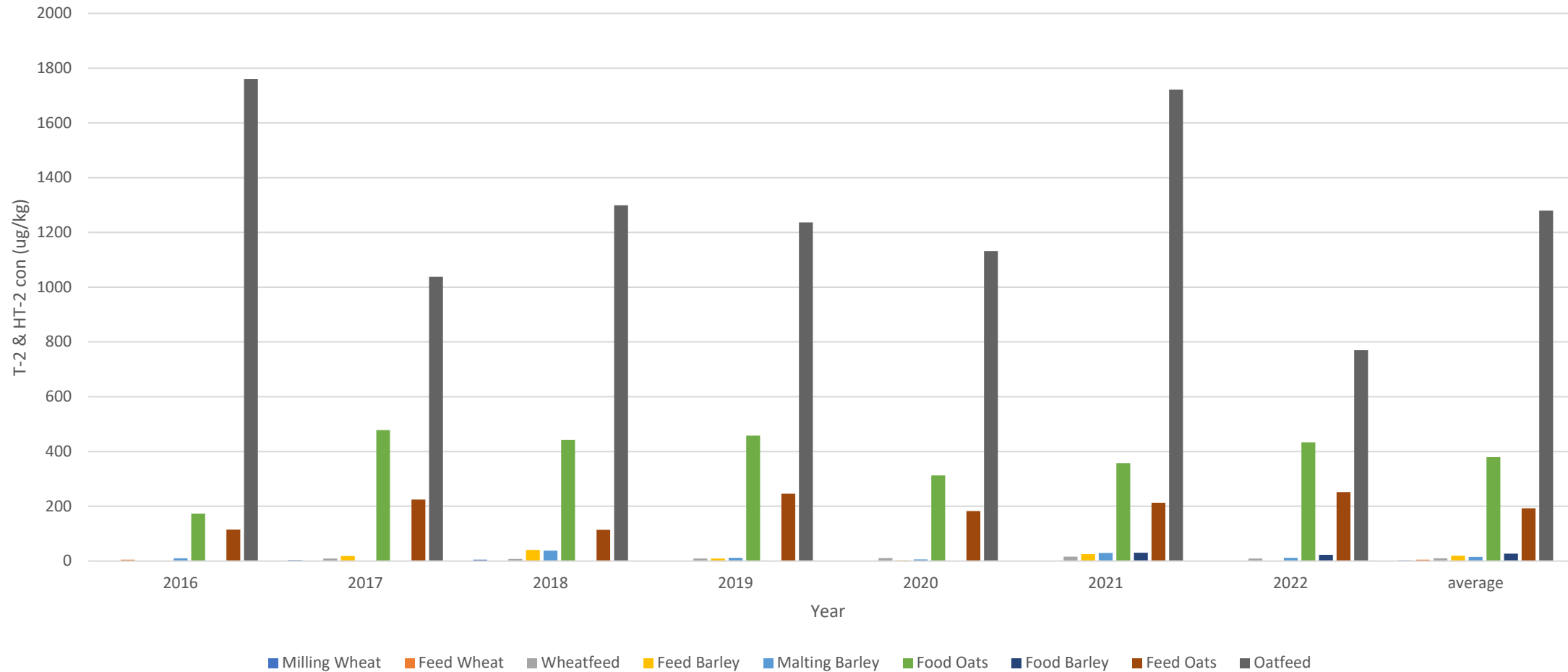
Collated results sum T-2 and HT-2 toxin 2016-22



	2022 Mean Level µg/kg
Milling Wheat	0.2
Feed Wheat	<20
Wheatfeed	9.6
Feed Barley	<20
Malting Barley	11.9
Food Oats	433
Food Barley	22.7
Feed Oats	252
Oatfeed	770

Collated results sum T-2 and HT-2 toxin 2016-22

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



T2-A3-Glucoside: harvest 2022 samples

T2-A3-Glc

Year 7

Harvest (September 2022)

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	2022 Mean Level µg/kg	2021 Mean Level µg/kg	2020 Mean Level µg/kg	2019 Mean Level µg/kg
Milling Wheat	50	0%	<10	0.0	0.0	<10	<10	<10
Feed Wheat	14	0%	<10	<10	<10	<10	1.0	<10
Wheatfeed	20	0%	<10	<10	<10	<10	<10	<10
Feed Barley	14	0%	<10	<10	<10	2.1	3.1	<10
Malting Barley	40	5%	<10	12.1	0.6	2.3	1.6	1.4
Food Oats	29	17%	<20	99	8.5	53.5	37.1	67.4
Food Barley	1	0%	0.0	0.0	0.0	<10	<10	<10
Feed Oats	6	33%	<10	24	7.8	37.7	61.5	28.9
Oatfeed	6	100%	43.0	134	83	188	118	231

Nivalenol: harvest 2022 samples

Nivalenol

Year 7

Harvest (September 2022)

	No. of Samples Analysed	% > Reporting Limit	Minimum Level µg/kg	Maximum Level µg/kg	2022 Mean Level µg/kg	2021 Mean Level µg/kg	2020 Mean Level µg/kg	2019 Mean Level µg/kg
Milling Wheat	50	2%	<50	65	1.3	2.4	<50	<50
Feed Wheat	14	0%	<50	<50	<50	12.1	13.5	<50
Wheatfeed	20	95%	<50	405	115	59.9	43.1	32.5
Feed Barley	14	7%	<50	130	9	165	131	50
Malting Barley	40	15%	<50	290	19.3	98.4	17.7	32.7
Food Oats	29	55%	<50	933	91	136	100.7	<50
Food Barley	1	0%	<50	<50	<50	850	<50	<50
Feed Oats	6	83%	<50	225	79	182	406	116
Oatfeed	6	100%	242	975	583	169	215	283

Other results

- No occurrence of 3 acetyl DON, wheatfeed only product to contain 15 acetyl DON (10 samples, max level 55 µg/kg, mean 17 µg/kg)
- Fusarenon X not detected
- Diacetoxyscirpenol only found in 2 food oats (10 and 14 µg/kg)
- Neosolaniol found in one malting barley (12 µg/kg)
- For oat products, NEO 38% occurrence in food oats (max level 145 µg/kg, mean 14 µg/kg), 100% incidence in oatfeed (max level 37 µg/kg, mean 23) and 1 feed oats sample (15 µg/kg)

Other results

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- For oat products, NEO 38% occurrence in food oats (max level 145 $\mu\text{g}/\text{kg}$, mean 14 $\mu\text{g}/\text{kg}$), 100% incidence in oatfeed (max level 37 $\mu\text{g}/\text{kg}$, mean 23 $\mu\text{g}/\text{kg}$) and 1 feed oats sample (15 $\mu\text{g}/\text{kg}$)

Other results

- Alpha-zearalenol was detected in one wheat feed at 3 µg/kg, the same sample contained 28 µg/kg zearalenone
- Alpha-zearalenol glucoside was not detected in any sample
- Beta-zearalenol was not detected in any sample, its glucoside was detected in 5 samples of oatfeed, max level 8 µg/kg
- Zearalenone glucoside was not detected

Total ergot alkaloids: harvest 2022

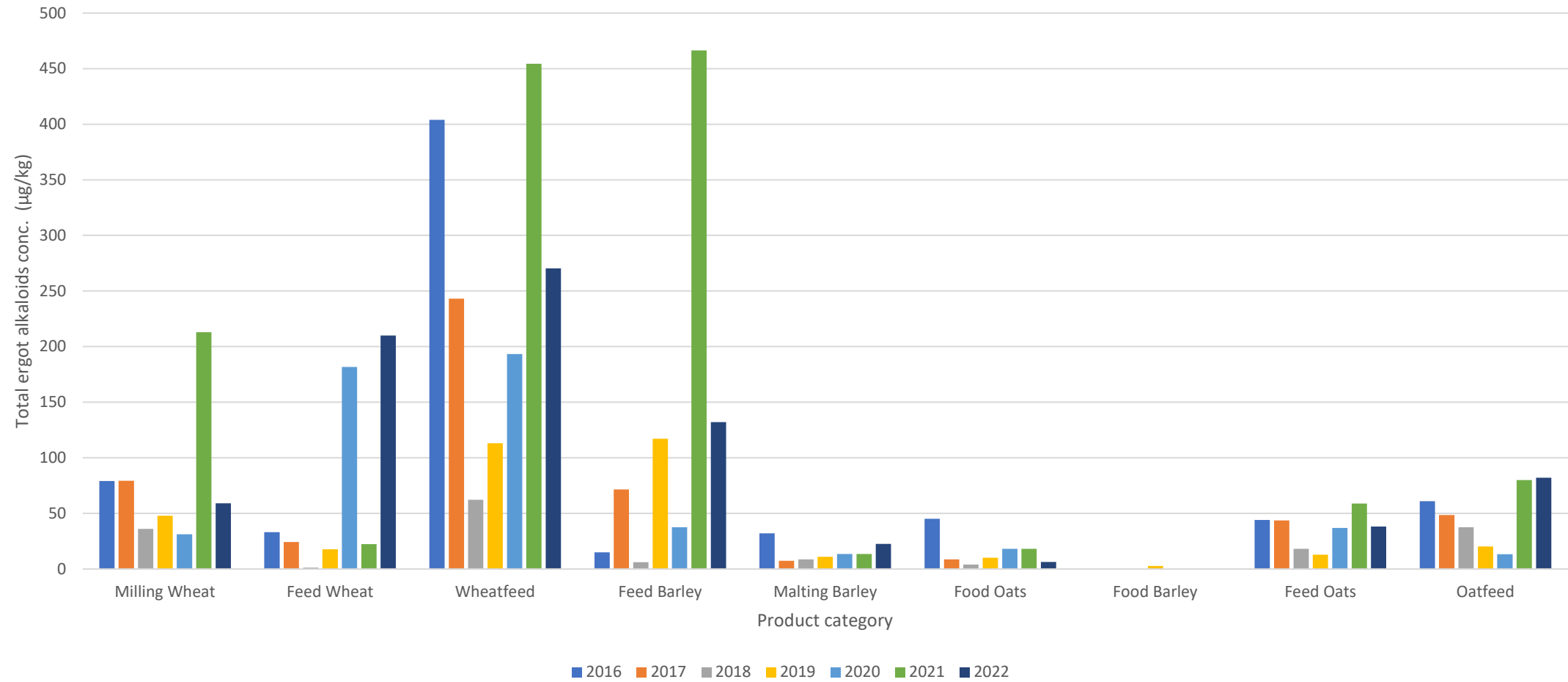
Total Ergot Alkaloids (n=12) [Sum of quantified residues]

Year 7

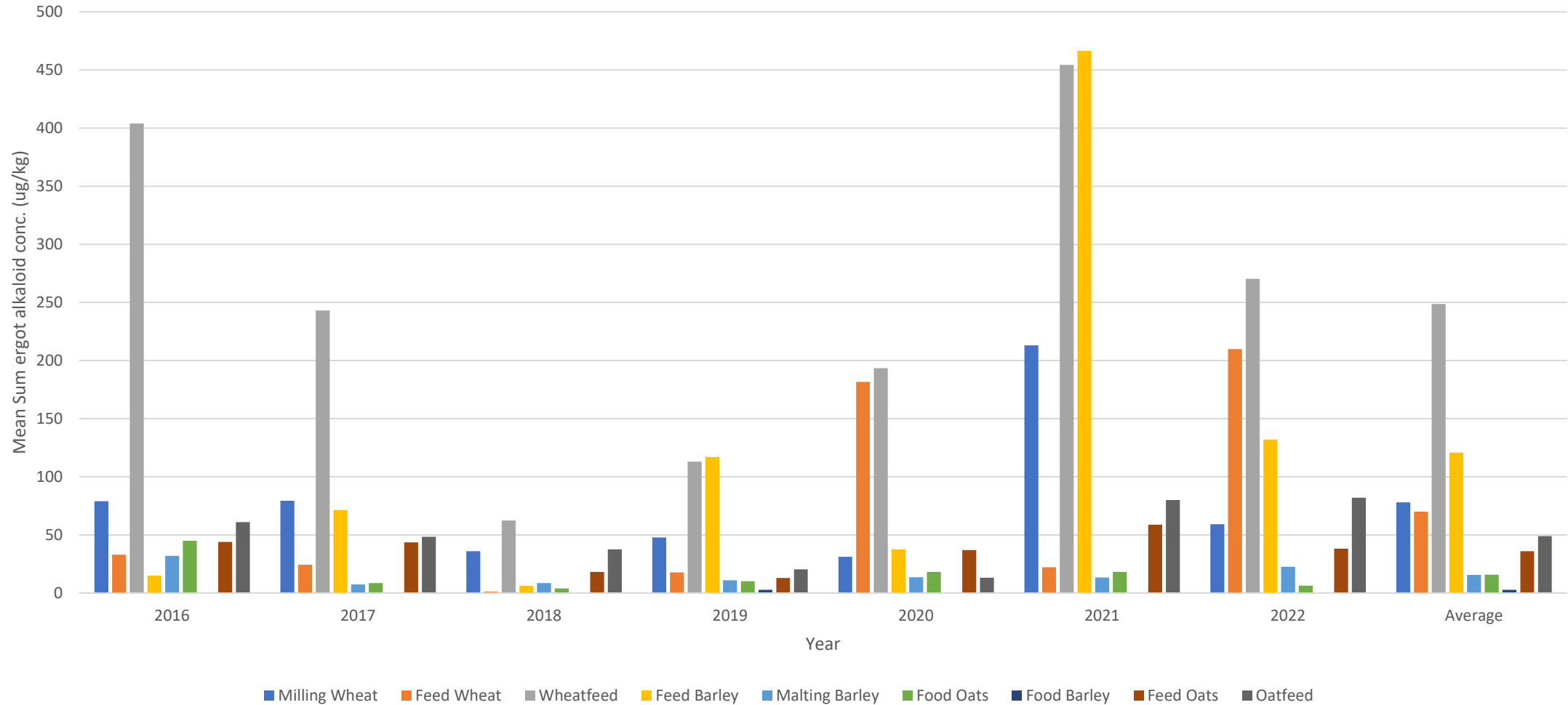
Harvest (September 2022)

	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	<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	N/A
Feed Oats	6	33%	<6.0	49	38.2	<6.0
Oatfeed	6	83%	<6.0	143	81.9	<6.0

Collated ergot alkaloid results 2016-22



Collated ergot alkaloid results 2016-22



Summary of project 2016-22

Year	No. harvest	Fusarium toxins	Ergot	Alternaria Toxins	Pesticides	Glyphosate	Metals	Beauvericin & Enniatins	Chlorate	Aflatoxins	PGRs	Total No. Tests	
2016-17	181	181	181	70	120	150					80	702	
2017-18	185	185	185		120	150					80	640	
2018-19	185	185	185	30	120	150	50				80	720	
2019-20	180	180	180		120	110		35			80	625	
2020-21	176	176	176		120	120	25		30		80	647	
2021-22	181	181	181		120	114	45			10	80	651	
Totals	1088	1088	1088	100	720	794	120	35	30	10	480	3985	
No. analytes		17	12	5	33	1	7	5	2	4	3	89	
Total No. results		18496	13056	500	23760	794	840	175	60	40	1440	59161	
Year	No. Stored	Fusarium toxins	OTA	STG	Pesticides	Metals	Dioxins	PAHs	Acrylamide	Chlorate	Aflatoxins	PGRs	Total No. Tests
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
Totals	1320	240	1320	30	1320	190	80	105	20	80	10	240	3635
No. analytes		17	1	1	33	7	34	28	1	2	4	3	131
Total No. results		4080	1320	30	43560	1330	2720	2940	20	160	40	720	56920

Overall project statistics 2016-22

Total number samples	2408
Total weight received (kg)	6728
Total number of analytes	220
Number of analytical methods used	16
Total number of tests	8100
Total number of results	116081
Extra pesticides screened	816000

Data collated before sampling for 2022-23 started

Conclusions

- Harvest 2022 – lowest DON results seen in lifetime of project (since 2016)
- DON 3-Glc, as expected, also very low
- ZON levels, occurrence and mean values, also among lowest seen through project life
- Sum T-2 and HT-2 levels were similar to other years for food oats, although slightly above the 7-year average for these and feed oats, while oatfeed was below the average
- Ratio of T-2 glucoside was approximately 10% of sum T-2 and HT-2, as in previous years
- Ergot alkaloid levels in all products, except feed wheat and malting barley, were lower than 2021
- No sample exceeded any maximum permitted levels.

Industry Partners' DON and ZON results

Screening tests (LFD) from UK Flour Millers and AIC (as to 16 September 2022)

	UK Flour Millers DON Results (ppb)					
Range	<250	≥250 to <500	≥500 to <750	≥750 to <1000	≥1000 to ≤1250	>1250
1,295 (Total samples)	1,263	20	9	3	0	0
	97.5%	1.5%	0.7%	0.2%	0.0%	0.0%

Samples	AIC DON Results (ppb)					
Range	<250	≥250 to <500	≥500 to <750	≥750 to <1000	≥1000 to ≤1250	>1250
1,099 (Total samples)	1,050	45	2	1	1	0
	95.5%	4.1%	0.2%	0.1%	0.1%	0.0%

	UK Flour Millers ZON Results (ppb)				
Range	<25	≥25 to <50	≥50 to <75	≥75 to ≤100	>100
899 (Total samples)	721	161	16	1	0
	80.2%	17.9%	1.8%	0.1%	0.0%

	AIC ZON Results (ppb)				
Range	<25	≥25 to <50	≥50 to <75	≥75 to ≤100	>100
1,706 (Total samples)	1,526	168	10	2	0
	89.4%	9.8%	0.6%	0.1%	0.0%

Industry Partners' DON results

Screening tests (LFD) from MAGB for 2022

	DON (ppb)
Number of samples	237
Mean	28.8
Maximum	800
Minimum	0
Total tonnes assessed	112,622

Thank you

- AHDB for funding this project, in particular Dhan Bhandari
- Colleagues at AIC, BOBMA, MAGB and UKFM for collaboration and support, particularly in responding to sample queries
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Stephen Chapman
Joanna Stratton
Andrew Woodward

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