Composting to Manage PFAS Contamination in Livestock

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Background

- Central Maine Farm that used land-applied biosolids during the 1990's up until 2000.
- Site houses a Swine, Dairy and Beef operation.
- Milk tested during 2020 found to be excessively high in PFAS compounds [PFOS].
- Farmer in consultation with DACF Animal Welfare decided to euthanize animals as depuration was not practical due to animal age.
- Composting chosen as carcass management tool as landfills not keen on accepting whole carcasses.
- Plan: Compost animals—test compost—decide on next steps.

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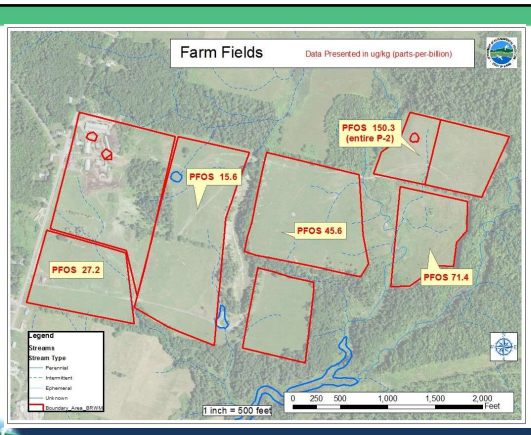

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Summary of PFAS Contamination in Milk, Manure and Meat

Milk

Sample ID	Sample Date	PFOS (ng/L)	Validation Qual	PFOA (ng/L)	Validation Qual
Fairfield Tank	6/24/20	12,700		31.9	
Fairfield Tank (re-test)	6/24/20	14,400		38.5	
Fairfield Tank (re-test)	6/24/20	14,900		52.9	J
Milk Tank	7/13/2020	32,200		46.5	J

Manure

Sample ID	Sample Date	PFOS (ng/g Dry)	Validation Qual	PFOA (ng/g Dry)	Validation Qual
BEEF MANURE PAD	7/31/2020	113	J	22.1	J
DAIRY MANURE PIT	7/31/2020	35.1	J	4.48	J
HOG MANURE STACK	7/31/2020	39.9	J	5.81	J

Average PFOS = 63 ng/g

Dairy Cow - Meat

Sample ID	Sample Date	PFOS (ng/g)	PFOA (ng/g)	Beef Action Level*
Dairy Female (muscle) –USDA	11/25/2020	133	ND	3.4 ng/g
Stillborn calf (muscle) - USDA	6/15/2021	155	ND	
Stillborn calf (plasma) – USDA	6/15/2021	326	ND	

1 Cow = 133 ng/g

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Summary of PFAS Contamination in Feed

Feed

Sample ID	Sample Date	PFOS (ng/g Dry)	Validation Qual	PFOA (ng/g Dry)	Validation Qual
GREEN CHOP	7/8/2020	31.43		1.58	J
HAY SILOED 2019	7/8/2020	0.44	J	ND	
HAY-1 (haybale)	7/8/2020	50.61		7.64	
SILAGE-2019	7/8/2020	ND		ND	
GRASS-RIDGE-1	7/31/2020	399.10		39.82	
GRASS-RIDGE-3	7/31/2020	396.07		86.06	
GRASS-201-5	7/31/2020	352.90		49.96	
R3-FIRST-A	9/14/2020	121.46	D	6.08	
R3-FIRST-B	9/14/2020	83.54	D	4.2	
R3-2ND-A	9/14/2020	54.97	D	6.09	
R3-2ND-B	9/14/2020	81.72	D	3.28	
2011-CORN-1	9/25/2020	7.89		ND	
2011-CORN-2	9/25/2020	1.44		ND	
2011-CORN-3	9/25/2020	11.18		ND	
2011-CORN-4	9/25/2020	2.03		ND	
2011-CORN-5	9/25/2020	13.51		ND	
R6-CORN-1	9/25/2020	30.59		ND	
R6-CORN-2	9/25/2020	6.6		ND	
R6-CORN-3	9/25/2020	37.5		ND	
R6-CORN-4	9/25/2020	2.52		ND	
R6-CORN-5	9/25/2020	37.17		0.57	J

Average PFOS = 82.0 ng/g

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Benefits of Composting Carcasses

- Ties-up nutrients.
- Reduces/treats leachate generation.
- Reduces odors and possible vector attraction.
- Makes materials less bulky and easier to handle/manage.
- Possible reduction of PFAS levels??

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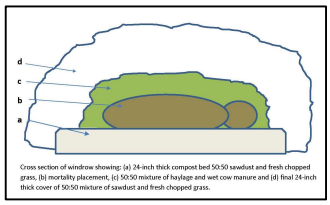
Compost Plan for Carcasses

Pile Layer	Ingredient #1	Ingredient #2	Mix Ratio
Base/Bed	Shavings	Haylage	50:50
Carcass Layer	Manure	Haylage	50:50
Cap	Shavings	Haylage	50:50



Cross section of windrow showing: (a) 24-inch thick compost bed 50:50 sawdust and fresh chopped grass, (b) mortality placement, (c) 50:50 mixture of haylage and wet cow manure and (d) final 24-inch thick cover of 50:50 mixture of sawdust and fresh chopped grass.

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35 Adult Market Ready Swine 600 -700 lbs. each

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Porcine Muscle Tissue Sampled by USDA FSIS

Meat Sample ID	Sample Date	PFOS (ng/g)	PFOA (ng/g)	Pork Action Level*
Porcine (muscle) – USDA	11/25/2020	7.32	ND	3.7
Porcine (muscle) – USDA	6/15/2021	12.2	1.4	3.7
Porcine (muscle) – USDA	6/15/2021	10.0	.89	3.7
Porcine (muscle) – USDA	6/15/2021	5.99	ND	3.7
Porcine (muscle) – USDA	6/15/2021	8.92	ND	3.7
Porcine (muscle) – USDA	6/15/2021	9.11	ND	3.7
Porcine (muscle) – USDA	6/15/2021	5.57	ND	3.7
Porcine (plasma) – USDA	6/15/2021	115	41.6	
Porcine (plasma) – USDA	6/15/2021	146	32.9	
Porcine (plasma) – USDA	6/15/2021	52	8.23	
Porcine (plasma) – USDA	6/15/2021	93.4	3.29	
Porcine (plasma) – USDA	6/15/2021	113	6.37	
Porcine (plasma) – USDA	6/15/2021	66	6.06	

ND" indicates that compound not detected in the sample *3.7 ng/g preliminary Maine Pork Action Threshold

Average Pork PFOS = 8.4 ng/g

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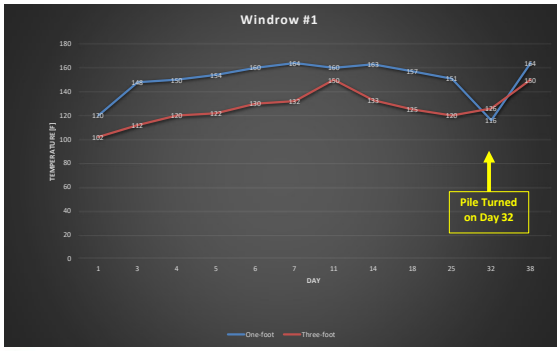
Temp Profile—Swine



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59 Adult Dairy Cows (1,100-1,500 lbs. each)

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Dairy Muscle Tissue Sampled by USDA FSIS from 14 dairy cows and (3 beef cattle).

USDA FSIS #	Cattle Sample #	Dairy (D) or Beef (B, BX)	Tissue PFOS (ppb)	PFHpA (ppb)	PFOA (ppb)	PFNA (ppb)	PFDA (ppb)	PFUnA (ppb)	PFDoA (ppb)
2441169	1	D	57.3	N/A	N/A	1.05	1.23	N/A	N/A
2441168	2	B	24	N/A	0.902	0.931	2.06	N/A	N/A
2441160	3	BX	22	N/A	N/A	1.17	1.12	N/A	N/A
2441159	4	D	113	N/A	N/A	0.984	2.62	N/A	N/A
2441167	5	D	96.3	N/A	N/A	1.06	2.15	N/A	N/A
2441166	6	D	83.1	N/A	0.538	0.993	2.82	N/A	N/A
2441165	7	D	37.5	N/A	N/A	N/A	0.634	N/A	N/A
2441164	8	D	35.6	N/A	N/A	N/A	0.708	N/A	N/A
2441163	9	D	67.2	N/A	N/A	1.42	1.71	N/A	N/A
2441162	10	D	26	N/A	N/A	N/A	0.526	N/A	N/A
2441161	11	D	20.7	N/A	N/A	N/A	N/A	N/A	N/A
2441158	12	D	82.8	N/A	N/A	1.38	2.11	N/A	N/A
2441156	13	D	46.5	N/A	N/A	0.514	1.16	N/A	N/A
2441155	14	D	56	N/A	N/A	0.762	1.17	N/A	N/A
2396250	15	D	36.1	N/A	N/A	0.563	5.11	1.33	
2396239	16	D	36.7	N/A	N/A	N/A	0.804	N/A	N/A
2395461	17	B	13.2	N/A	N/A	N/A	1.13	N/A	N/A

Average PFOS = 50.2 ng/g

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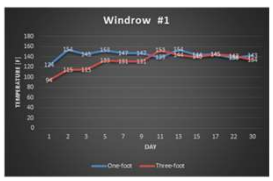
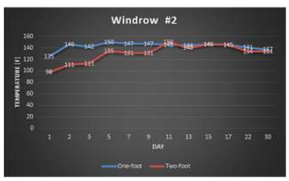
Temp Profile—Dairy Cows





On September 1, 2021, two compost windrows measuring approximately 100 feet long by 15 feet wide were constructed at a Central Maine farm to help manage a mixture of 59 adult and calve dairy cows and beef livestock mortalities. Each windrow consisted of a 24-inch-thick bed of a 50:50 mixture of sawdust shavings and fresh-chopped hay. The mortalities were placed on the bed and immediately covered with a 50:50 blend of haylage and manure. This mixture was wet, dense, and especially hot and active. Finally, a 24-inch-thick cover consisting of a 50:50 mixture of sawdust shavings and fresh-chopped hay was placed on top of the mortalities to complete each windrow.

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Gallons of Potential Leachate Mitigated

Ave. weight of animals x %H20 x # of animals/8 lbs./gallon

– Hogs
- 650 lbs. x 0.60 x 35/8 lbs./gallon = 1,706 gallons

– Dairy Cows
- 1,300 lbs. x 0.60 x 59/8 lbs./gallon = 5,753 gallons

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PFOS Results for Hog and Dairy Cow Compost

Compost Type	PFOS Result ng/g
Hog Compost	97.5
Dairy Cow Compost	104

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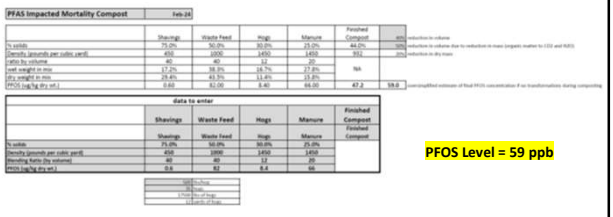
What PFOS Level Should Have Been



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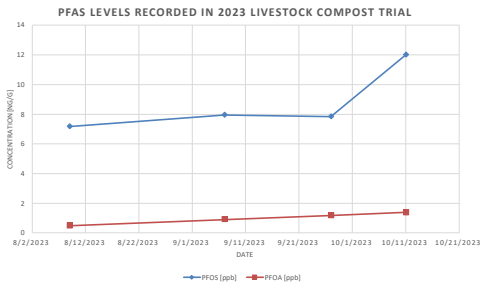
Could There be Precursor Transformation?



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Future Research Directions

- Containerized Composting.
- Using Hyperaccumulators to remediate soils.
- Using Composted PFAS materials beneficially:
  - Allows Nutrient Reuse/avoids disposal.
  - Repeated cropping with lower PFOS levels allow fields to rejuvenate.
  - Can use compost as an “Alternative Daily Cover” substitute.

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Containerized Composting

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