

Aflatoxins M1 and M2 in Raw Milk and Milk Powder: Seasonal and Geographic Occurrence

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Milk production in Poland in the EU context



Poland is one of the leading milk producers in the European Union.



- In 2024, milk production in Poland reached **15.6 billion litres**, corresponding to approximately **16.0 million tonnes**.



- Germany, France, Poland, the Netherlands and Italy together accounted for **65.1%** of EU raw cows' milk production in 2024.

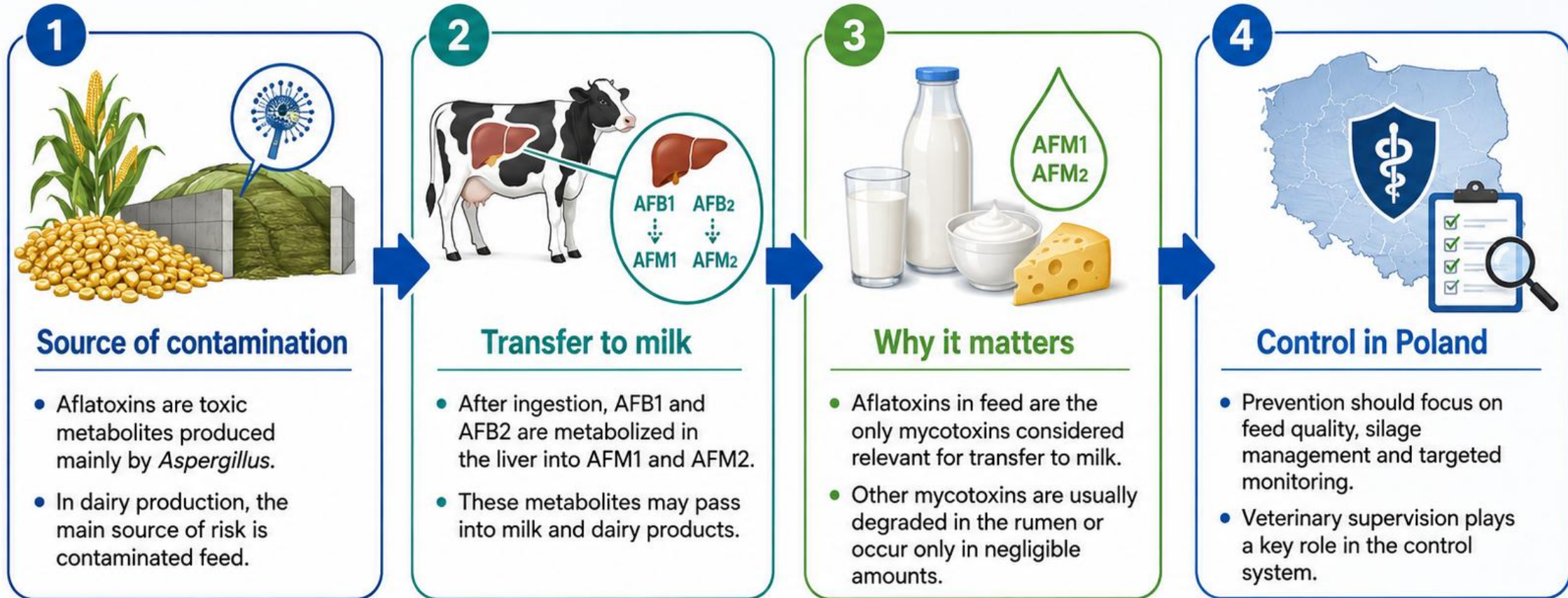
Raw cow's milk production in selected EU countries, 2024

million tonnes



Sources: Eurostat (2024); Statistics Poland (GUS).

Why monitor aflatoxins in milk?



The key point of control is the feed chain — before contamination reaches milk.

RESEARCH OBJECTIVE



The aim of this study was to:

1

RAW MILK MONITORING



Assess the occurrence of **AFM1** and **AFM2** in Polish raw milk



Evaluate potential **seasonal** and **regional** trends.



2

MILK POWDER COMPARISON



Determine the presence of **AFM1** and **AFM2** in commercial milk powders from:



Poland



other V4 countries
(Czech Republic, Slovakia, Hungary)



Iran



KEY FOCUS AREAS



Occurrence of
AFM1 and **AFM2**



Seasonal
trends



Regional
trends



International comparison
of milk powders

RAW MILK – TWO RESEARCH MODELS

Poland, January–December 2025



MODEL I

INTENSIVE DAIRY FARMS



228 raw bulk tank milk samples



January–December 2025



Large-scale farms (420–1,050 cows)



Indoor housing throughout the year



TMR feeding system based on maize silage and grass / alfalfa silage/haylage, concentrates and mineral supplements



1–2 samples per month



MODEL II

CONVENTIONAL FAMILY FARMS



56 raw milk samples



Winter (n = 29)
Summer (n = 27)



Provinces: Lubelskie, Mazowieckie, Podlaskie



Family-owned farms



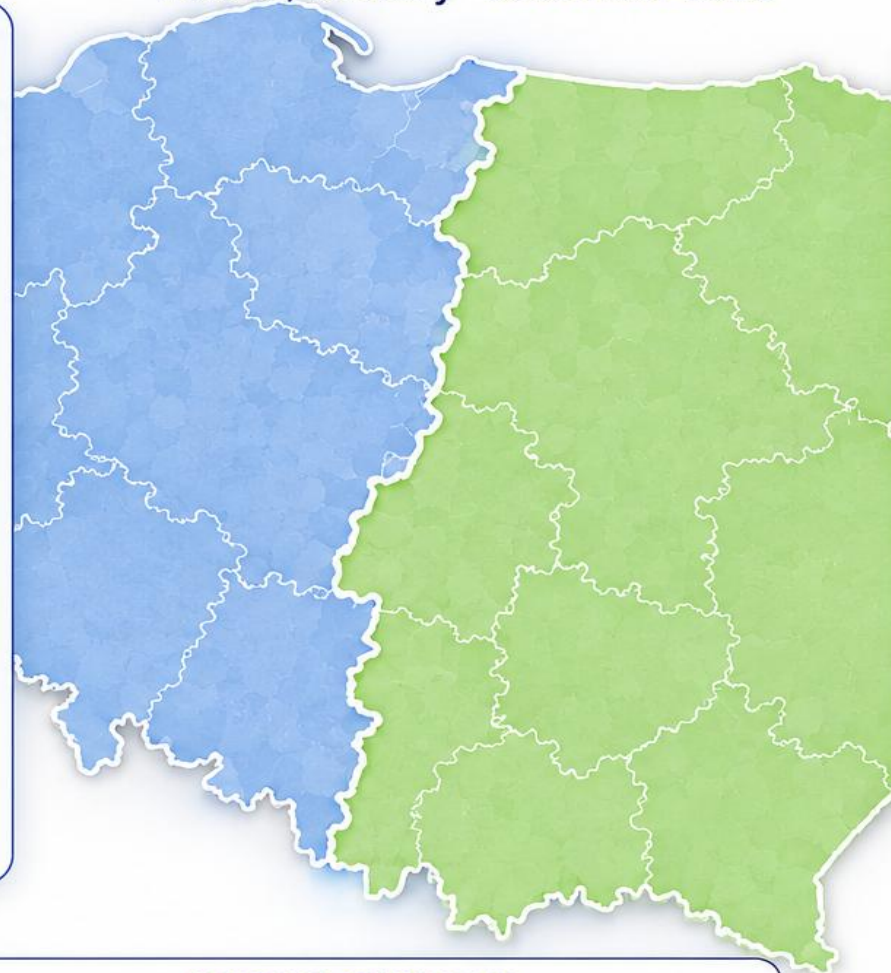
20–120 cows



Semi-intensive production



Conventional dairy farming practices



SAMPLES COLLECTED (BY SEASON)



Winter n = 29



Summer n = 27

Total 56

 **Model I area**
(western and central Poland)

 **Model II area**
(eastern Poland)

OVERALL SUMMARY



Total raw milk samples

284

 **Model I**

Intensive farms

228 samples

 **Model II**

Conventional farms

56 samples



Transport:
4 °C



Storage in laboratory:
–18 °C

• MILK POWDER MATERIALS •



The second material tested consisted of **whole** and **skim** milk powder samples.

SAMPLES OVERVIEW



POLAND

Milk powder samples obtained from Polish producers and purchased from retail chains throughout the country.

35
samples



OTHER V4 COUNTRIES

Milk powder samples produced in the Visegrad Group countries: Slovakia, Czech Republic, Hungary.

25
samples



IRAN

Milk powder samples produced in Iran.

10
samples

KEY INFORMATION



All milk powder samples were purchased in **2025**.



Samples represent **3 regions**: Poland, V4 countries, and Iran.



Total number of milk powder samples **n = 70**



COMPARATIVE APPROACH



Allows assessment of **geographical differences** in AFM1 and AFM2 contamination.



Supports comparison of **international products** available on the market.

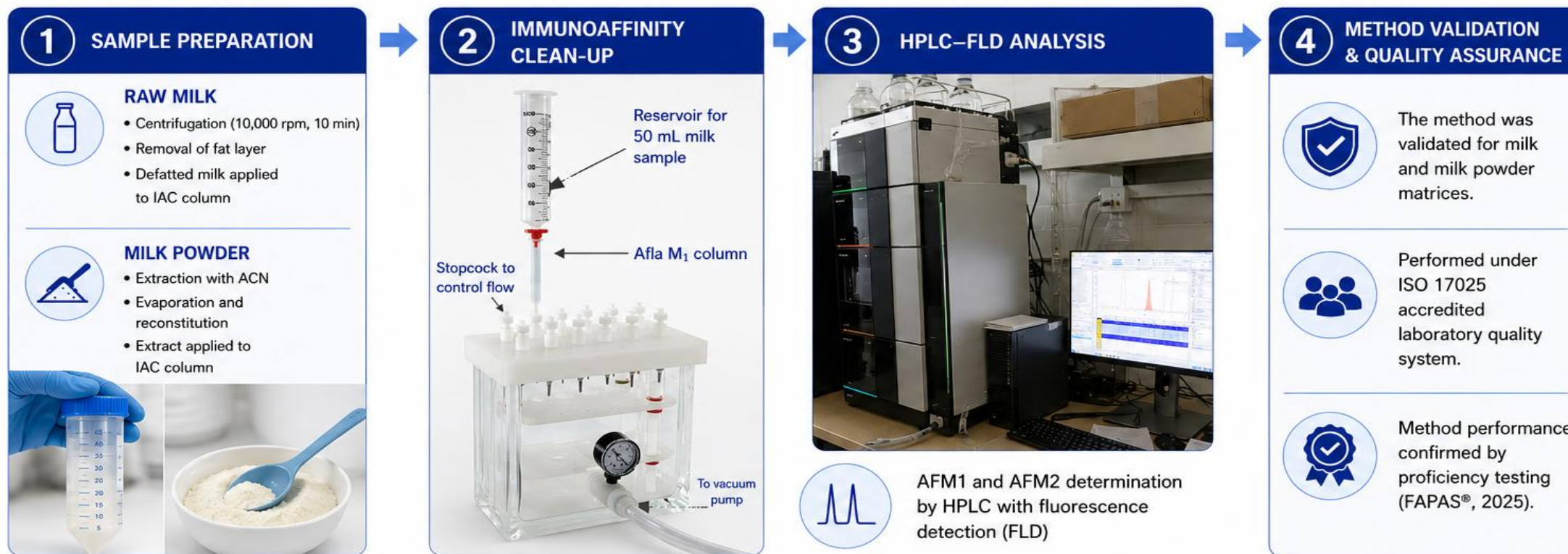


Provides broader insight into potential exposure through milk powders.

METHODS



Quantitative determination of AFM1 and AFM2 in raw milk and milk powder



OVERVIEW OF THE ANALYTICAL PROCESS



Sample preparation



Immunoaffinity clean-up



HPLC-FLD analysis



Validated results



RELIABLE & ACCURATE RESULTS

Our validated methodology ensures accurate, sensitive and reproducible determination of AFM1 and AFM2 in raw milk and milk powder samples.



RESULTS – RAW MILK

Occurrence of AFM1 and AFM2 in raw milk (Model I + II)



OVERALL SUMMARY



284 raw milk samples analyzed

AFM1

- Detected in **4** samples
- 1.4%** of all samples
- Range: **0.004 – 0.019** µg/kg

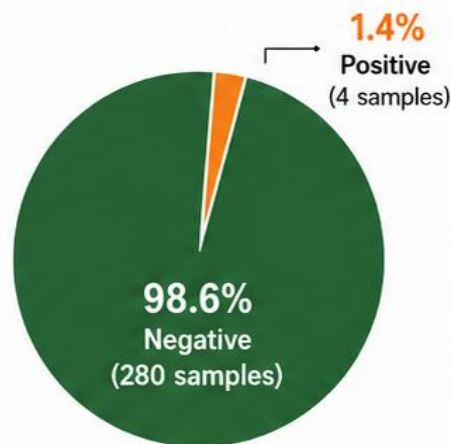
AFM2

- Detected in **3** samples
- Sporadic occurrence
- All concentrations < **0.078** µg/kg



NO SAMPLE EXCEEDED
the EU limit of 0.05 µg/kg for AFM1

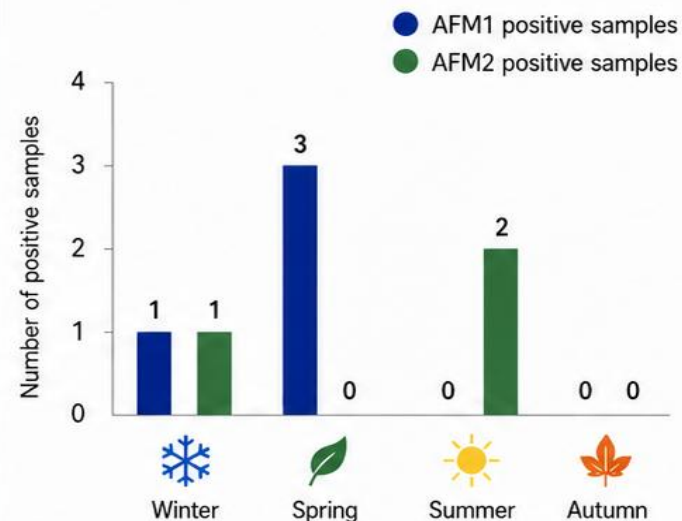
AFM1 OCCURRENCE (all samples)



■ Negative ($\leq$ LOQ) ■ Positive ($>$ LOQ)

LOQ: **0.002** µg/kg

SEASONAL OCCURRENCE (Model I)



Positive samples occurred mainly in spring (AFM1) and summer (AFM2).



KEY OBSERVATIONS



Very low frequency of both aflatoxins throughout the year.



All detected concentrations were far below the EU limit of **0.05 µg/kg** for AFM1.



Raw milk produced in Poland showed a **high level of mycotoxicological safety**.



RAW MILK IN POLAND IS CHARACTERIZED BY VERY LOW OCCURRENCE OF AFM1 AND AFM2.



RESULTS – MILK POWDER

Occurrence of AFM1 and AFM2 in commercial milk powder from different geographical regions

OVERALL SUMMARY (70 samples)

AFM1

- Detected in **4** samples
- Range: **0.042 – 0.101** µg/kg
- Highest value: **0.101** µg/kg

AFM2

- Detected in **6** samples
- Range: **0.011 – 0.049** µg/kg
- Highest value: **0.049** µg/kg



AFM1 reached higher concentrations, while **AFM2** was mainly associated with **Iran**.

POLAND (35 samples)

5.7%

AFM1

Positive
(2 samples)



91.4%
≤ LOQ

2.9%

AFM2

Positive
(1 sample)

Detected:

- AFM1 in 2 samples
0.077 and **0.101** µg/kg
- AFM2 in 1 sample
0.049 µg/kg

V4 COUNTRIES

Czech Republic, Slovakia, Hungary
(25 samples)

0%

Positive



100%

≤ LOQ



No AFM1 or AFM2
detected above LOQ
(100% of samples)

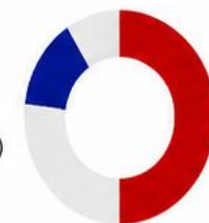
IRAN

(10 samples)

20%

AFM1

Positive
(2 samples)



50%

AFM2

Positive
(5 samples)

Higher contamination:

- AFM1: 0.042 – 0.049** µg/kg
- AFM2: 0.011 – 0.026** µg/kg

SAMPLES WITH AFM1 AND/OR AFM2 ABOVE LOQ

Origin	No. of samples / positive samples / % of total	Samples (positive)	AFM1 [µg/kg] ± SD	AFM2 [µg/kg] ± SD
Poland	35 / 2 / 6%	1	0.077 ± 0.016	0.049 ± 0.010
		2	0.101 ± 0.021	< LOQ
Czech Republic, Slovakia, Hungary	25 / 0 / 0%	–	< LOQ	< LOQ
Iran	10 / 5 / 50%	1	0.049 ± 0.010	0.026 ± 0.006
		2	< LOQ	0.019 ± 0.004
		3	0.042 ± 0.009	0.023 ± 0.005
		4	< LOQ	0.014 ± 0.003
		5	< LOQ	0.011 ± 0.003

KEY FINDINGS



Marked **geographical differences** in contamination profile.



Higher occurrence in **Iran** is associated with **warm climate**, **humidity** and challenges in feed control and storage.



Drying and processing concentrate **AFM1** in milk powder due to its **high thermal stability**.



Continuous **monitoring** of raw materials and finished products remains essential to ensure consumer protection.



NO REGULATORY LIMITS EXIST FOR AFM1 AND AFM2 IN MILK POWDER AT THE EU LEVEL.

However, monitoring and risk management are essential to protect public health.

CONCLUSIONS

POLISH RAW MILK



Favourable safety profile:

AFM1 detected in **4/284** samples (1.4%) and AFM2 in **3/284** samples (1.1%).



All positive results were below the EU maximum limit of 0.05 µg/kg for AFM1.



Positive raw milk samples were detected only sporadically, mainly during the **winter, spring and summer** feeding periods.



In the conventional family farm model **all 56 samples were below the LOQ** for both AFM1 and AFM2.



Overall, the occurrence of AFM1 in Polish dairy products was low and sporadic. Continued monitoring remains important due to climate-related contamination risks and the potential concentration of AFM1 during milk powder production.

MILK POWDER (70 SAMPLES)



POLAND (35 samples)

- AFM1 detected in **2** samples: **0.077** and **0.101 µg/kg**
- AFM2 detected in **1** sample: **0.049 µg/kg**



V4 COUNTRIES

(Czechia, Slovakia, Hungary; 25 samples)

- Neither AFM1 nor AFM2 was **detected above the LOQ.**



IRAN (10 samples)

- AFM1 detected in **2** samples: **0.042** and **0.049 µg/kg**
- AFM2 detected in **5** samples: **0.011–0.026 µg/kg**



Higher occurrence of AFM1 and especially AFM2 in milk powder from **Iran** compared to the **V4 countries.**



AFM1 IN POLAND – PRACTICAL SUMMARY



1. CURRENT STATUS



- AFM1 occurrence in Polish raw milk is **low and sporadic**.
- **All detected levels were well below the EU limit of 0.05 µg/kg.**

2. MAIN RISK FACTORS



- Maize silage and feed quality
- Poor silage storage and mould growth
- Imported feed components

3. WHAT NEEDS ATTENTION



- Climate change may increase future risk.
- Targeted monitoring of high-risk feed batches.
- Focus on silage management and traceability.

4. PRACTICAL APPROACH



- Maintain basic official supervision.
- Use risk-based monitoring.
- Strengthen communication across the dairy chain.



Main challenge in Poland: prevention, not frequent AFM1 exceedances.

Thank you for your attention!

Questions & Answers



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