Stopping the Hidden Thief : Mycotoxins

Dr. Max Hawkins

Global Tech Support

Mycotoxin Management Team

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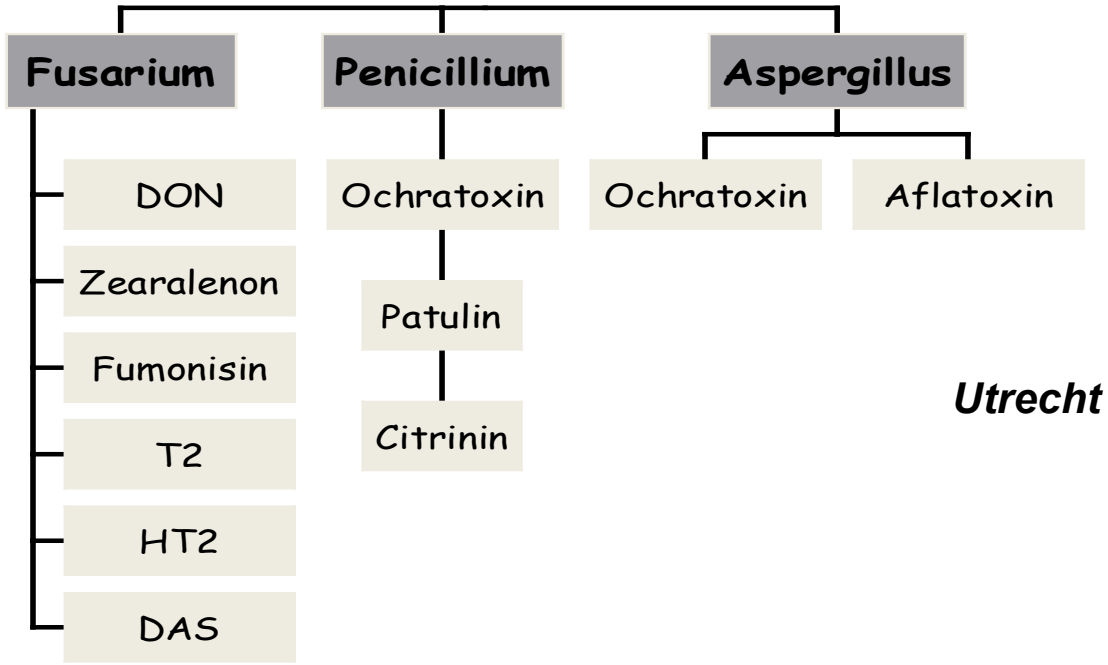
MYCOTOXIN
MANAGEMENT

"Mycotoxicosis in (dairy) cattle is often the result of exposure to **multiple toxins**, due to **pre-harvest infestation** of feed materials by ***Fusarium species*** *as well as from* ***postharvest*** **contamination** of stored/ensiled materials by ***Penicillium*** *(P. roqueforti, P. carnosum a.o.) and Aspergillus species"*



Fink-Gremmels,
Utrecht University, The Netherlands

Mycotoxin Cost

Is the cost lower milk or components ?

Lead question is,

Are your cows as healthy today as they were 365 days ago ?

Economics have pressured inputs and increased mycotoxin inclusion

Cow Health $ - Transition Issues

Health Issues

-Hypocalcemia
- Ketosis
- Lameness
- Left Displaced Abomasum
- Mastitis
- Metritis
- Retained Placenta

Costs

- Veterinary and Health Trt.
- Labor
- Milk Loss
- Discarded Milk
- Culling Cost
- Extended Days Open
- On-Farm Death

Liang et al. 2017

Cow Health $ - Transition Issues

Clinical Disease		Total Cost (Multiparous)
Hypocalcemia		$246.23 ± $52.25
Ketosis		$180.91 ± $63.74
Lameness		$333.17 ± $68.76
Left Displaced Abomasum	Mycotoxins	$639.51 ± $114.10
Mastitis		$426.50 ± $80.27
Metritis		$262.65 ± $56.15
Retained Placenta		$313.49 ± $64.66

Categories
Vet and Health
Milk Loss

Liang et al. 2017

General Symptoms of Mycotoxicosis in Dairy Cattle

- Reduced feed intake
- Reduced milk yield and milk components
- Rough hair coat and lethargy
- Intermittent diarrhea (sometime with blood or dark manure)
- Increase the incident the infection and metabolic diseases: mastitis, metritis, retained placenta, ketosis, displaced abomasum. Cows do not response well to Veterinarian Rx
- Poor reproductive performance

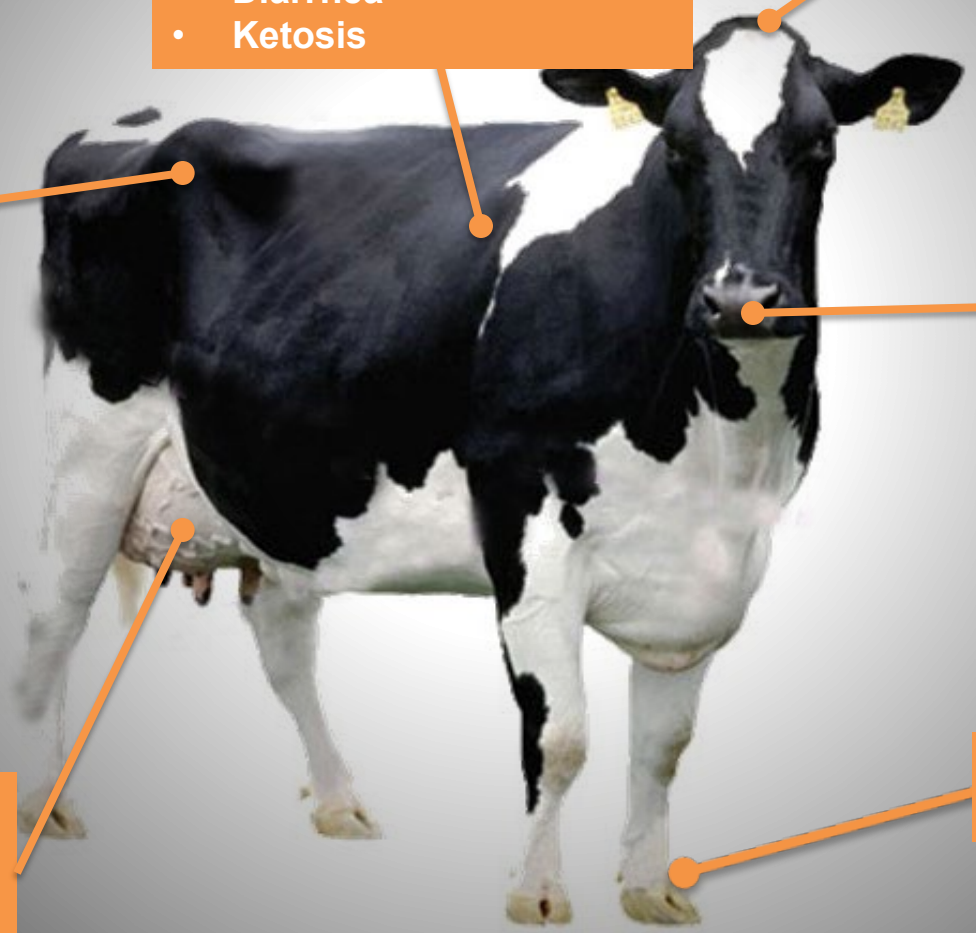
May et al., 2000. Can. J. Microbiol . 46: 692-699

Negative Effect of Mycotoxins in Dairy Cattle

T-2 Toxin, DON, AFB1
- Gastroenteritis
- Intestinal hemorrhage
- Impaired rumen function
- Diarrhea
- Ketosis

Ergots
- Impaired thermoregulation
- Convulsions

ZEN, Ergots
- Low conception rate
- Irregular heats
- Ovarian cysts
- Embryonic loss Diarrhea
- Abortions
- Low sperm production
- Low testicular development



T-2 Toxin, DON, Ergots
- Decreased feed intake
- Decreased feed efficiency

AFB1, T-2 Toxin, DON
- Milk contamination
- Decreased milk yield
- Mastitis

Ergots, Fusaric acid, DON
- Laminitis

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Mycotoxins Impair Rumen Function

Table 1. Specific growth rates per hour (μ) and doubling times in hours (T_2).

Fusaric acid (μg/mL)	*M. ruminantium*			*R. albus*		
	μ	T_2	*r*	μ	T_2	*r*
0	0.0906	7.7	0.9985	0.1417	4.9	1
15	0.0814	8.5	0.9994	0.1192	5.8	0.9999
30	0.0645	10.8	0.9883	0.0986	7	0.9971
45	0.0399	17.4	0.9937	0.0854	8.1	0.9994
60	0.0287	24.2	0.9924	0.077	9	0.9966
120	0.0259	26.8	0.9928	0.0366	19	0.9932
240	0.009	78.4	0.8857	0.0123	56.4	0.9884
480	0.002	386.6	0.9043	0.0079	87.7	0.9684

r = Correlation coefficient.

May et al., 2000. Can. J. Microbiol . 46: 692-699

Changes to Rumen Fluid

Dairy cows consuming a mixture of mycotoxins including 3,100 ppb DON

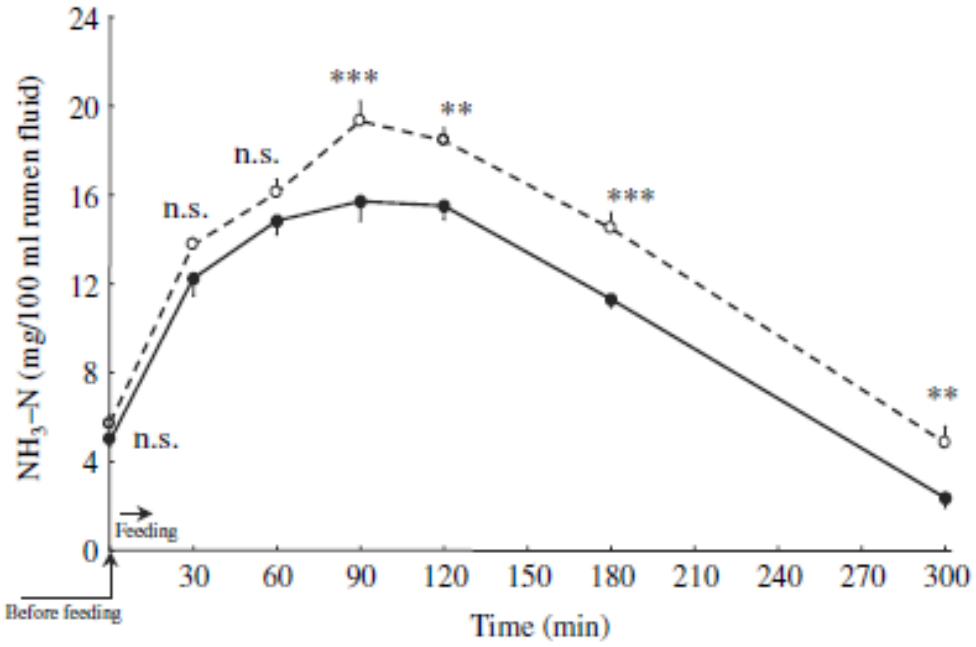


Fig. 2 Time course of ammonia concentration in rumen fluid collected before feeding and at different time intervals after feeding (Expt 2, data points are mean values of four replications, bars indicate SD, 7 kg dry matter intake/day; ns, not significant; **p < 0.01, ***p < 0.001). —•—, control period; - -○- -, mycotoxin period.

(Danicke et al., 2005)

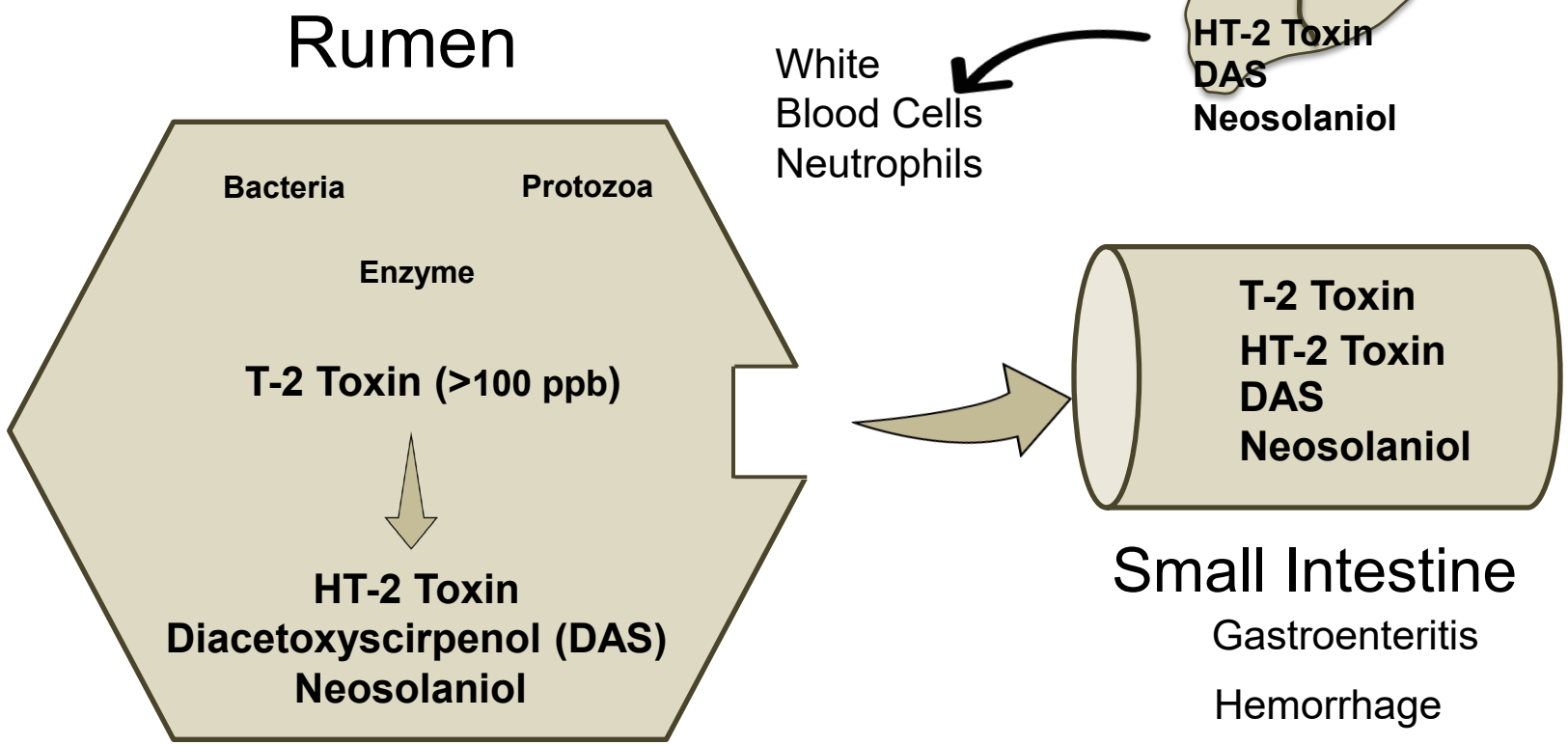
Effect of DON on Rumen Protein Synthesis

Duodenal Flow of:	Control	DON 3.1 ppm
Crude Protein, g/day	1180	950
RUP, g/day	225	186
Microbial Protein, g/day	862	680
Metabolizable Protein, g/day*	1091	871

*** 20% less MP**

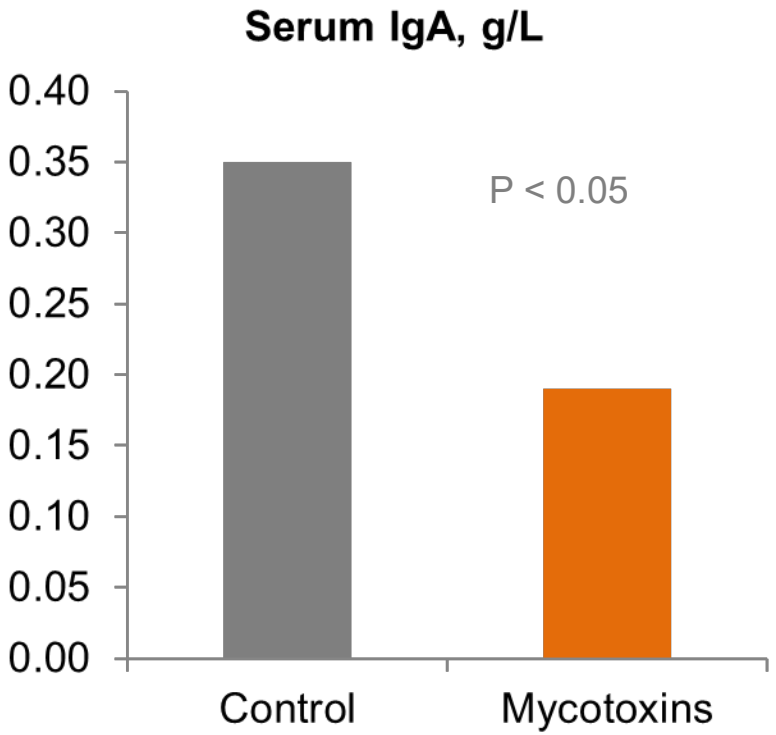
Danicke et al., 2005

Mycotoxins Impair Rumen Function



Adapted from May et al., 2000. Can. J. Microbiol . 46: 692-699

Impact on Immune Response

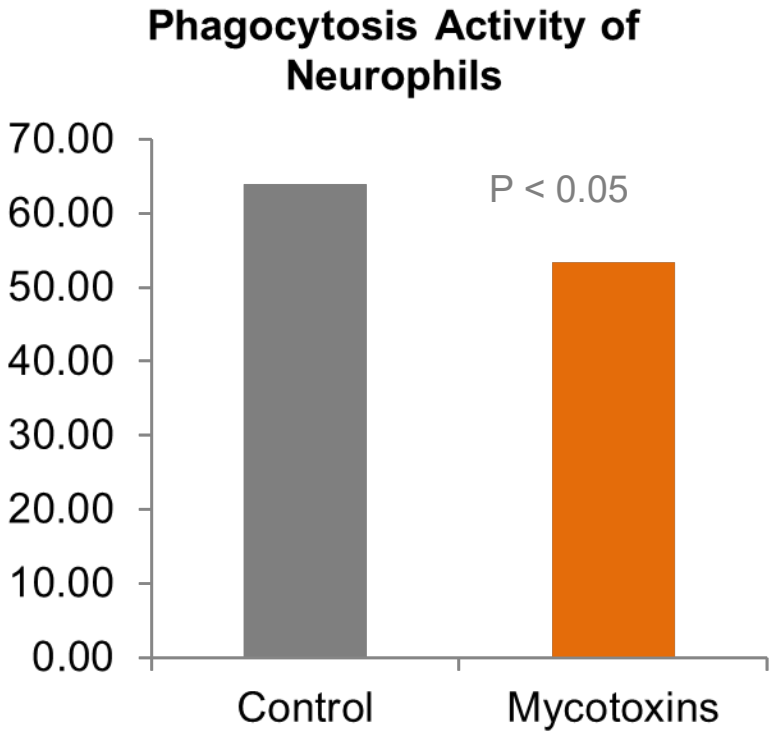


Cows in midlactation
40% Primiparous
60% Multiparous

Cows consuming
3,200 ppb DON
280 ppb 15-Acetyl DON
240 ppb Zearalenone

(Korosteleva et al., 2007)

Impact on Immune Response



Cows in midlactation
40% Primiparous
60% Multiparous

Cows consuming
3,500 ppb DON

(Korosteleva et al., 2009)

Low Risk REQ and Pregnancy Rate

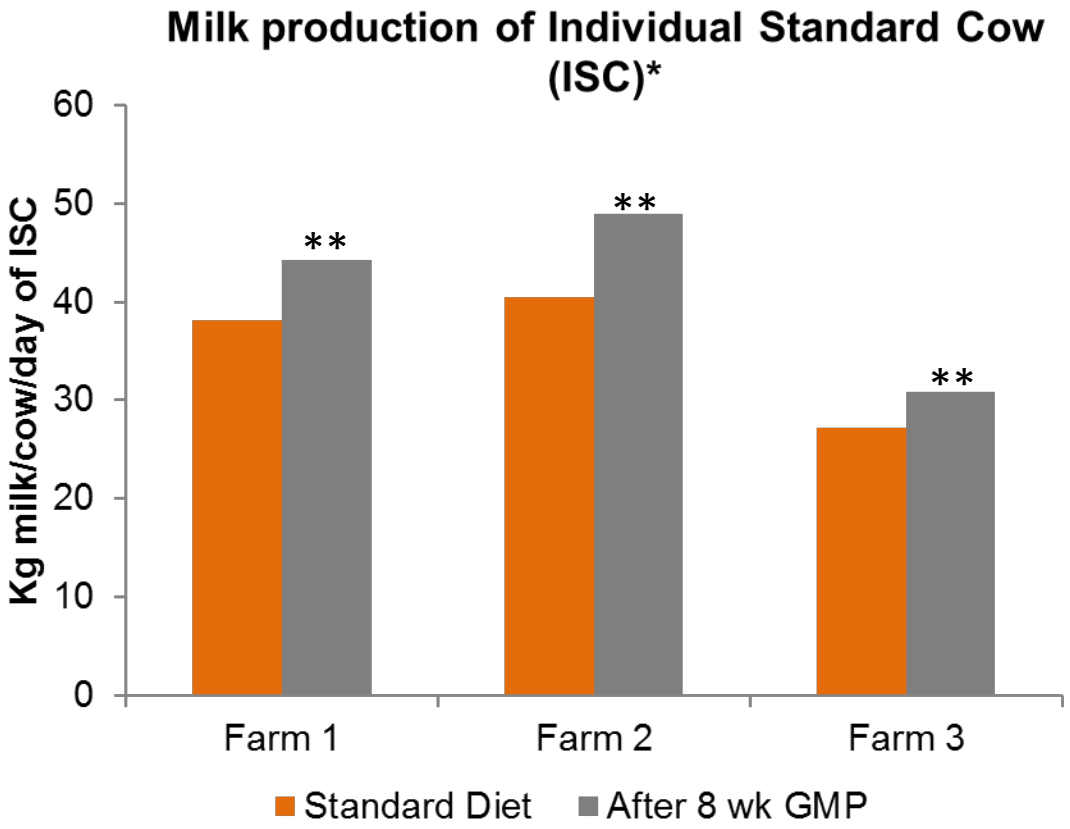
Mycotoxin suppressed pregnancy rate by 19.3%

	DON	T-2	ZEA	REQ
9/10 – 9/30	328	36	92	79
10/1 – 11/13	178	354	92	306
11/14 – 12/3	538	25	86	85
12/4 – 1/13	358	25	77	69
1/14 – 2/22	304	29	135	85

Hulik, 2014

Impact on Milk Production

(Santos and Fink-Gremmels, 2014)



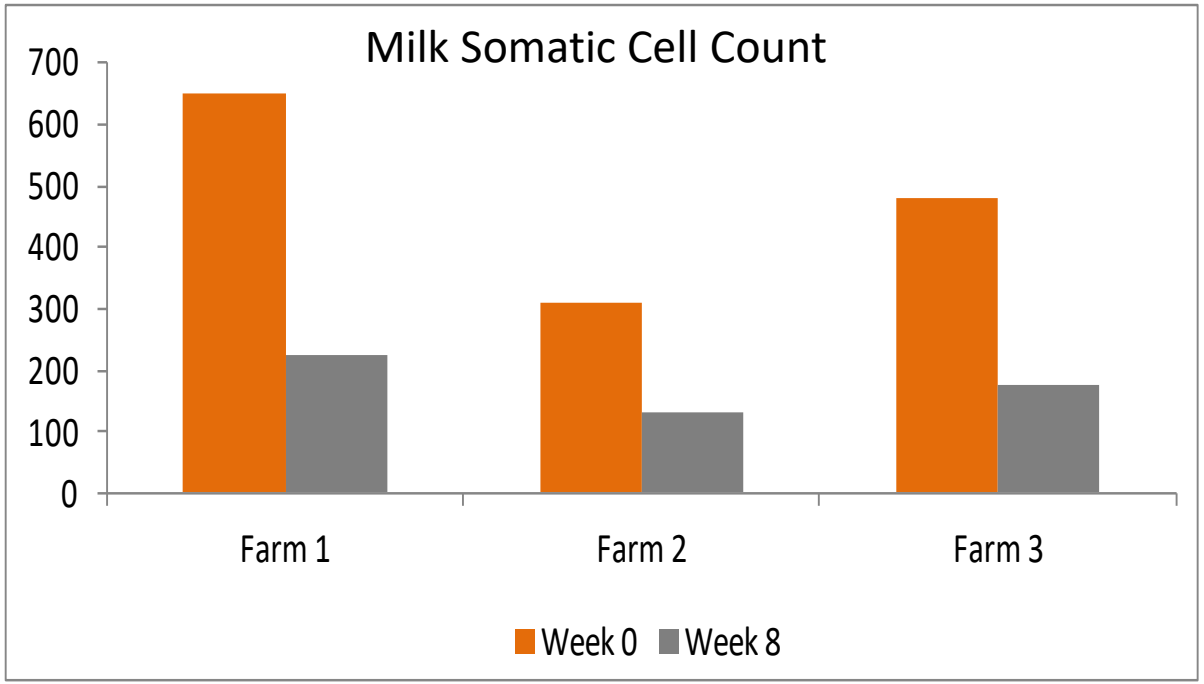
*ISC: normalizes milk production to days in milk.

**P < 0.05

Used current feed
-High *Penicillium* mycotoxins
-High *Aspergillus* mycotoxins
-Higher ZEA (91-240 ppb)
-Lower DON (91-240 ppb)

Feeding mycotoxins resulted in average **decrease of 6.1 kg milk/cow/day (13.2 lb)**

Improving milk quality



*When cows consumed **mycotoxins** only, **somatic cell count** was an **average of 62% higher***

*Feeding of **YCW reduced milk somatic cell count** on all three farms*

Mycotoxins:
-Higher *Penicillium* mycotoxins
-Higher *Aspergillus* mycotoxins
-Higher ZEA (91-240 ppb)
-Low/moderate DON (205 - 761 ppb)
YCW material added for 8 weeks

(Santos and Fink-Gremmels, 2014; Koresteleva et al., 2007)

Negative Effect of Mycotoxins in Dairy Cattle

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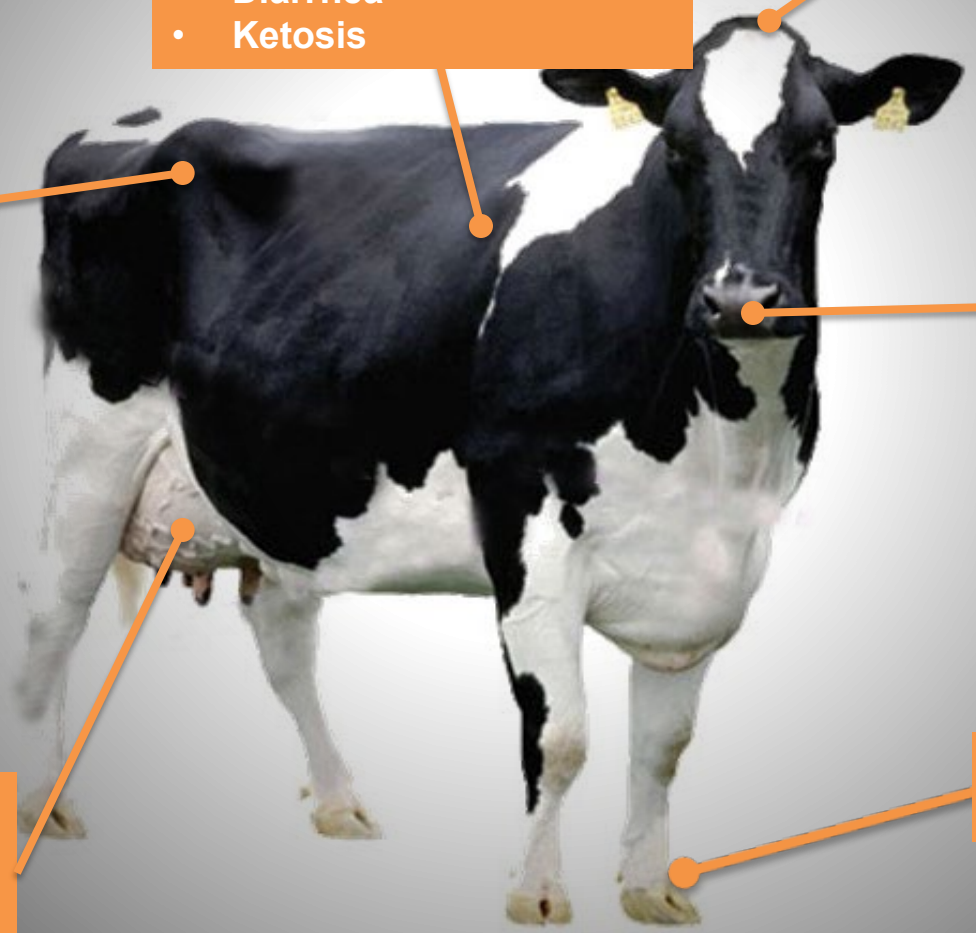
- Low sperm production
- Low testicular development



T-2 Toxin, DON, Ergots
- Decreased feed intake
- Decreased feed efficiency

AFB1, T-2 Toxin, DON
- Milk contamination
- Decreased milk yield
- Mastitis

Ergots, Fusaric acid, DON
- Laminitis

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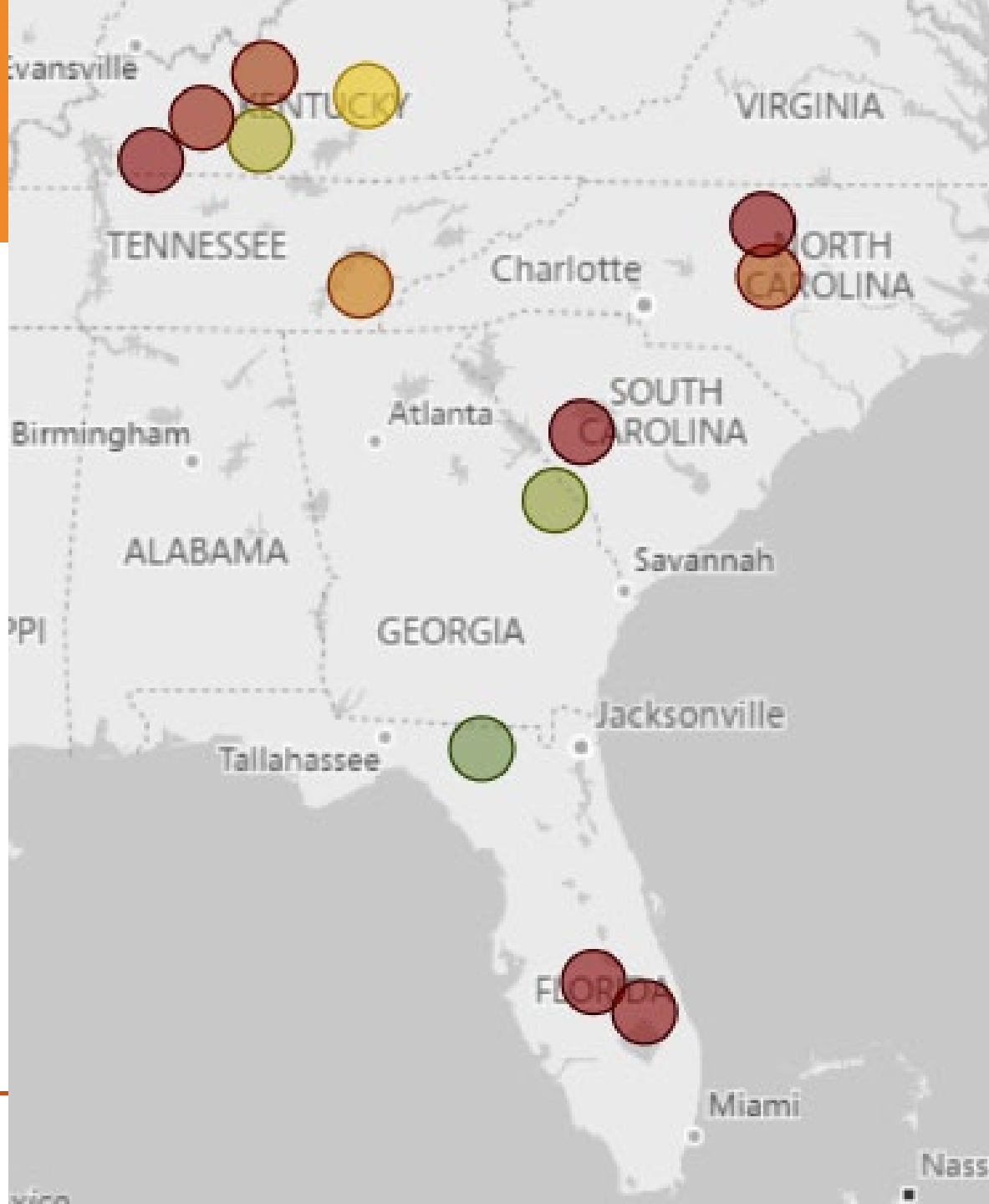
MYCOTOXIN MANAGEMENT

TMR Risk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ALABAMA
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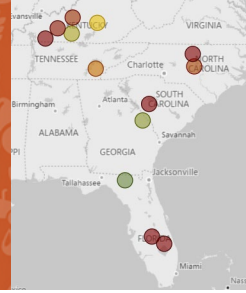
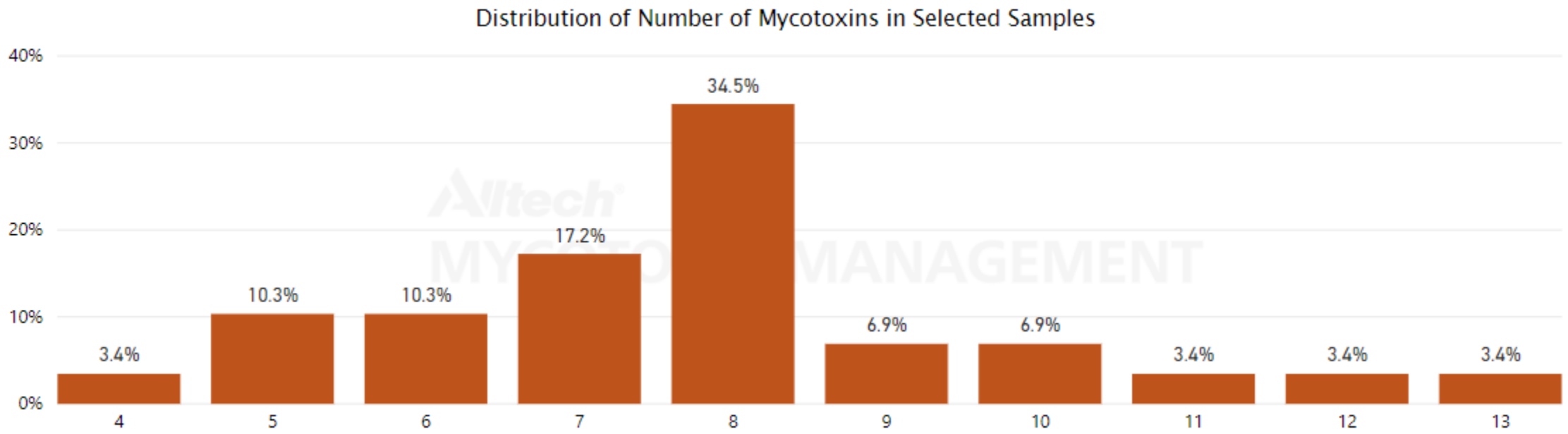
Miami

TMR Risk

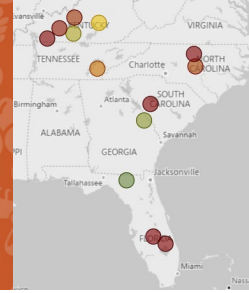


7.79

Average of Number of Mycotoxins



TMR Risk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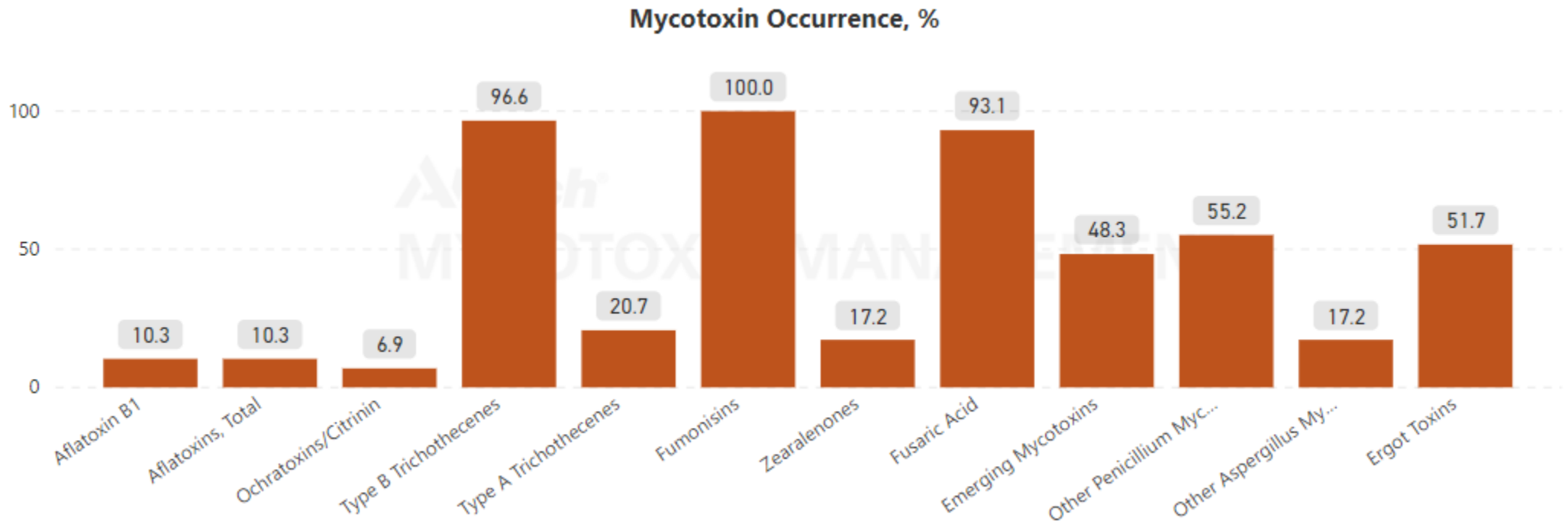
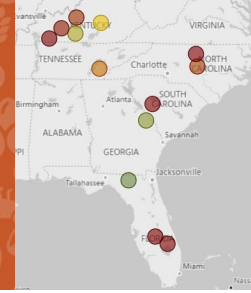
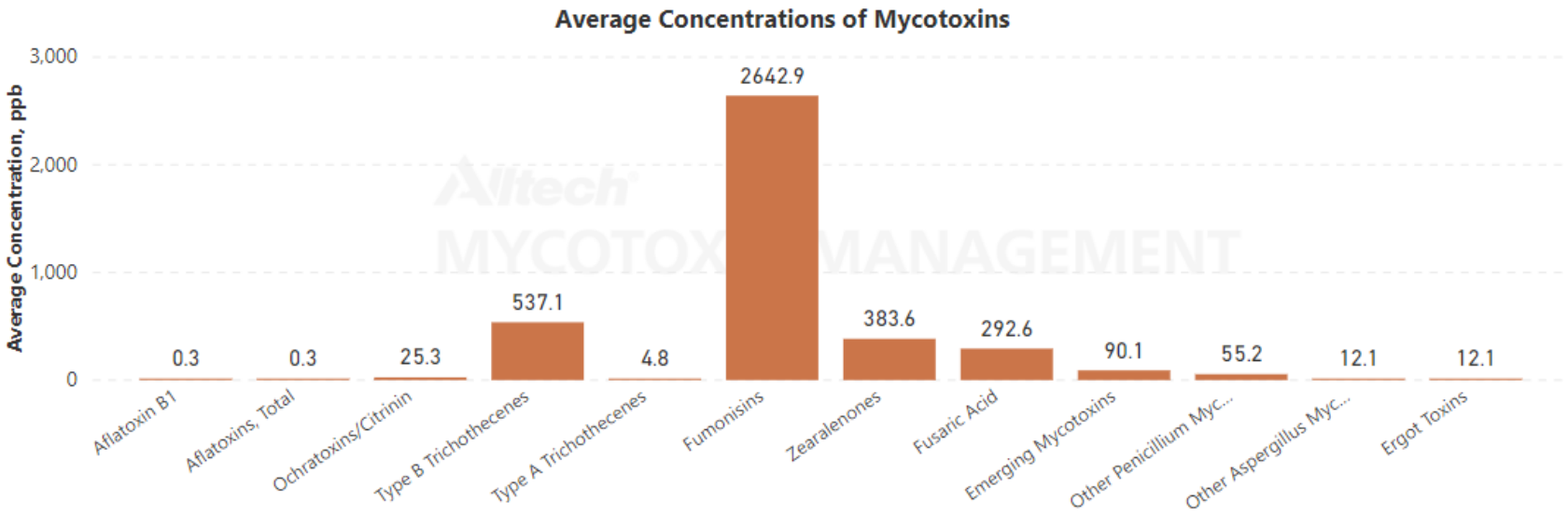

Mycotoxin Occurrence, %
100
50
0
10.3
10.3
6.9
96.6
20.7
100.0
17.2
93.1
48.3
55.2
17.2
51.7
Aflatoxin B1
Aflatoxins, Total
Ochratoxins/Citrinin
Type B Trichothecenes
Type A Trichothecenes
Fumonisins
Zearalenones
Fusaric Acid
Emerging Mycotoxins
Other Penicillium Myc...
Other Aspergillus My...
Ergot Toxins

TMR Risk





Maximum Level Detected

- Aflatoxin B1: 6 ppb
- Total Aflatoxins: 6 ppb
- Ochratoxins/Citrinin: 637 ppb
- Type B Trichothecenes: 2419 ppb
- Type A Trichothecenes: 55 ppb
- Fumonisins: 7863 ppb
- Zearalenones: 9402 ppb
- Fusaric Acid: 973 ppb
- Emerging Mycotoxins: 1271 ppb
- Other Penicillium Mycotoxins: 361 p...
- Other Aspergillus Mycotoxins: 284 p...
- Ergot Toxins: 99 ppb

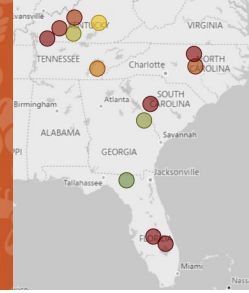
TMR Risk

REQ is a summation of all of the mycotoxin present

Average Mycotoxin Assessment for Performance Impairment for Dairy Cows

Mycotoxin Group	Average, ppb	Lower, ppb	Moderate, ppb	Higher, ppb
Aflatoxin B1	0.2	50	100	150
Aflatoxins, Total	0.2	50	100	150
Ochratoxins/Citrinin	38.6	500	1000	1500
Type B Trichothecenes	546.4	500	1000	2000
Type A Trichothecenes	7.3	50	100	200
Fumonisins	1678.7	10000	20000	30000
Zearalenones	46.3	100	250	500
Fusaric Acid	235.7	1000	2000	3000
Emerging Mycotoxins	121.8	1000	2000	3000
Other Penicillium Mycotoxins	53.4	50	100	200
Other Aspergillus Mycotoxins	15.4	50	100	200
Ergot Toxins	12.1	200	350	500
REQ	145.9	50	100	150

TMR Risk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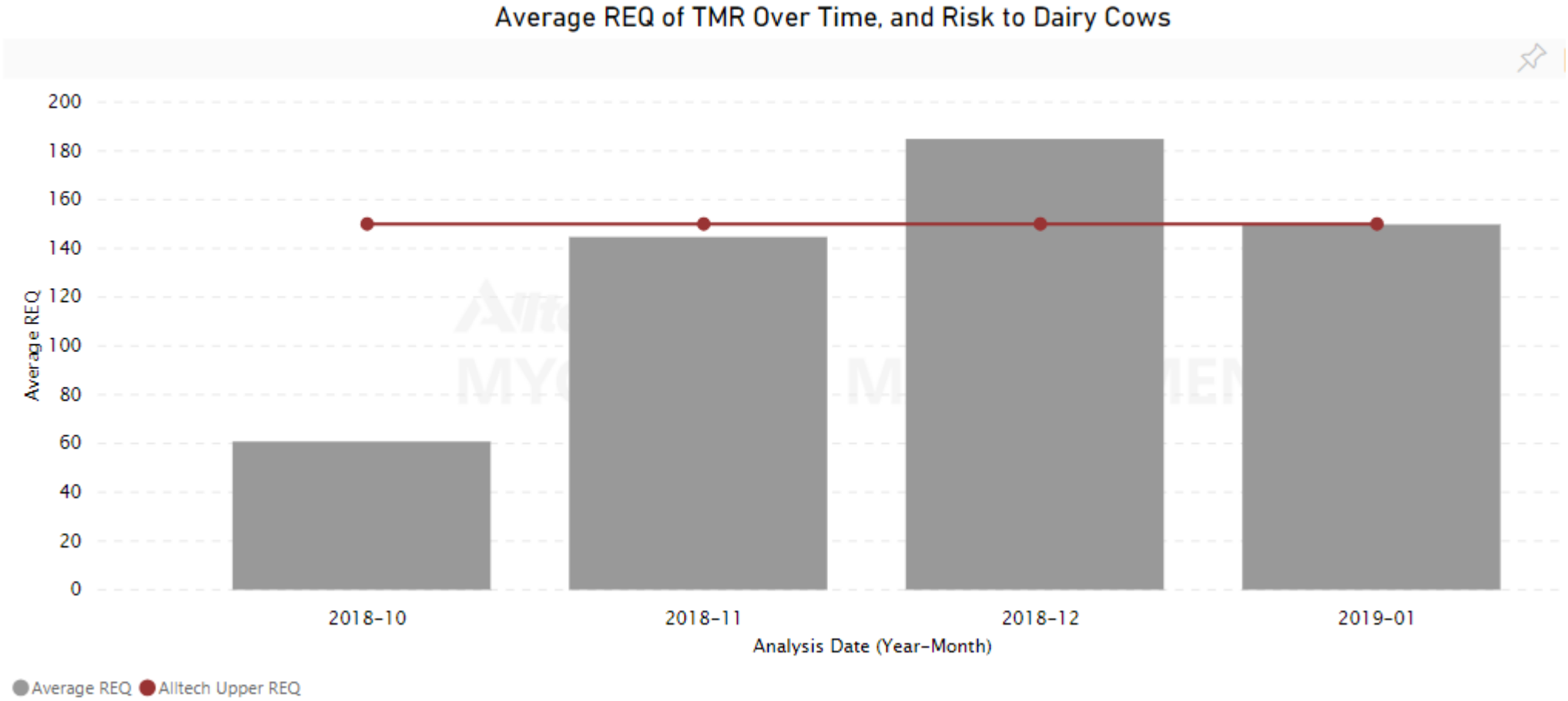
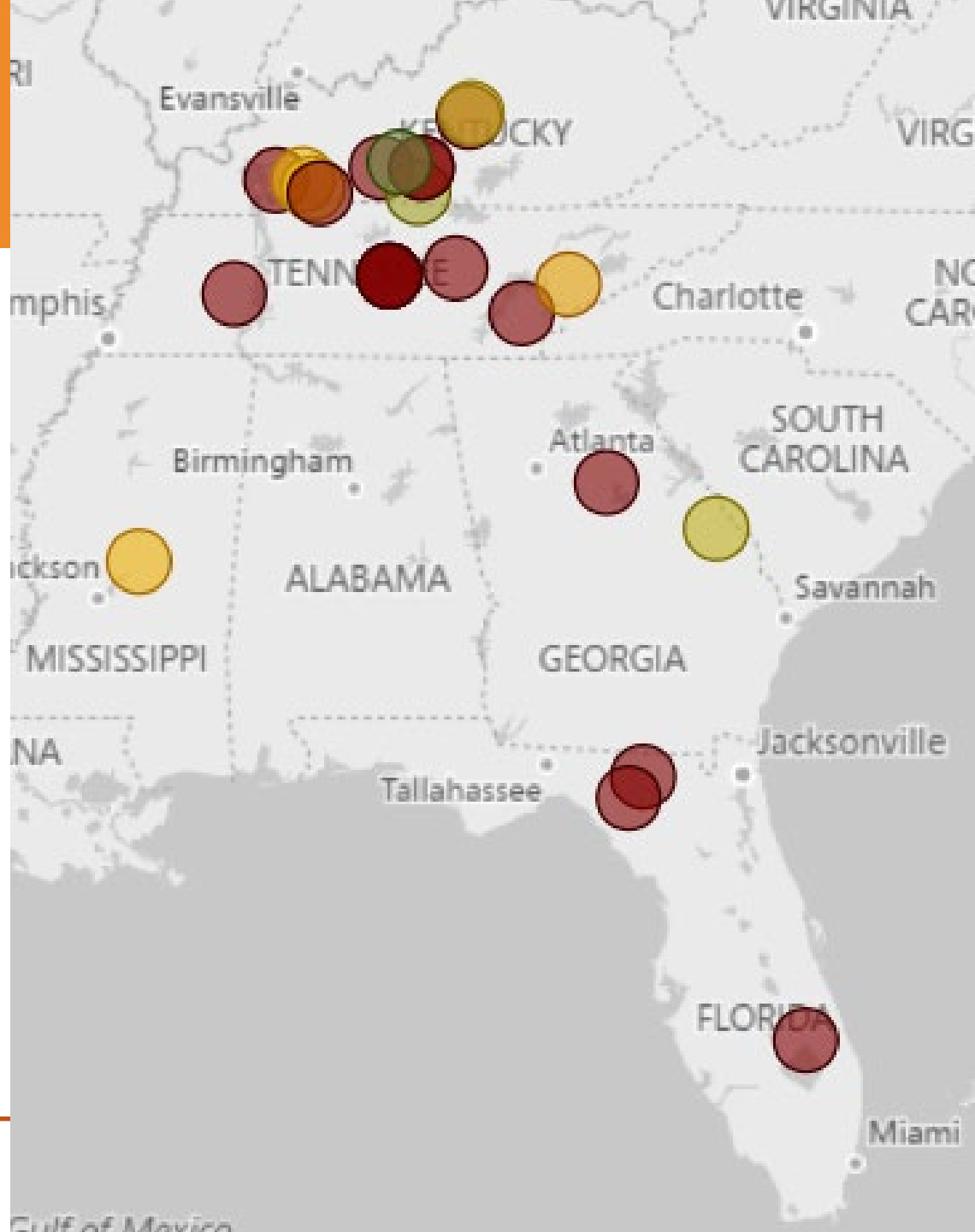
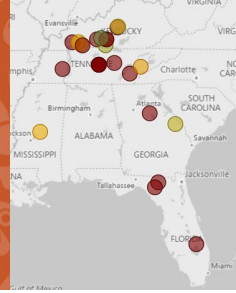

Average REQ of TMR Over Time, and Risk to Dairy Cows
200
180
160
140
120
100
80
60
40
20
0
Average REQ
2018-10
2018-11
2018-12
2019-01
Analysis Date (Year-Month)
Average REQ
Alltech Upper REQ

Corn Silage Risk



Corn Silage Risk

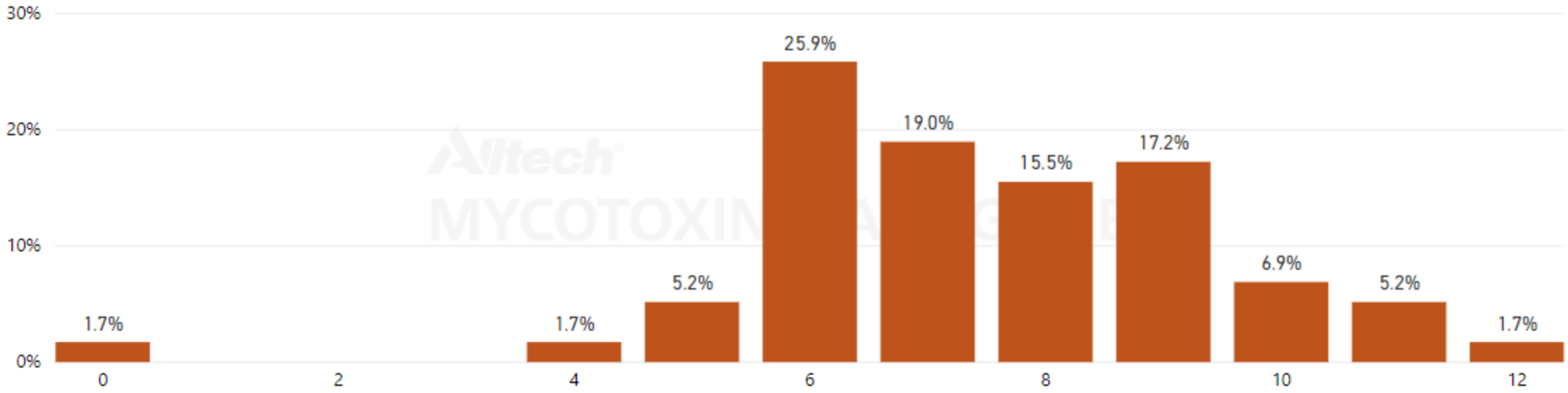


Number of Samples: 58

7.47

Average of Number of Mycotoxins

Distribution of Number of Mycotoxins in Selected Samples



Corn Silage Risk

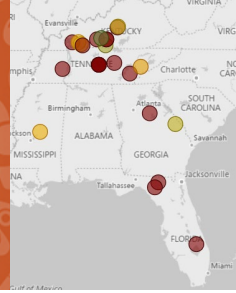
Maximum Level Detected

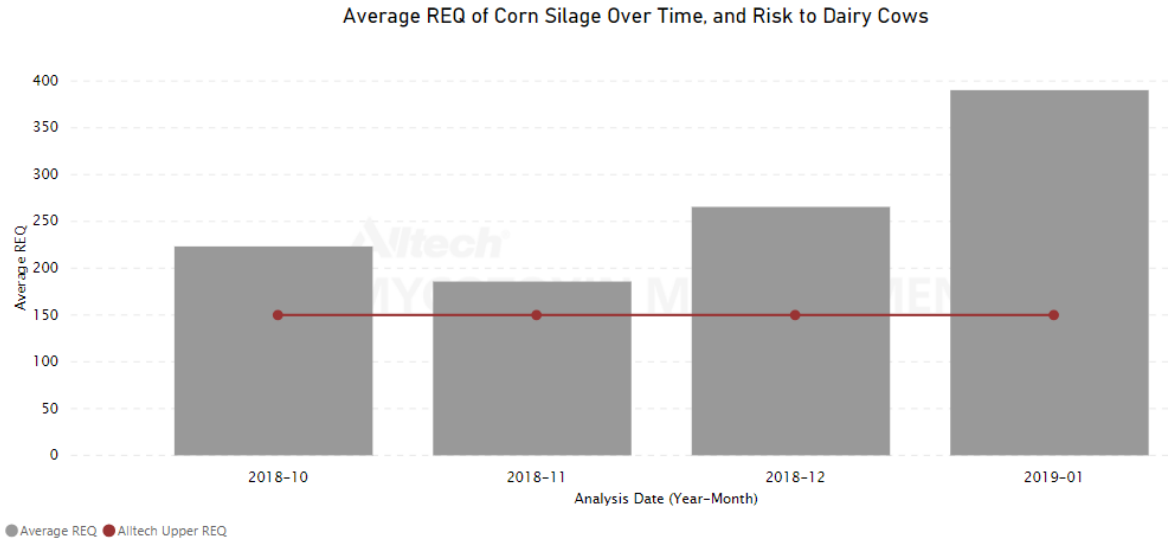
- Aflatoxin B1: 12 ppb
- Total Aflatoxins: 15 ppb
- Ochratoxins/Citrinin: 1756 ppb
- Type B Trichothecenes: 2755 ppb
- Type A Trichothecenes: 166 ppb
- Fumonisins: 40623 ppb
- Zearalenones: 504 ppb
- Fusaric Acid: 3024 ppb
- Emerging Mycotoxins: 1951 ppb
- Other Penicillium Mycotoxins: 908 p...
- Other Aspergillus Mycotoxins: 540 p...
- Ergot Toxins: 73 ppb

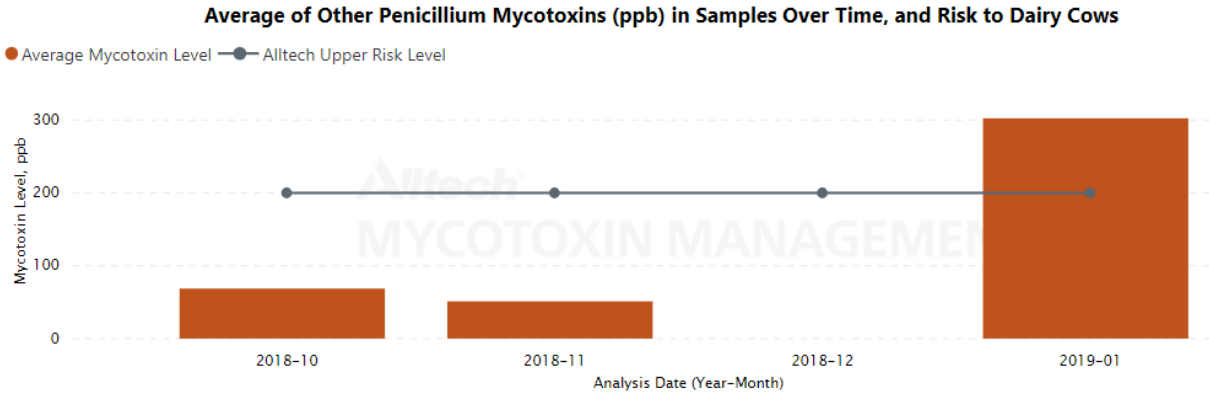
Average Mycotoxin Assessment for Performance Impairment for Dairy Cows

Mycotoxin Group	Average, ppb	Lower, ppb	Moderate, ppb	Higher, ppb
Aflatoxin B1	1.0	50	100	150
Aflatoxins, Total	1.5	50	100	150
Ochratoxins/Citrinin	156.6	500	1000	1500
Type B Trichothecenes	591.3	500	1000	2000
Type A Trichothecenes	10.9	50	100	200
Fumonisins	7211.3	10000	20000	30000
Zearalenones	13.9	100	250	500
Fusaric Acid	753.5	1000	2000	3000
Emerging Mycotoxins	119.0	1000	2000	3000
Other Penicillium Mycotoxins	81.7	50	100	200
Other Aspergillus Mycotoxins	13.9	50	100	200
Ergot Toxins	4.5	200	350	500
REQ	226.6	50	100	150

Corn Silage Risk







Take Home

TEST

Transition issues begin in dry period

Poor repro and immune function are correlated to lower rumen function

Mycotoxins decrease energy and protein from the rumen