Digestate Alone and With Compost - Designing for Specific End Uses

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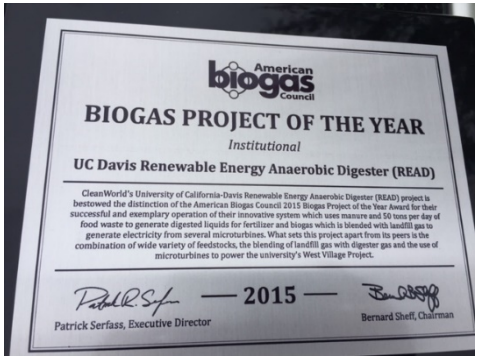
California Bioresources Alliance 2017 Symposium

November 2, 2017

Presentation Outline

- UC Davis Renewable Energy Anaerobic Digester (READ)
- Need to create values for digestate
- Benefits of digestate to composting
- UC Davis research in transforming digestate into biofertilizer products

UC Davis
Renewable Energy Anaerobic Digester



- Treats 20,000 tons per year of mixed organic wastes
- Combines biogas and landfill gas to generate 5.6 GWh electricity per year
- Partnership between CleanWorld, UC Davis, U. S. Department of Energy and the California Energy Commission

Completed in January 2014

UC Davis Renewable Energy Anaerobic Digester Powers Campus with Food and Farm Waste

Digester Feedstock: Food Waste

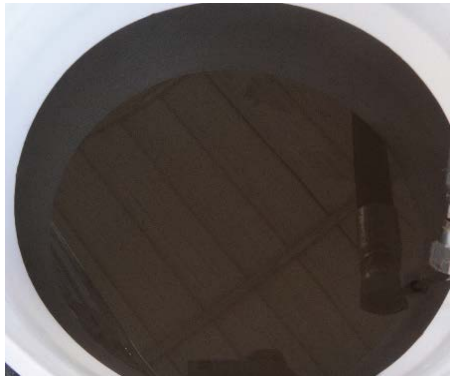
Example Feedstock Characteristics

Feedstock	No. of Sample Collected	TS (%, w.b.)	VS (%, w.b.)	VS/TS (%)
UC Davis food waste	29	33.0±18.6	29.6±16.6	90.3±5.0
Commercial food waste	6	31.5±3.6	27.9±2.8	88.8±4.5
Mouse bedding	11	85.0±9.6	79.3±8.2	93.3±0.8
Produce food waste	6	12.6±0.9	11.3±0.7	90.2±2.4
Ice cream waste	5	44.5±8.4	43.4±8.1	97.6±0.4
Tomato waste	6	7.3±0.5	6.6±0.5	89.7±1.9
Animal feed	1	89.6	81.5	91.0
Senior gleaners	4	33.7±1.3	31.3±1.1	93.1±1.6
Municipal organic solid waste	5	34.7±1.3	31.2±0.9	89.9±0.9
Folsom prison waste	3	22.7±1.6	21.7±1.7	95.4±0.5

Feedstock Loading

Digestate Management

About 6000-7000 gallons of liquid digestate are produced each day. Digestate has been given to farms and agricultural material facilities at a cost of over 10 cents per gallon.



Value Proposition of Digestate

- Contains nutrients and microbes
- Has compounds that promote plant growth and has disease suppression potential

Benefits of Digestate for Composting Operations

- Digestate is a good water and nutrient source for compositing operation.
- Mixing digestate with organic feedstock can increase composting rate due to higher nutrient contents.
- Composting increases the maturity and stability of digestate.

Desired Properties for Digestate Derived Fertilizer Products

- Known, consistent and stable physical, chemical and biological properties
- Sufficiently high nutrient contents (>2% nitrogen)
- Easy to transport, store and apply

Liquid Drip Irrigation

Slurry Injection

Solids Spreader

UC Davis Research On Transforming Digestate into Biofertilizer Products

- Developed digestate treatment technologies for producing concentrated liquid and solid fertilizer products from digestates
- Tested biofertilizers products for vegetable and corn production

Digesters in Study

UC Davis Renewable Energy Anaerobic Digester (READ)

- Thermophilic High Solids Digestion technology
- Treats 20,000 tons per year of mixed organic wastes
- Combines biogas and landfill gas to generate 5.6 GWh electricity per year
- Operational since the beginning of 2014

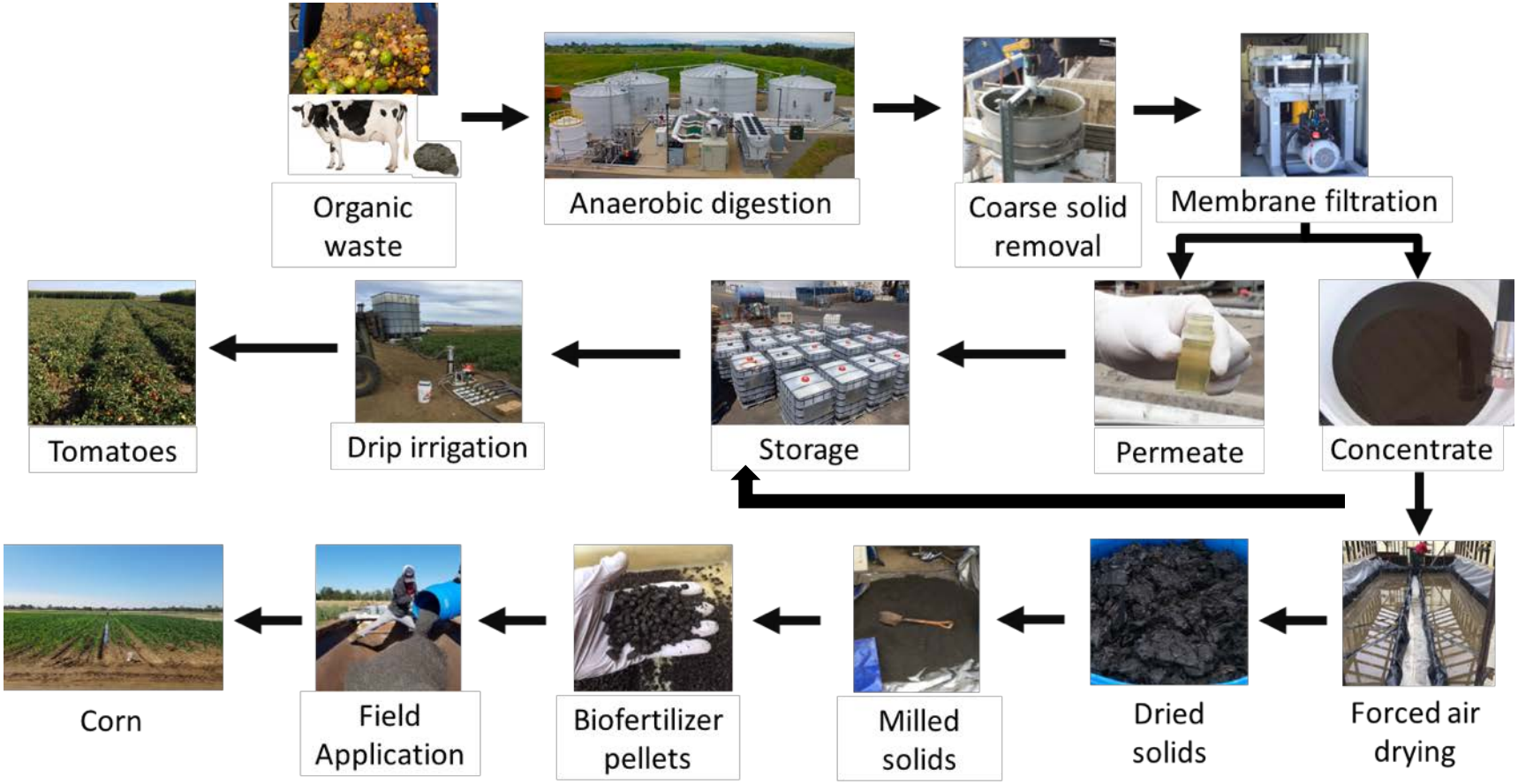
UC Davis READ Food Waste Digester

Dairy Manure Digester

- Mesophilic Completely Mixed Digester
- Treats scraped dairy manure from ~1,200 cows (144,000 wet lbs per day)
- Generates 1.94 GWh electricity per year
- Operational since the beginning of 2013

Dairy Manure Digester

Digestate Processing and Land Application



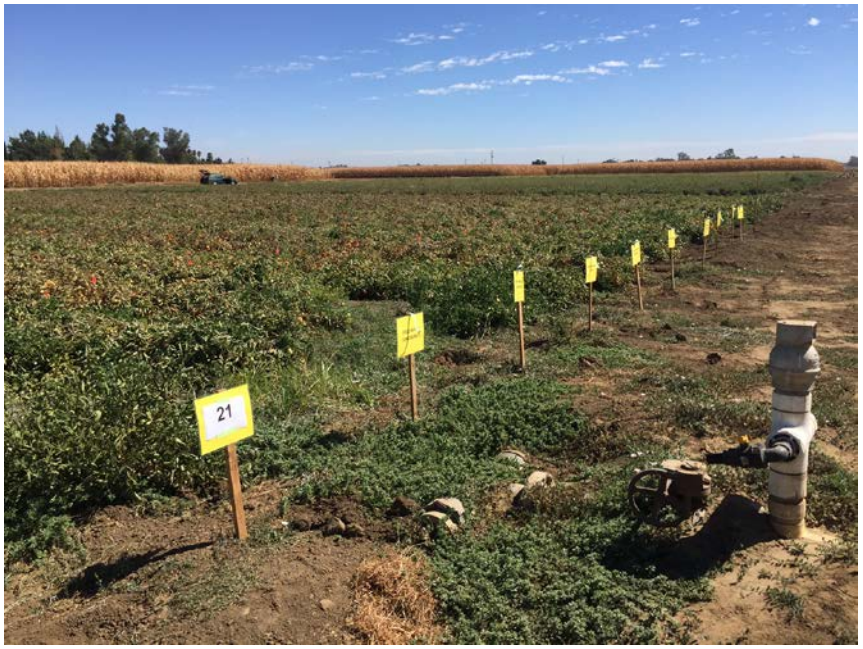
Raw Digestate Characteristics

Parameter *(mg/L)*	Dairy manure digestate	Food waste digestate
TS	37,000	50,0000
EC *(dS/m)*	14.4	22.4
TKN	2,142	4,037
NH_4-N	1,075	2,286
P	422	490
PO_4-P	12.3	52.1
Cl	1,397	1,379
K	2,180	1,692
Ca	879	887
Mg	571	266
Na	522	958

Liquid Biofertilizer Composition

Parameter	Liquid Products (*mg/L*)			
	Ultrafiltered Food Waste Digestate	Ultrafiltered Dairy Manure Digestate	Concentrated Food Waste Digestate	Concentrated Dairy Manure Digestate
TS (% wb)	0.9	0.59	5.6	6.8
TKN	2302	1226	5796	4228
NH_4-N	2164	1139	3133	1624
P	15	4	491	385
K	1303	1563	1126	1570
Na	1040	383	768	354
Ca	52	31	851	763
Mg	45	213	129	432

Testing Liquid Fertilizer Products for Growing Tomato



Field experimental design

1 acre plot

1050 ft^2 rows

4 rows/treatment (randomized)

Fertilizer application 180 lb N/acre

5 treatment conditions

- 2 controls:
  - No fertilizer
  - Synthetic commercial fertilizer (UAN 32)
- Ultrafiltered Dairy Manure Digestate
- Concentrated Dairy Manure Digestate
- Concentrated Food Waste Digestate

Russell Ranch
Sustainable Agriculture Facility
Home of the Century Experiment
A PROGRAM OF THE AGRICULTURAL SUSTAINABILITY INSTITUTE
UC DAVIS COLLEGE OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES

Tomato Harvesting and Measurement

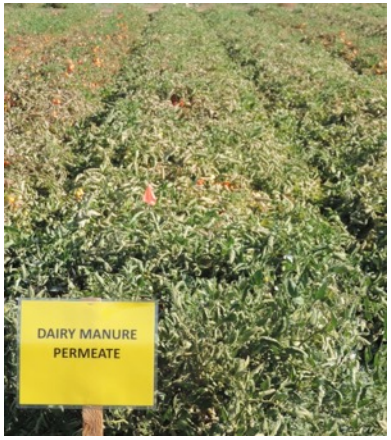
Analyses

Biomass yields (fruit and plant)

Tomato Quality (color, moisture, brix, pH, size)

Plant Comparison

Ultrafiltered Dairy Manure Digestate

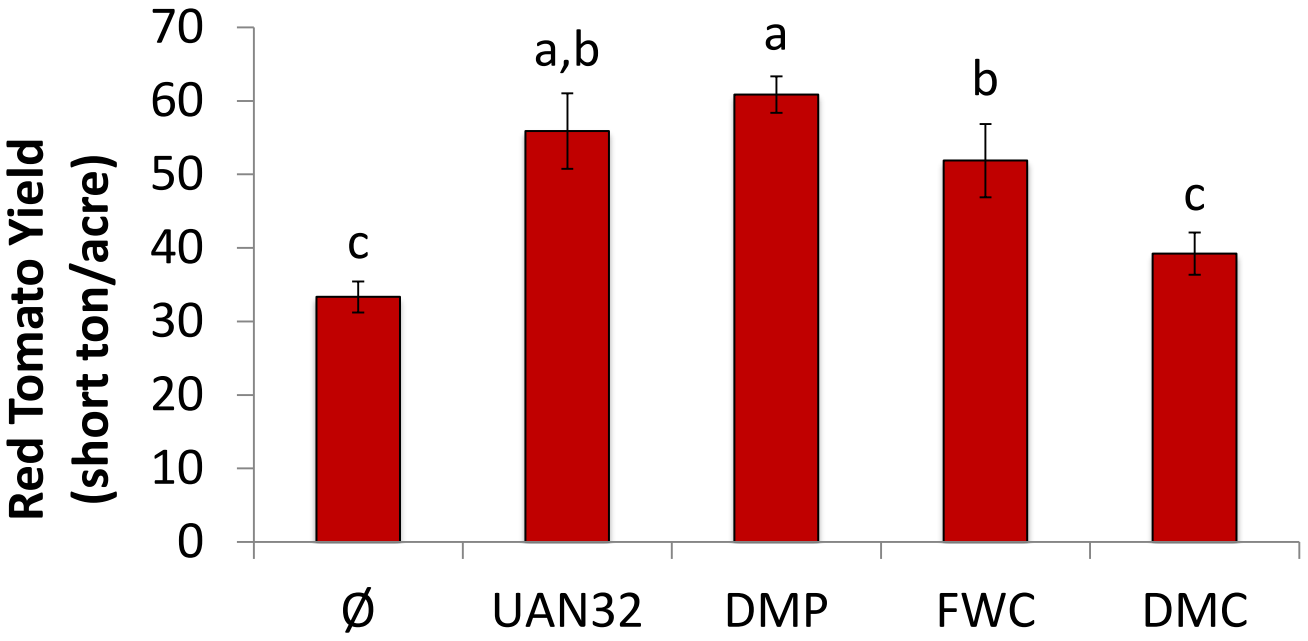


Concentrated Food Waste Digestate

No Fertilizer

Synthetic Fertilizer

Red Tomato Yield



Φ – No Fertilizer
UAN32 - Synthetic Fertilizer
DMP – Ultrafiltered Dairy Manure Digestate
FWC – Concentrated Food Waste Digestate
DMC – Concentrated Dairy Manure Digestate

*treatments with different letters are significantly different at the $p < 0.05$ level

Conclusions from Tomato Field Testing

- Compared to synthetic fertilizers, biofertilizers resulted in similar or better yields of red tomatoes, less sunburnt tomatoes, and higher yield of soluble solids in tomatoes.

Testing Solid Fertilizer Products for Growing Corn

Type: Short season corn

Size: 3,150 ft^2 microplots x 3 replicates

9,450 ft^2 total or 0.22 acres/trt

Irrigation: Flood irrigation

Nitrogen Rate: 210 lbs N/acre

Treatments

1) No fertilizer (negative control),
2) Synthetic/mineral, UAN-32
   - 32% Nitrogen product
   - Urea (16%), Ammonium-Nitrate (16%)
   - 11.08 lbs/gal; 3.55 lbs N/gal
3) Composted Poultry manure
4) Food Waste Digestate Pellets

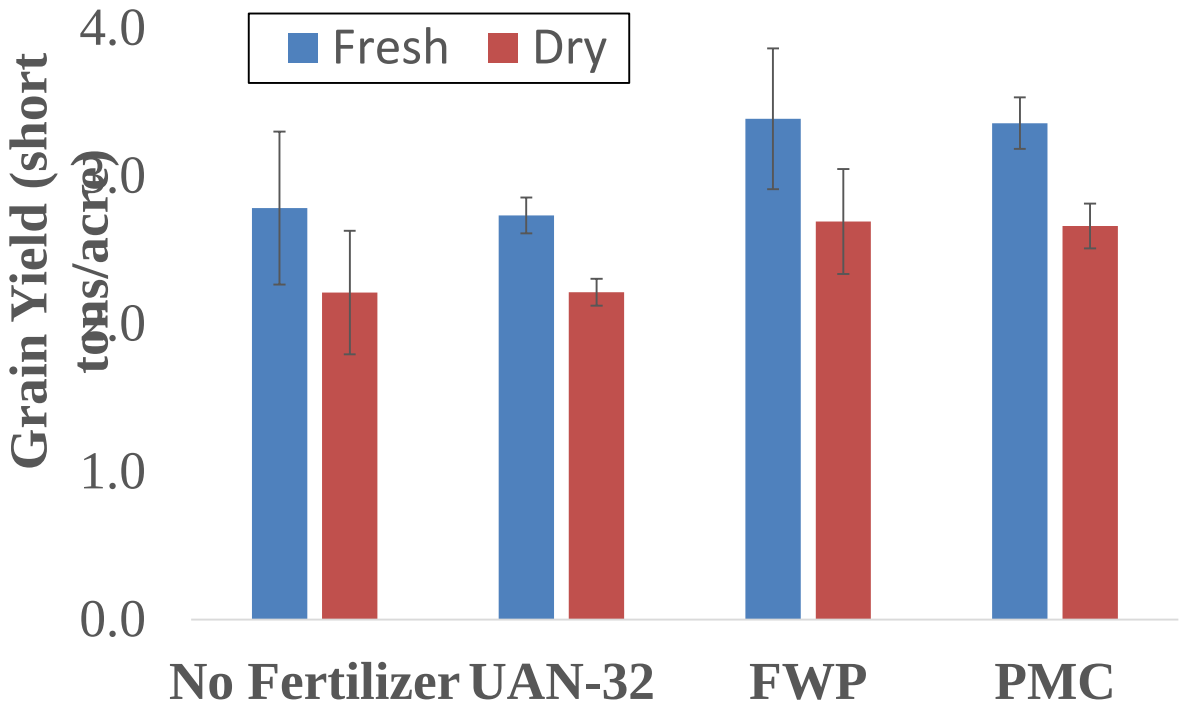
Food waste digestate pellet composition

Parameter	Food Waste Pellet[1]
Moisture Content	8.98
Total Nitrogen	4.99
Carbon	37.76
Phosphorus	1.75
Potassium	2.67
Sodium	1.29
Calcium	4.04
Magnesium	0.41

[1]Values as % wet basis

Corn Harvesting

Corn Yield Results: Fresh & Dry grain



FWP = Food waste pellets; **PMC** = Poultry Manure compost;

UAN-32 = urea ammonium nitrate; **No fertilizer** = no fertilizer applied

Outlook of Digestate and Compost

- A potentially large number of new fertilizer and soil amendment materials can be derived from digestate and compost.
- Growing demand for organic fertilizers for farms and gardens and need to replace conventional fertilizers on non-livestock farms will continue to create new markets.
- Integration of anaerobic digesters and composters will increase Bioproducts' portfolio.

Acknowledgements

Project Sponsors

California Department of Food and Agriculture

Central Valley Regional Water Quality Control Board

Researchers at UC Davis

Biological and Agricultural Engineering Department

- Ruihong Zhang, Hossein Edalati, Tyler Barzee, Hamed El Mashad, Tanner Garrett, Brandon Roosenboom, Ashwin Bala, Yutao Liu

Sustainable Agricultural Institute

- Kate Scow, Emma Torbert, Bibiana Molinos

Collaborators

CleanWorld: Josh Rapport, Caleb Adams, Michele Wong

New Hope Dairy and CalBio: Arlin Van Groningen, Arlan Van Leeuwen, Ross Buckenham

Sacramento Municipal Utility District: Valentino Tiangco