# Digestate Alone and With Compost - Designing for Specific End Uses

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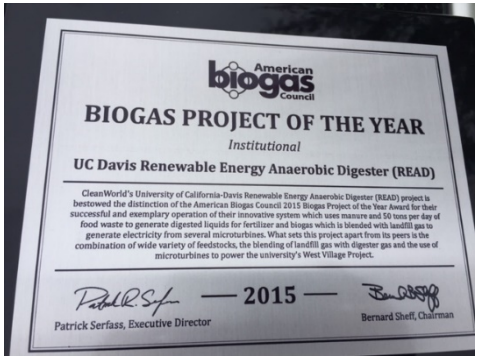
# Presentation Outline

- 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

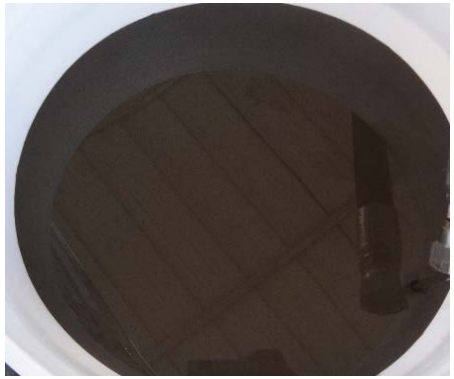
# Example Feedstock Characteristics

| 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

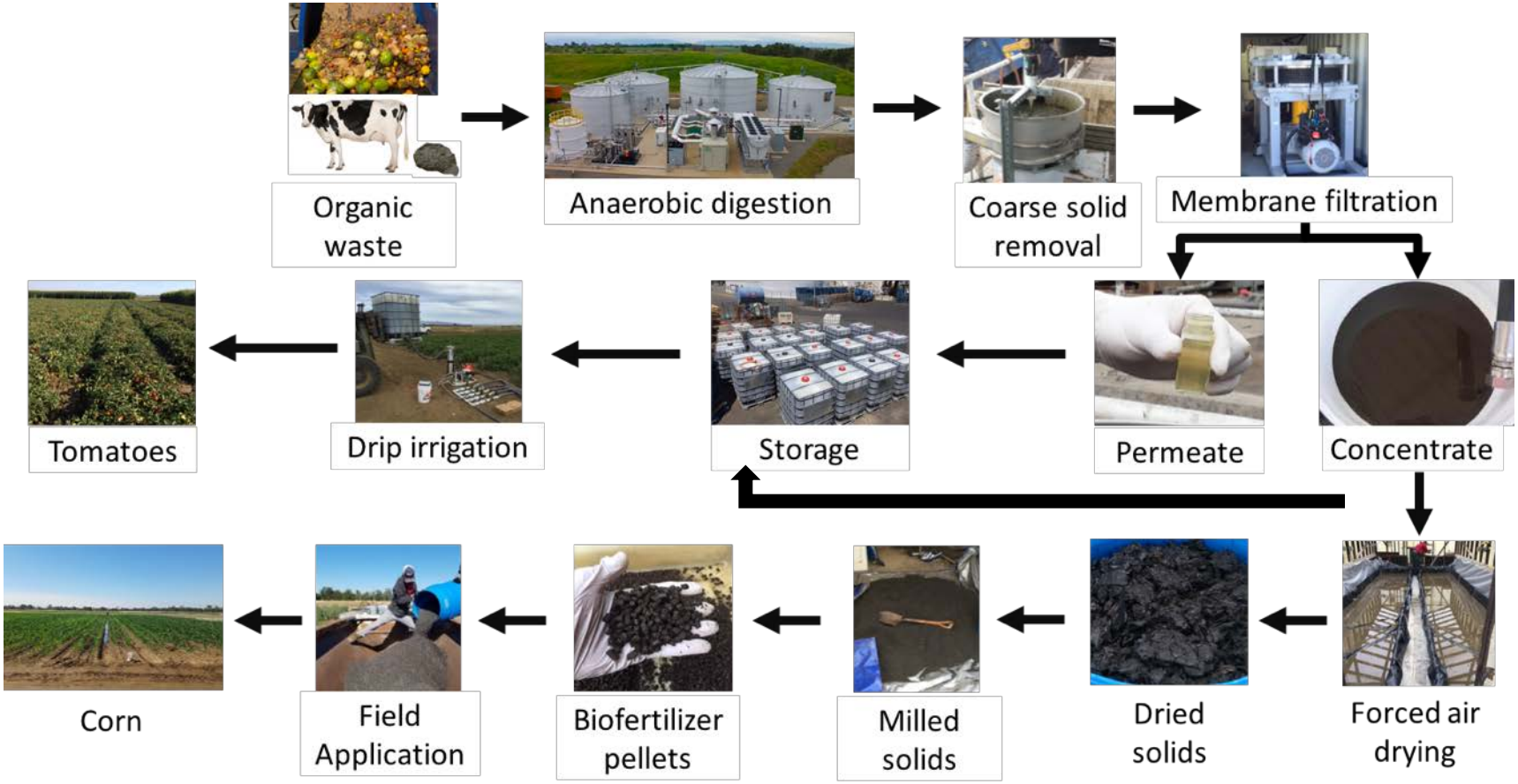
*UC Davis READ Food Waste Digester*

**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



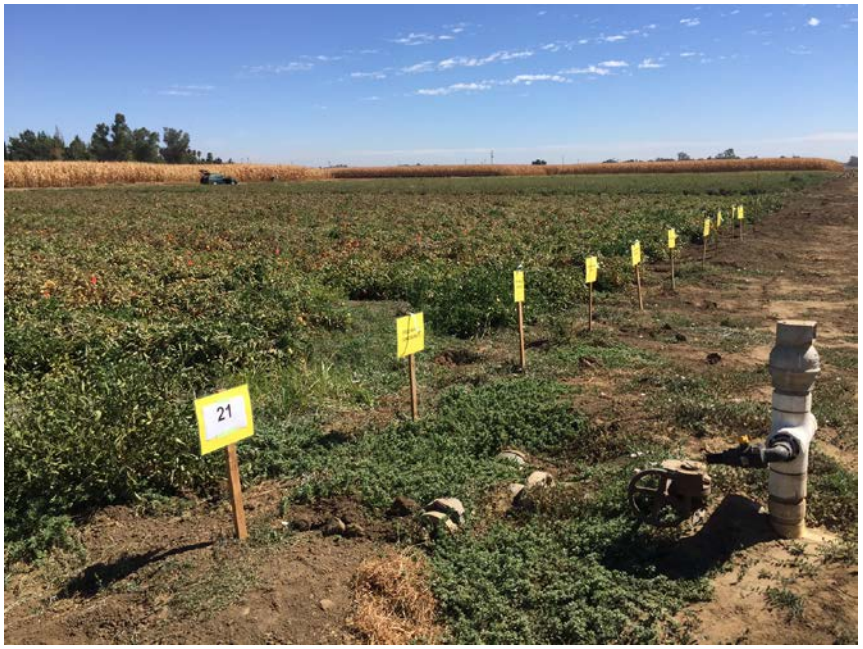
# Raw Digestate Characteristics

| 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

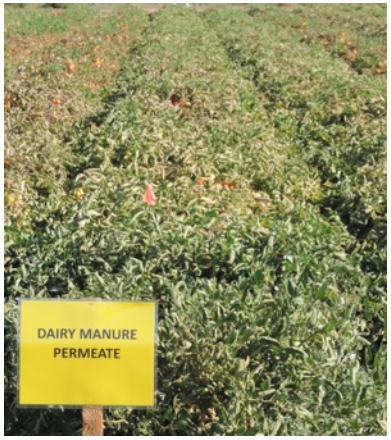
**Analyses**

Biomass yields (fruit and plant)

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

# Plant Comparison

Ultrafiltered Dairy Manure Digestate

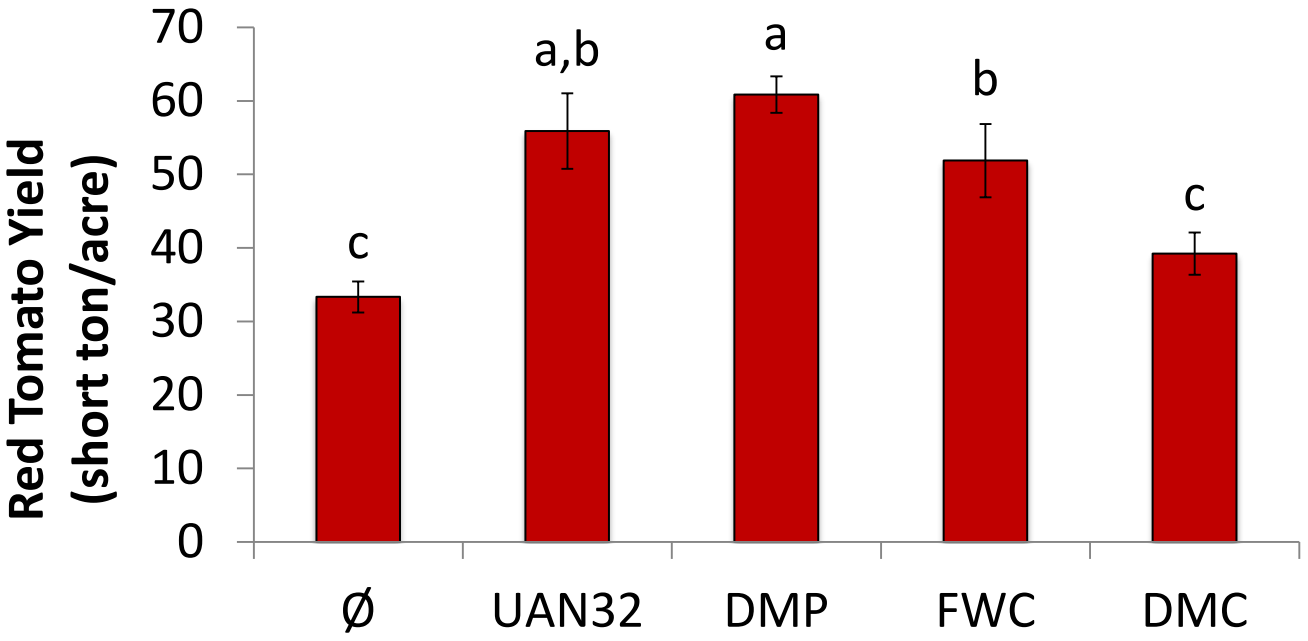



Concentrated Food Waste Digestate


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

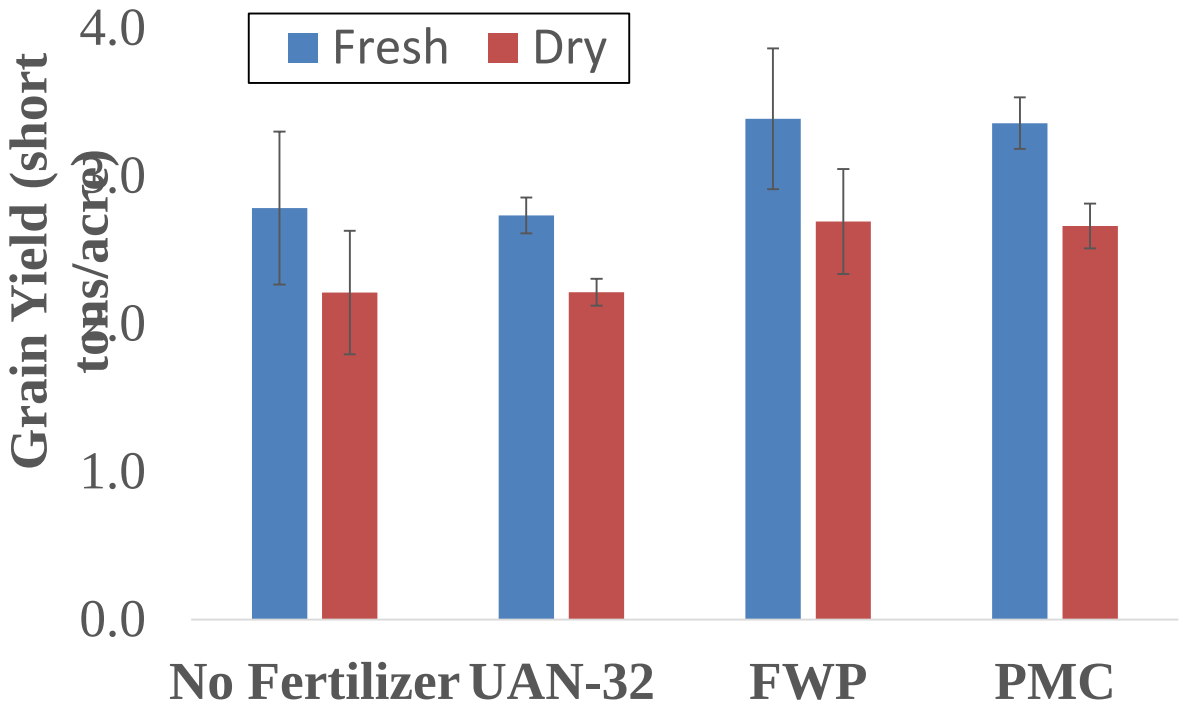
# Food waste digestate pellet composition

| 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.

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