

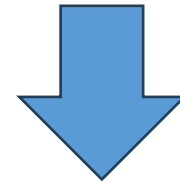
Implication of Manure Treatment Technologies on Nutrient Composition

Deanne Meyer and Nicholas Clark

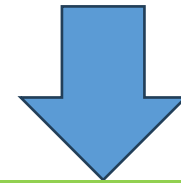
dmeyer@ucdavis.edu

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More advanced technologies coming



Effluent streams transportable



Agronomic value and awareness

Decision drivers

**NITRATE
MANAGEMENT
ZONES**

SJAPCD

**REGIONAL
WATER
QUALITY
CONTROL**

**CEQA
NOISE, LIGHTING, ROAD USE, ETC**

SB 1383

SGMA

Nitrogen Management Emphasis



Nitrate Management zones 2021 +



2014, 2017, 2022...



WHICH TECHNOLOGY

Anaerobic digester

Vacuum

Mechanical separator

Flocculants



What does each dairy want to manage?



Carbon



Nitrogen or Phosphorus

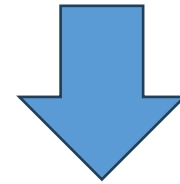


Form (liquid to solid)

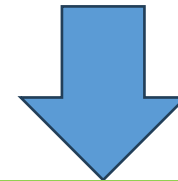


Odor, traffic, lighting

More advanced technologies coming



Effluent streams transportable

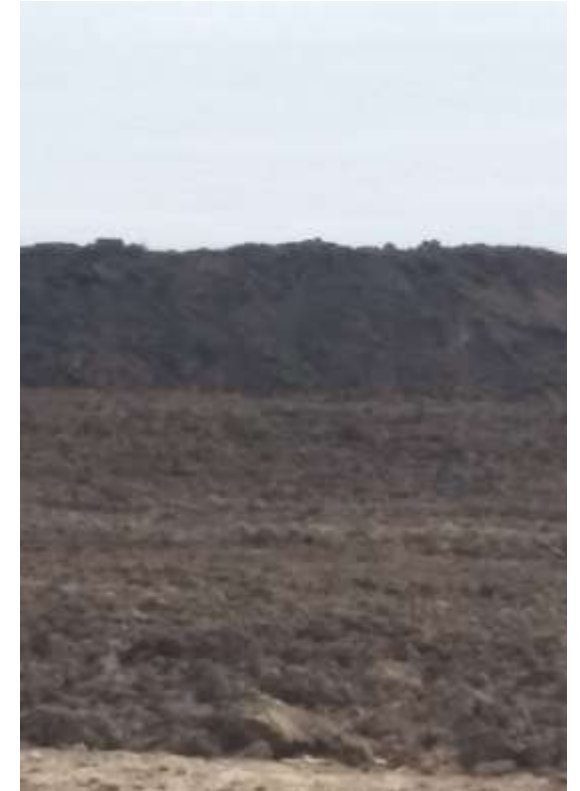


Agronomic value and awareness





Nutrient
composition and
quantity depend on
animal management



Anaerobic digestion with biogas recovery and use



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Composition of digestate expressed as **pounds per acre-inch** of water unless noted otherwise.

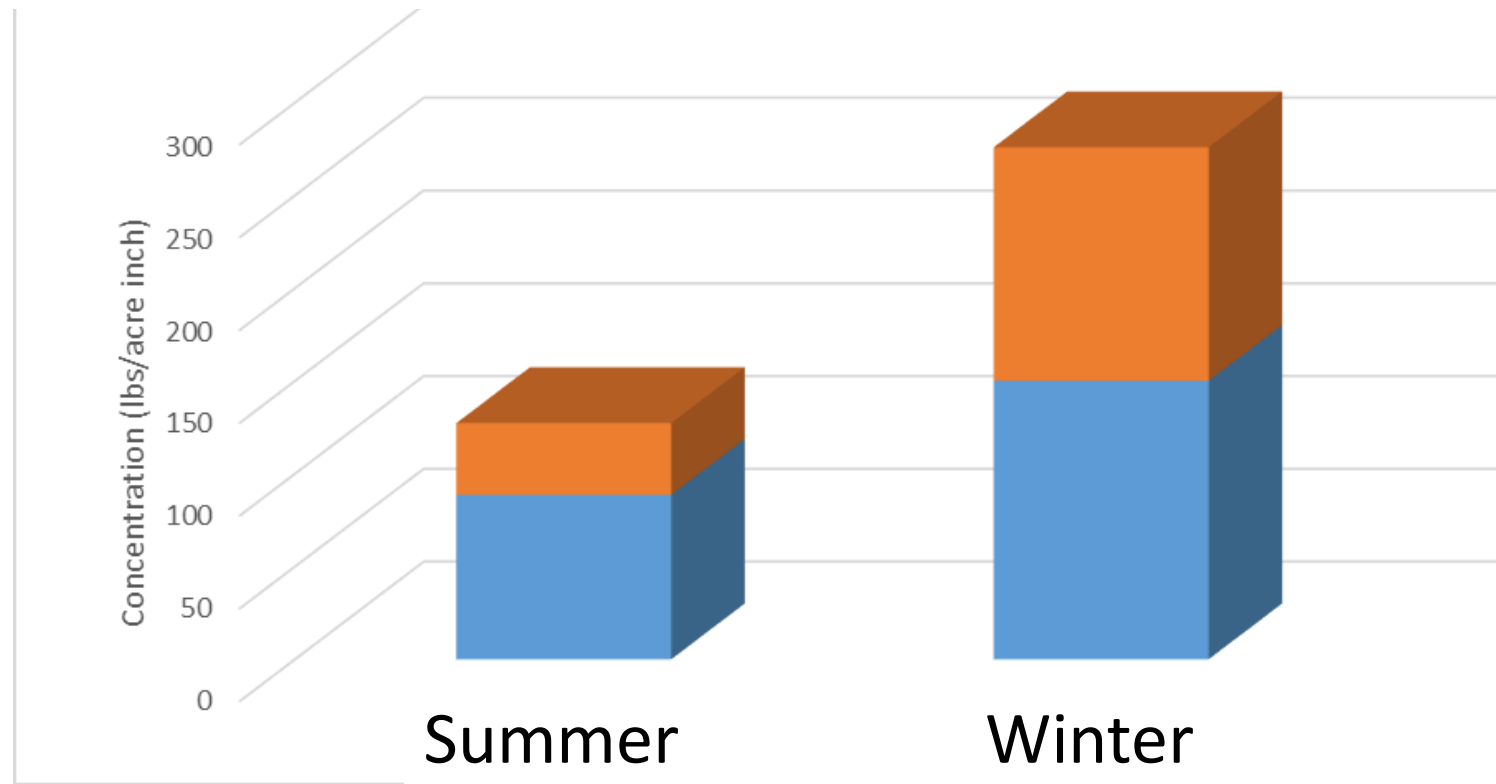
Analyte	Average		Range (low to high)	
	Summer	Winter	Summer	Winter
Total solids	1,177	4,086	659 – 3,030	2,126 – 7,102
Volatile solids	560	2,675	325 – 1,228	1,193 – 4,707
Carbon	73	185	43 – 103	95 – 292
Organic nitrogen	39	126	5 – 124	63 – 244
Ammonium nitrogen	89	150	33 – 169	85 – 276
Total phosphorus (P ₂ O ₅)	44	104	23 – 82	71 – 226
Total potassium (K ₂ O)	164	244	99 – 264	185 – 387
Electrical conductivity (dS/m) ²	5.8	7.3	3.4 – 9.8	4.9 – 9.4

2:1:4

1.5:1:2.5



Use of digester effluent N



Source Hollingsworth et al. presentation WAE

Composition of digestate expressed as **pounds per acre-inch** of water unless noted otherwise.

Measured	Average	
	Summer	Winter
Total solids	1,177	4,086
Volatile solids	560	2,675
Carbon	73	185
Organic nitrogen	39	126
Ammonium nitrogen	89	150
Total phosphorus (P ₂ O ₅)	44	104
Total potassium (K ₂ O)	164	244
Electrical conductivity (dS/m) ²	5.8	7.3

3 in. of summer effluent=

325 lbs available N
(267 lbs available N+
50%117 lbs org. N)

132 lbs P₂O₅,
492 lbs K₂O

Composition of digestate expressed as **pounds per acre-inch** of water

Analyte	Average	
	Summer	Winter
Total solids	1,177	4,086
Volatile solids	560	2,675
Carbon	73	185
Organic nitrogen	39	126
Ammonium nitrogen	89	150
Total phosphorus (P ₂ O ₅)	44	104
Total potassium (K ₂ O)	164	244
Electrical conductivity (dS/m)²	5.8	7.3

Corn tolerance 1.8 dS/m

yield reduces 7.4% per 1 dS/m increase

3.4 dS/m effluent

↓ yields by 11.8%

dilution important!



Source water N and EC



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Source Fulford et al. presentation WAE

Vacuum then ?????



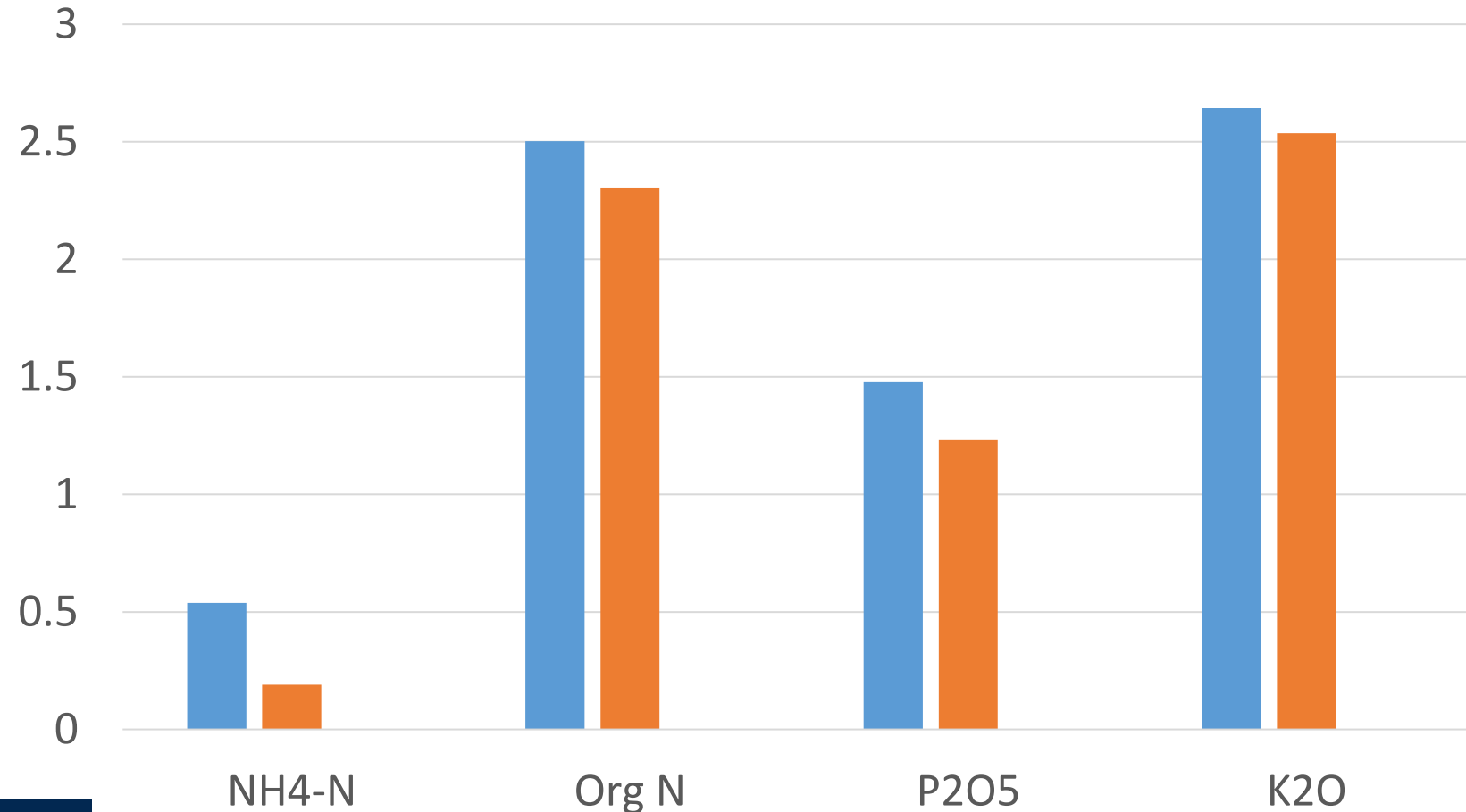
Photos by Nick Clark





Total solids (dry matter) %	Moisture (%)
17.5	82.5

Nutrient composition of vacuumed manure percent dry matter basis



Vacuumed Manure Composition

Facility	Season	Total N (lb N/ton)	P (lb P ₂ O ₅ /ton)	K (lb K ₂ O/ton)
V1	Warm	35	23	29
	Cold	36	25	29
V2	Warm	55	24	43
	Cold	69	34	64
V4	Warm	53	29	59
	Cold	79	31	68
V3 (Heifer)	Cold	57	22	72

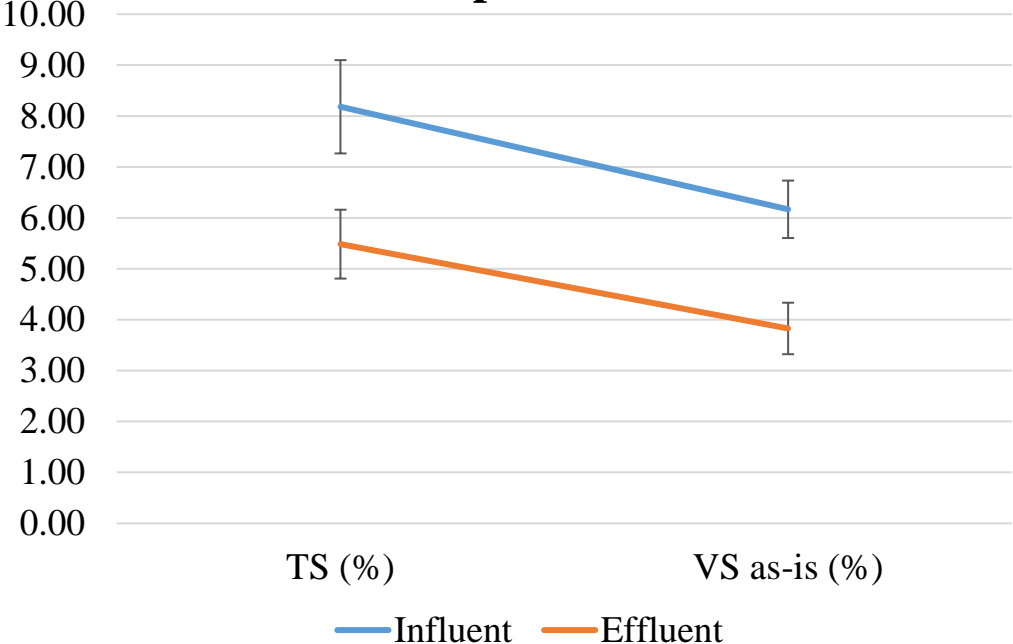
Scrape then dewater



Solids removal



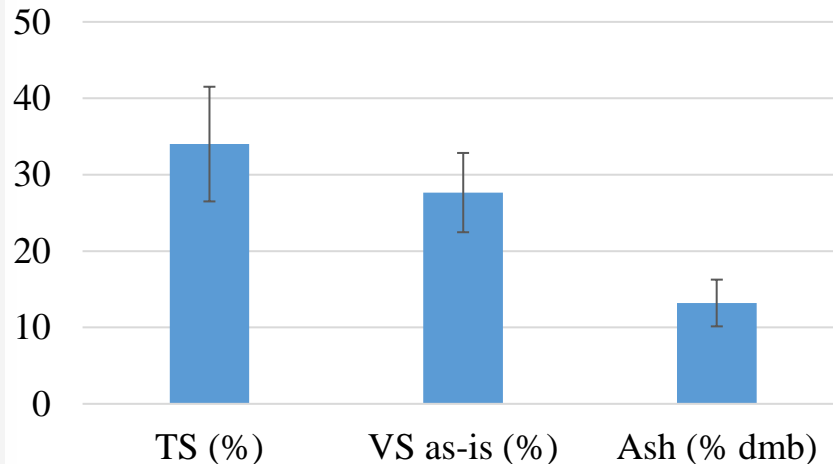
Solids Profile - Scraped manure to screw press



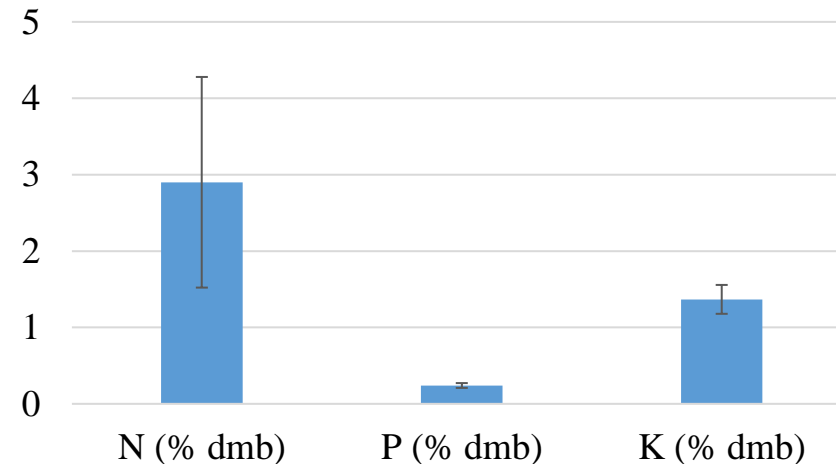
Source Clark et al. presentation WAE



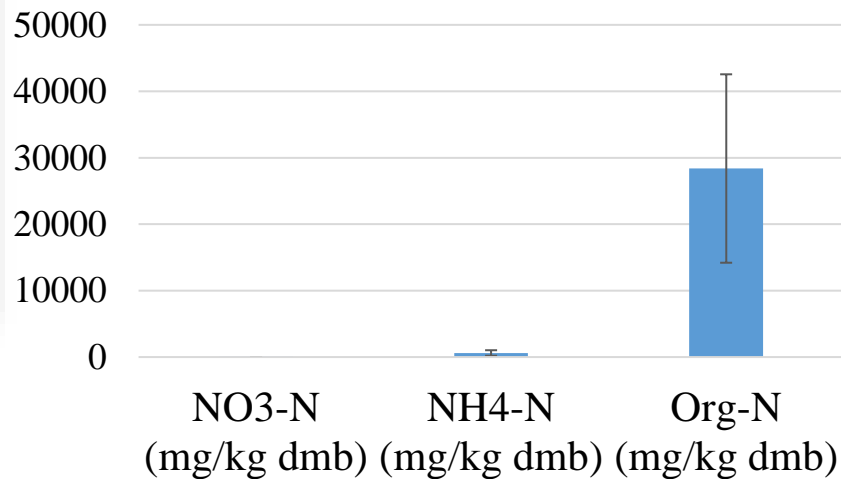
Solids profile



Macronutrients



Nitrogen profile



Land application of nutrients in solids at 70% MC

Applied (tons/acre)	N	P	K
10	170	13	77
15	255	20	116
20	340	26	154

C:N of **15** (slow-release N fertilizer)

Easier to spread and stack

Compost Bedded Pack Barn



Compost Bedded Pack Manure Composition

Facility	Season	Total Solids (%)	Moisture (%)
CBPB1	Cold	46	52
CBPB1	Warm	55	44
CBPB2	Warm	68	31
CBPB2 (Heifer)	Warm	73	23

LOTS of added CARBON

Compost Bedded Pack Manure Composition

Facility	Season	Total N (lb N/ton)	P (lb P ₂ O ₅ /ton)	K (lb K ₂ O/ton)
CBPB1	Warm	48	32	89
CBPB1	Cold	38	24	86
CBPB2	Warm	47	17	35
CBPB2	Warm (Heifer)	43	19	37

Great CARBON source



Source Fulford et al. presentation WAE

Anaerobic + aerobic treatment



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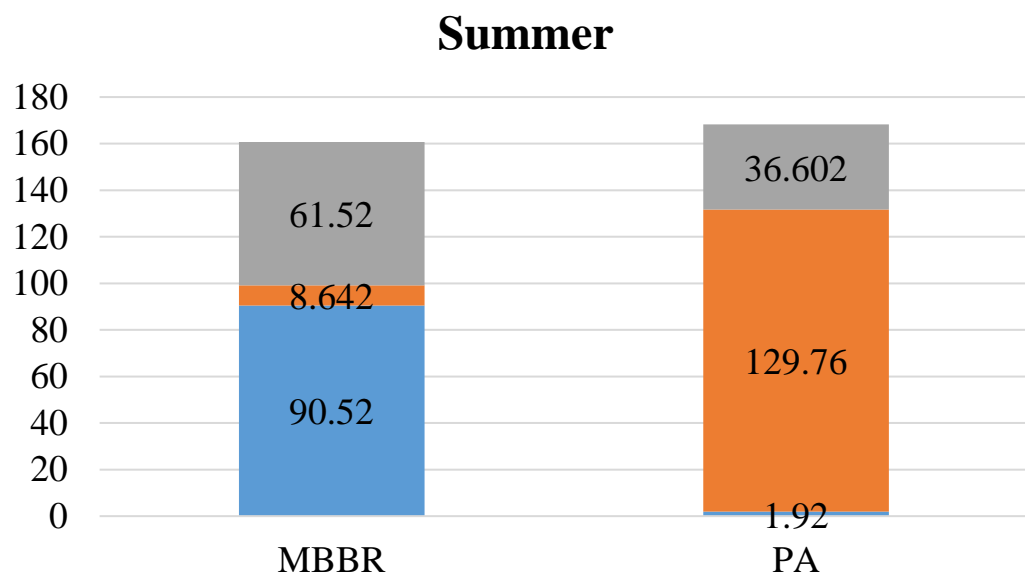
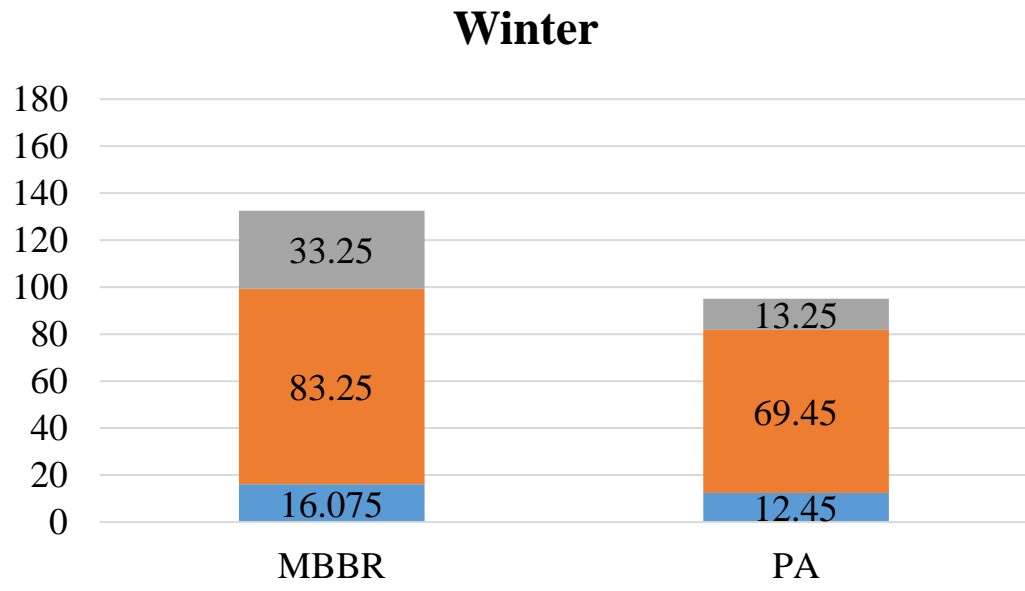
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Nitrogen Fractions in Summer and Winter

Sample location abbreviation key

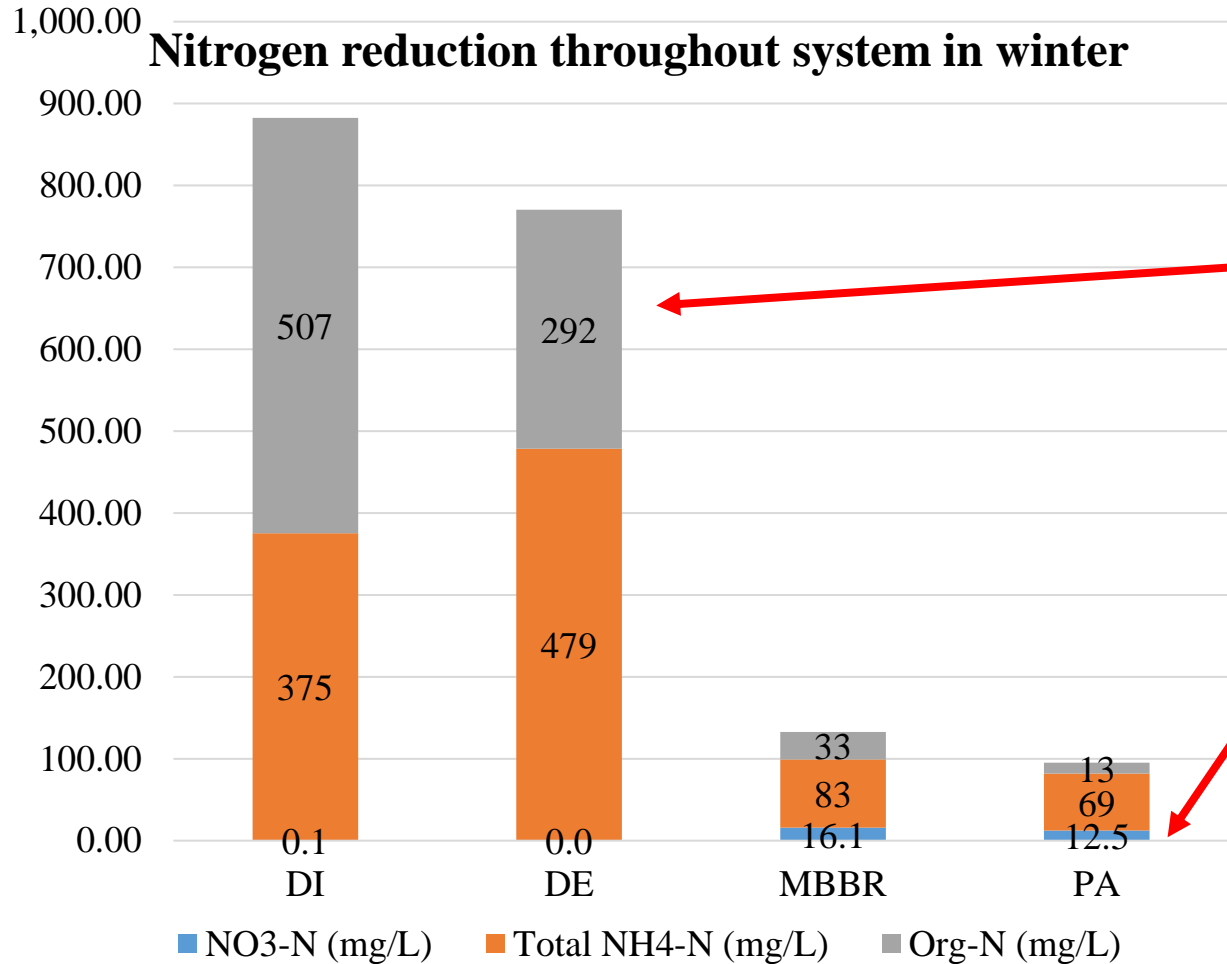
Abbreviation	Description
DI	Digester influent
DE	Digester effluent
MBBR	After moving bed biofilm reactor
PA	Post algae raceway



■ NO3-N (mg/L) ■ Total NH4-N (mg/L) ■ Org-N (mg/L)



How does it fertigate?



177 lbs N/acre*inch of water applied

22 lbs N/acre*inch of water applied

What's at the bottom of ponds?

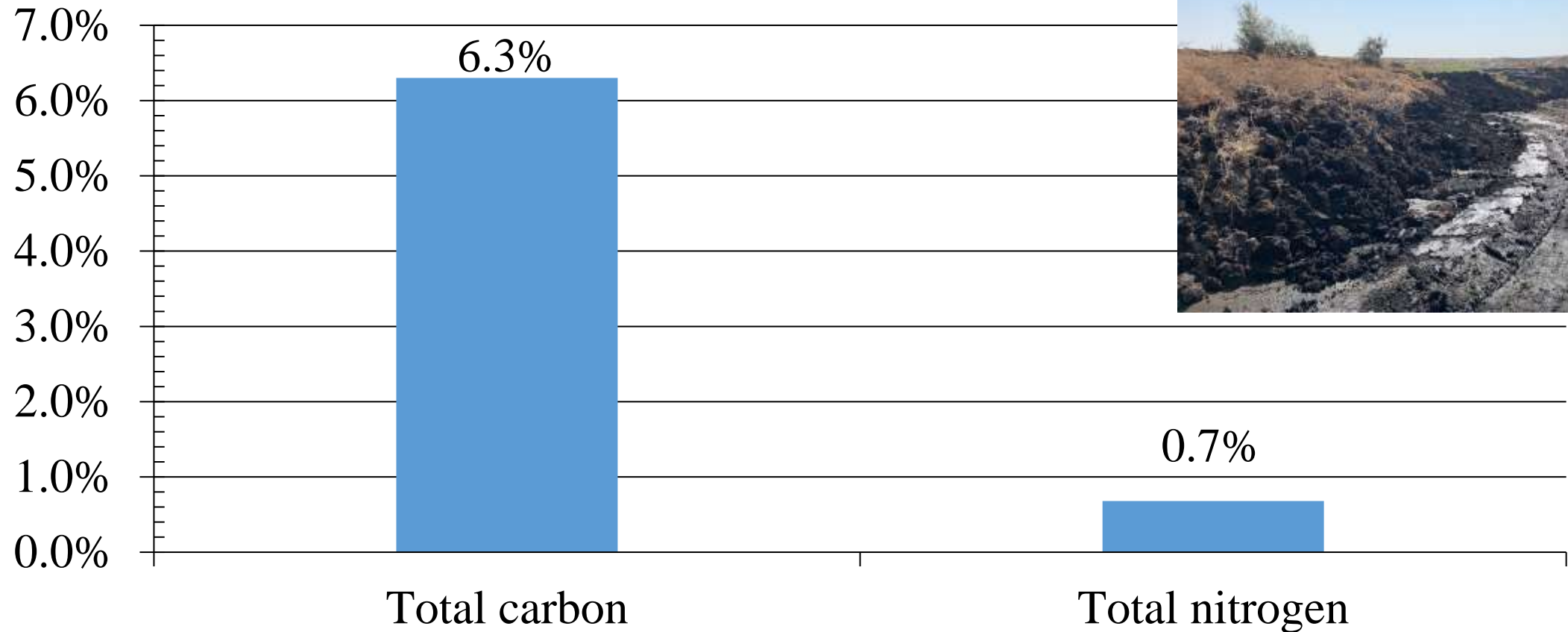


Check salts



Carbon and nitrogen content as received by the lab

Material has a C:N of 9.0



Source Clark et al. presentation WAE



RECORDED WEBINARS

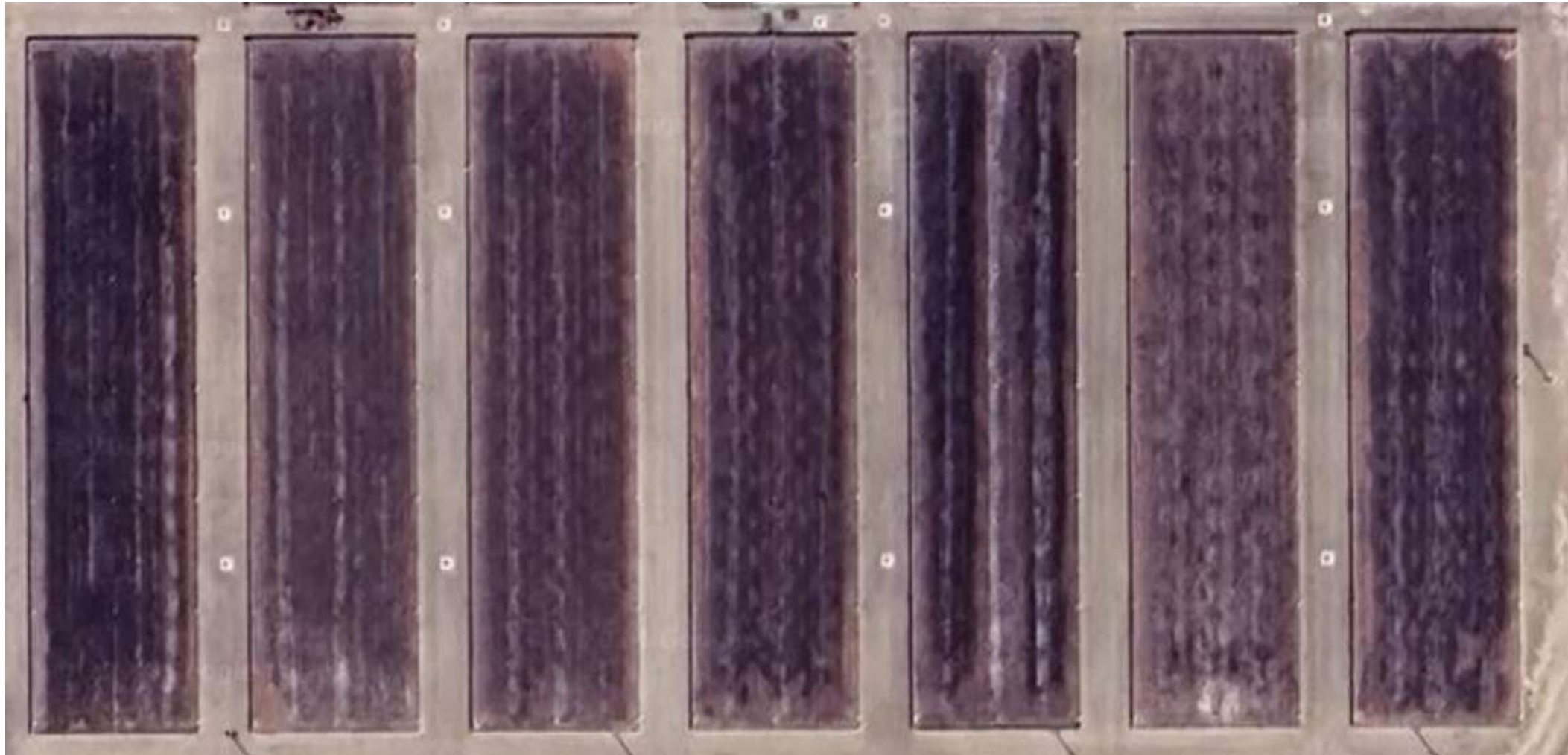


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In process of testing







Thank YOU to all who led and contributed to this project

- Funding from the California Dairy Research Foundation
- Dairy operators
- Advisors Anthony Fulford, Jennifer Heguy, Joy Hollingsworth
- Staff Laura Gonzales, Ben Halleck, Joyce Pexton, Chaitanya Muraka, Patricia Price, Zaira Joaquin-Morales, Madeline Morataya, Ramandeep Brar, Cara Wolfe, Ruben Chavez



**POST DOC and Project
Scientist positions
AVAILABLE**

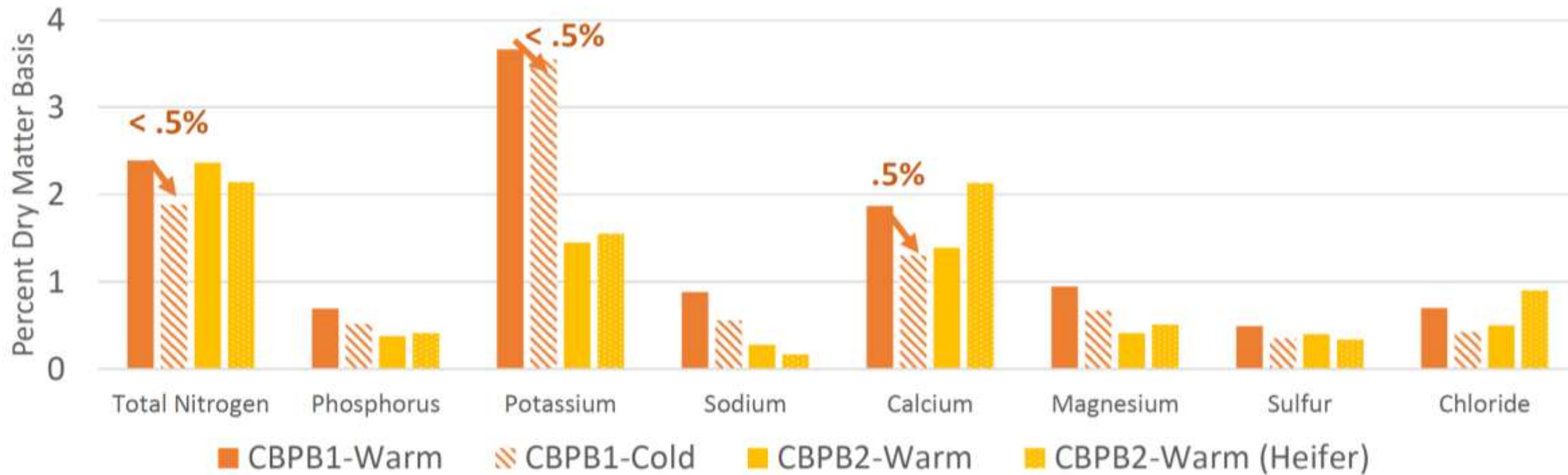
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Card by [Amy Krouse Rosenthal](#) (Author), [Tom Lichtenheld](#) (Illustrator)

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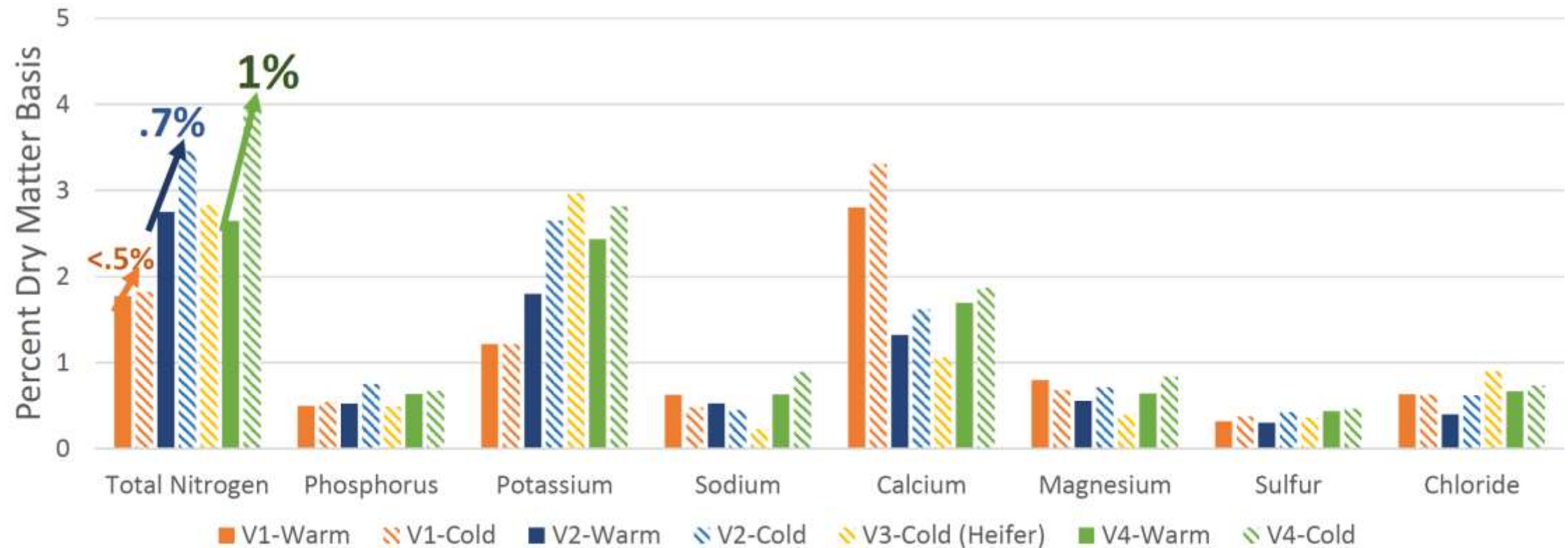


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Vacuumed Manure Composition

Manure Nutrient Content



Summary

- Winter samples more concentrated than summer samples
- Relatively high salinity
- Important to test before applying to field
- Calculate dilution factors so not over applying nutrients or salt

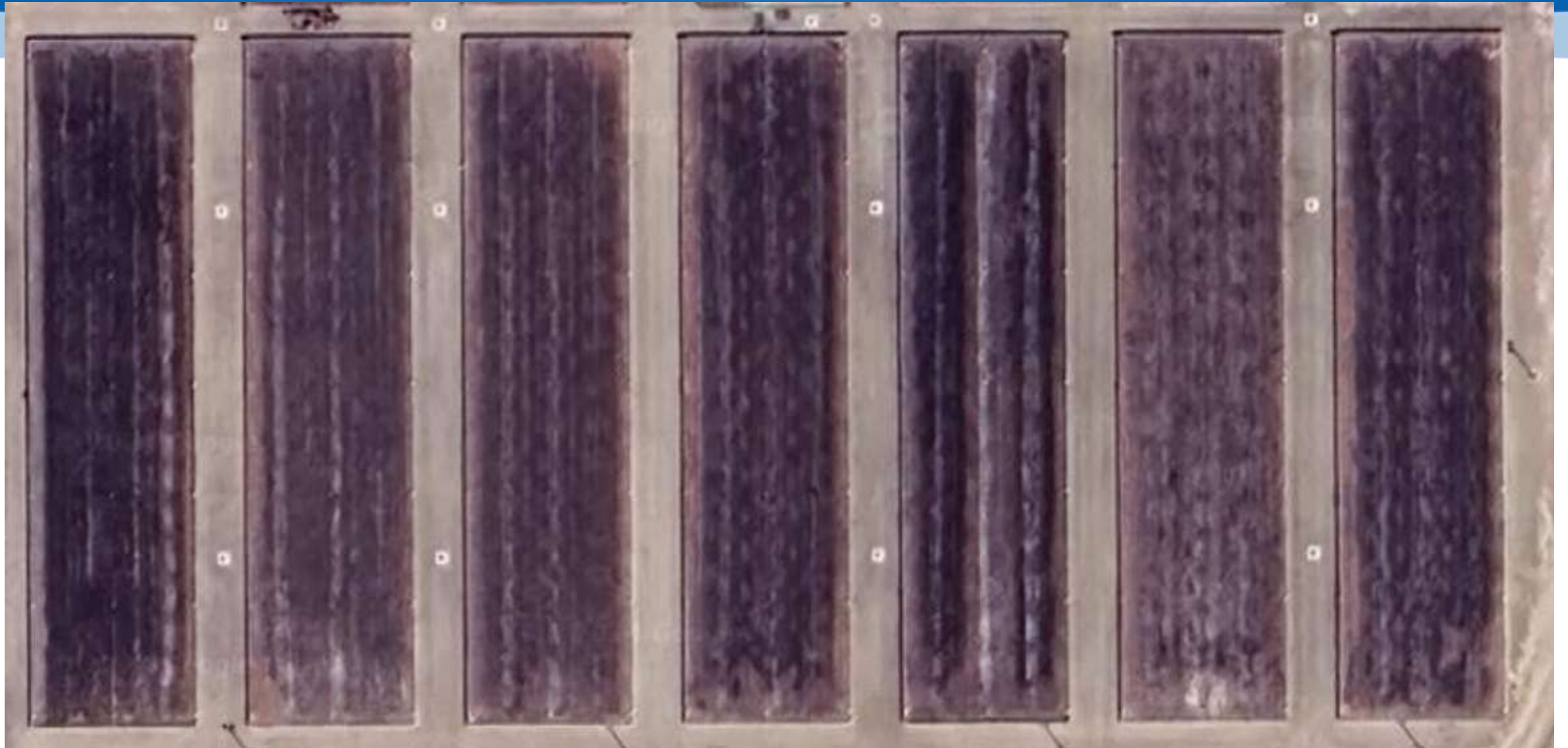






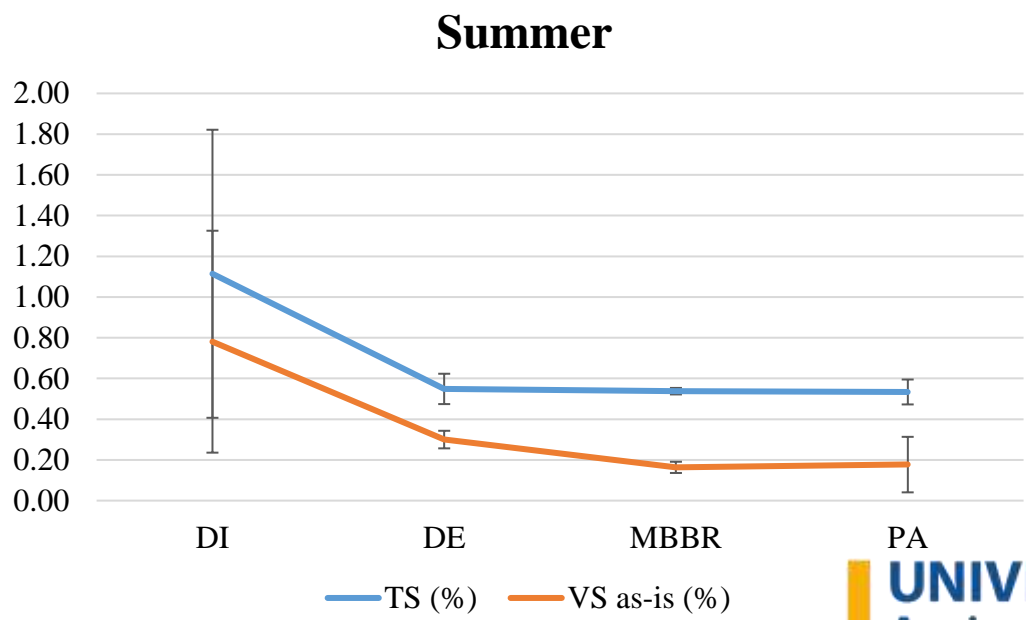
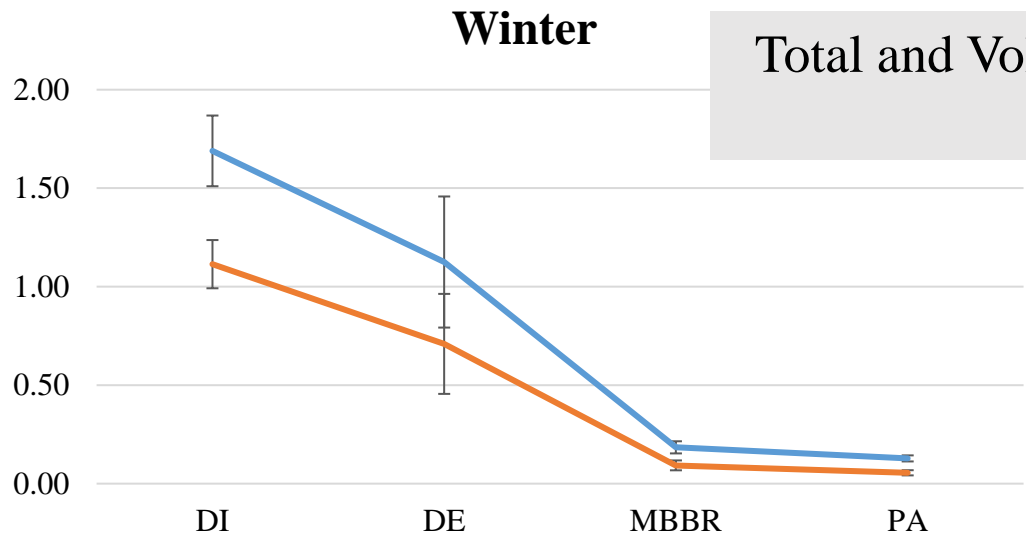
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Total and Volatile Solids (%) in Winter and Summer



Sample location abbreviation key

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