Assessing PFAS in Agricultural Settings
“Things we have learned in the past 5 years”

Andrew Smith, SM, ScD
State Toxicologist
Maine Center for Disease Control and Prevention
Presented at the 2021 Agricultural Trade Show
January 14, 2022
PFAS – Perfluoroalkyl Substances
Naming conventions

Perfluorooctanoic acid (PFOA)
8 carbons

Perfluorohexanoic acid (PFHxA)
7 carbons

Perfluorononanoic acid (PFNA)
9 carbons

Perfluorodecanoic acid (PFDA)
10 carbons

Perfluorooctanesulfonic acid (PFOS)
8 carbons

Perfluorohexanesulfonic acid (PFHxS)
6 carbons

Perfluorobutanesulfonic acid (PFBS)
4 carbons
PFAS soil levels can vary a lot within a field.
PFAS soil levels can vary a lot between fields

- Fields range from low of 29 ppb PFOS to high of 232 ppb.
Uptake of PFOS by hay can vary by field

- Preliminary Results -

PFOS All Sward Transfer Factors by Fields and Replicates

Plot Replicate  1  2  3

Plot 4-5
Plot 4-6
Plot 5-1
Plot 8
Plot R1
Plot R2
The “Forever Chemicals” are not forever in milk

PFOS Milk levels at a Dairy Farm Nov 2020 – Dec 2021
The “Forever Chemicals” are not forever in eggs

Australian PFAS water chicken egg study

<table>
<thead>
<tr>
<th>Compound</th>
<th>Half-life</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFOS</td>
<td>3.5 days</td>
</tr>
<tr>
<td>PFOA</td>
<td>5.4 days</td>
</tr>
</tbody>
</table>

Source:
AECOM. 2017. Off-Site Human Health Risk Assessment -
The “Forever Chemicals” are not forever in beef

Panel A: tPFOS

Panel B: Tissue:serum partition coefficients

The “Forever Chemicals” are not forever in beef.

PFAS in Beef

PFAS in Cow Muscle Tissue

PFAS Concentration (ppb)

Farm A

PFOS  PFOA  PFNA  PFDA  PFUnA  PFDa

Farm B

Farm C

Maine Department of Health and Human Services
PFAS move differently between media

Maine Department of Health and Human Services
PFAS move differently within plants

PFAS move differently within plants

Source: Lechner and Knapp. 2011. [https://pubs.acs.org/doi/10.1021/jf201355y](https://pubs.acs.org/doi/10.1021/jf201355y)

Maine Department of Health and Human Services
PFAS move differently within plants


Maine Department of Health and Human Services
Changing thinking on the toxicity of PFAS

**PFOS Toxicity Values**

<table>
<thead>
<tr>
<th></th>
<th>Tolerable Daily Dose (ng/kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA</td>
<td>20</td>
</tr>
<tr>
<td>MA</td>
<td>5</td>
</tr>
<tr>
<td>NH</td>
<td>3</td>
</tr>
<tr>
<td>MN</td>
<td>3</td>
</tr>
<tr>
<td>MI</td>
<td>3</td>
</tr>
<tr>
<td>WI</td>
<td>2</td>
</tr>
<tr>
<td>NY</td>
<td>1.8</td>
</tr>
<tr>
<td>NJ</td>
<td>1.8</td>
</tr>
<tr>
<td>ATSDR</td>
<td>2</td>
</tr>
<tr>
<td>EFSA*</td>
<td>0.6</td>
</tr>
<tr>
<td>CA**</td>
<td>0.6</td>
</tr>
</tbody>
</table>

- **EFSA*** - Human data, immune system toxicity, sum of PFOA, PFOS, PFNA, PFHxS
- **CA** - Human data, changes in cholesterol, proposed
How much is too much PFAS in food?

Toxicity Value
----------------
Consumption Rate

\( \times \) Relative Source Contribution
How much is too much PFOS in milk?
What we currently have...

\[
\frac{20 \text{ ng/kg/day}}{0.074 \text{ L/kg/day}} \times 0.80 = 210 \text{ ng/L}
\]
How much is too much PFOS in milk?

If we do things as FDA does ....

\[
\frac{2 \text{ ng/kg/day}}{0.040 \text{ L/kg/day}} \times 1 = 50 \text{ ng/L}
\]

FDA does not apply an RSC
How much is too much PFOS in soil

\[ SL_{soil} = \frac{C_{milk} \times (D_{milk})^{-1}}{TF_{milk} \times \left[ \left( I_{fodder} \times F_{land-f} \times F_{year-f} \times (TF_{plant} + MLF) \right) + \left( I_{soil} \times F_{land-g} \times F_{year-g} \right) \right]} \]

- **Milk Action Level** “adulterated”
- **Milk density**
- **Transfer factor intake to milk**
- **Feed ingestion rate**
- **Fraction of time exposed to contaminated feed**
- **Plant transfer factor**
- **Soil mass loading factor**
- **Soil ingestion rate**
- **Fraction of time exposed to contaminated soil**

How much is too much PFOS in soil
Grass-based Dairy Farm

Pasture Fodder Only
SSL = 6.8 µg/kg, \textit{dw}

Corn-Silage Fodder Only
SSL = 120 µg/kg, \textit{dw}

https://www.maine.gov/dep/spills/topics/pfas/Agronomic-Pathway-Soil-Screening-Levels-Soil-Fodder-Cows-Milk-09.16.20.pdf
For more information

Andrew Smith, SM, ScD
State Toxicologist
Maine Center for Disease Control and Prevention
andy.e.smith@maine.gov

Thomas Simones, PhD
Toxicologist
Maine Center for Disease Control and Prevention
Thomas.simones@maine.gov