Dairy Lagoon Nutrient Extraction with Vermicomposting

WORC Annual Conference
Introduction of Royal Dairy, home of the Worm BIDA system

General Challenges of Dairy Industry

Solutions to Royal Dairy...worms

How BIDA works

Byproduct-Worm Castings

Worm Casting Applications
ROYAL DAIRY OVERVIEW

350,000 lbs of milk a day

850,000 lbs of feed per day

750,000 lbs of manure created per day, including winter months

150,000 gallons avg of new water used daily for cows drinking and parlor cleaning

All water that comes on our dairy footprint either flows to our capture system or our asphalt containments and is then put through the process

Dry cows and young stock raised on site

⅔ Free stall flush ⅓ open lot vacuum
Cows Eat Animal Feed and Poop Plant Feed

COWS ARE CRUCIAL TO SUSTAINABLE AGRICULTURE!

WE NEED TO UTILIZE THE NUTRIENTS FROM COWS BETTER, ESPECIALLY THAT WITHIN THE LIQUID
## Getting More Out of Liquid Manure Using Feed Manure Milk

<table>
<thead>
<tr>
<th>Feed</th>
<th>Manure</th>
<th>Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>67% Expenses</td>
<td>8% Expense</td>
<td>98% Revenue</td>
</tr>
<tr>
<td>Revenue</td>
<td>8% Expense on Liquid Manure</td>
<td></td>
</tr>
</tbody>
</table>

The cow's digestive process turns that feed into a valuable soil feed, we need to figure out how to process and utilize it better.

Most of that expense is in the liquid manure, solid manure turned to compost is a break even for the dairy, is an asset to the farm but not enough to pay the dairy much on top of handling cost.

Goal is to take the nutrients out of the water and use them properly as an asset to create revenue and improve farming. Use the water for irrigation.
Dairy Challenges

Lagoons.. likely the biggest challenge for a dairy farmer today

Agronomically disposing of nutrient rich dairy liquid

Lots of land needed, lots of trucks on the road, shipping lots of water

Pre worms=4,000 acres needed for 50,000,000 gallons of water a year

Jury is still out on Nutrient Dairy Water, Science still in the air to show how much is agronomical

Lagoon=biggest source of odor and methane gas on the dairy

Reusing dirty water to clean pens is less effective
Worms Pulling out the Nutrients

Through the Biological Passive Flow through the BIDA system the vast majority of these plant nutrients can be pulled out of the water and digested by worms to make a very effective plant food.
How Biofiltro Works

BIDA® System Patented Process

"Method and system for inoculating bacteria in contaminated water using earthworm humus"

US 7,540,960
Filed in 2007
Issued in 2009

https://vimeo.com/21424089
81,000 square feet
200,000 gallons a day
Runs aprox 7 minutes per hour, in the cold it’ll run 1 minute per 15 minutes
Aprox 4 hours from sprinkler to irrigatable water
At peak about 500 worms per square foot
The Biology Within

Worms

- Solids
- Burrow - Aerate and Saturate
- Neutralize pH (5 - 8)
- 6-10 year lifespan
- ~ 4 Cocoons Per Week
- Microbe rich castings - benevolent
- Stabilization

Industry Specific Microbes

- Target soluble and dissolved solids
- Billions of colonies

Symbiotic relationship forms biofilm, a dynamic external digestive layer, across the system medias for...
Royal Dairy, Royal City, WA (2015)
Dairy Farm
Phase 1: 6,000 GPD
Phase 2: 200,000 GPD (To Be Completed in Summer 2017)

<table>
<thead>
<tr>
<th></th>
<th>LAGOON</th>
<th>AFTER BIDA</th>
<th>EFFICIENCY</th>
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<tbody>
<tr>
<td></td>
<td>TSS (mg/L)</td>
<td>TSS (mg/L)</td>
<td>% removal TSS</td>
</tr>
<tr>
<td>1</td>
<td>14,560</td>
<td>144</td>
<td>99%</td>
</tr>
<tr>
<td>2</td>
<td>19,940</td>
<td>1,620</td>
<td>92%</td>
</tr>
<tr>
<td>3</td>
<td>2,446</td>
<td>1,14</td>
<td>95%</td>
</tr>
<tr>
<td>4</td>
<td>29,180</td>
<td>2,600</td>
<td>91%</td>
</tr>
<tr>
<td>5</td>
<td>35,320</td>
<td>290</td>
<td>99%</td>
</tr>
<tr>
<td>6</td>
<td>14,680</td>
<td>514</td>
<td>96%</td>
</tr>
<tr>
<td>7</td>
<td>23,860</td>
<td>332</td>
<td>99%</td>
</tr>
<tr>
<td>8</td>
<td>21,890</td>
<td>490</td>
<td>98%</td>
</tr>
<tr>
<td>9</td>
<td>25,200</td>
<td>278</td>
<td>99%</td>
</tr>
<tr>
<td>10</td>
<td>22,420</td>
<td>252</td>
<td>99%</td>
</tr>
<tr>
<td>11</td>
<td>13,060</td>
<td>447</td>
<td>97%</td>
</tr>
<tr>
<td>Average</td>
<td>22,011</td>
<td>697</td>
<td>97%</td>
</tr>
</tbody>
</table>
Water Treatment

Average of 10+ samples of pilot and full scale system

99% Removal of TSS

90% Removal of TN

70% Removal of TP

99% Removal of FECAL COLIFORM

70+% Reduction in Greenhouse Gasses
We treat aprox 200,000 gallons a day

4000 acres down to 250 acres needed for same amount of water
Castings

Take about 1 year for worms to convert the top foot of the filter to castings, this top foot is where a majority of the nutrients out of the water will be.

Harvest about 2,500 yards or 1,000 tons every 18 months

Harvest using an excavator we skim off the first 1’ - 2’ of casting on top of filter

We will then use a traumel screen to separate out some worms and put them back in the system if needed
**Assay Name** | **Result** | **Units** | **Desired Level** | **Commentary**
---|---|---|---|---
Light | 0.61 | N/A | 0.20 to 0.80 | Within normal moisture levels.
Active Fungi | 1.64 | μg/g | > 3.00 | Fungal activity low, foods may be required.
Total Fungi | 237.64 | μg/g | > 300.00 | Low fungal biomass, inoculum and foods may be required. Fairly good fungal diversity, hyphal diameter: 1.5 to 6um
Hyphal Diameter | 2.90 | μm | > 2.50 | Good balance of fungi.
Active Bacteria | 38.05 | μg/g | > 3.00 | Bacterial activity within normal levels.
Total Bacteria | 708.15 | μg/g | > 300.00 | Good bacterial biomass.
Actinobacteria | 15.03 | μg/g | < 50.00 | 

**Organism Biomass Ratios**

| Assay Name | Ratio | Range | Commentary |
---|---|---|---|
TF:TB | 0.34 | 0.01 to 10.00 | Balanced fungal and bacterial biomass.
AF:TF | 0.01 | < 0.10 | Good fungal activity.
AB:TB | 0.05 | < 0.10 | Good bacterial activity.
AF:AB | 0.04 | 0.01 to 10.00 | Bacterial dominated, becoming more bacterial.

**Protozoa (Protists)**

| Assay Name | Result | Units | Desired Level | Commentary |
---|---|---|---|---|
Flagellates | 76,028.77 | number/g | > 10,000.00 | Should provide a good inoculum of protozoa.
Amoebae | 760,287.73 | number/g | > 10,000.00 | 
Ciliates | 4,577.24 | number/g | < 8363.00 | 
Nitrogen Cycling Potential | 300+ | lbs/acre | Nitrogen levels dependent on plant needs. Estimated availability over a 3 month period |

**Nematodes**

| Assay Name | Result | Units | Desired Level | Commentary |
---|---|---|---|---|
Nematodes | 2.45 | number/g | > 10.00 | Low numbers and diversity.
Bacterial | 2.25 | number/g | 
Fungal | 0.00 | number/g | 
Fungal/Root | 0.20 | number/g | 
Predatory | 0.00 | number/g | 
Predatory | 0.00 | number/g |
Root | 0.60 | number/g |
For interpretation of this report please contact your local Soil Steward or the lab.

<table>
<thead>
<tr>
<th>Nematode Genus</th>
<th>number/g</th>
<th>Units</th>
<th>Group</th>
<th>Common Name</th>
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</thead>
<tbody>
<tr>
<td>Butlerius</td>
<td>0.13</td>
<td>number/g</td>
<td>Bacterial Feeders</td>
<td></td>
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<tr>
<td>Cucicircularia</td>
<td>0.07</td>
<td>number/g</td>
<td>Bacterial Feeders</td>
<td></td>
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<tr>
<td>Diploscapter</td>
<td>0.40</td>
<td>number/g</td>
<td>Bacterial Feeders</td>
<td></td>
</tr>
<tr>
<td>Monhystrella</td>
<td>0.46</td>
<td>number/g</td>
<td>Bacterial Feeders</td>
<td></td>
</tr>
<tr>
<td>Rhabditidae</td>
<td>1.19</td>
<td>number/g</td>
<td>Bacterial Feeders</td>
<td>Stem &amp; Bulb nematode</td>
</tr>
<tr>
<td>Ditylenchus</td>
<td>0.20</td>
<td>number/g</td>
<td>Fungal/Root Feeders</td>
<td></td>
</tr>
</tbody>
</table>
35 Seeds to start
Castings Application

Use Raw Castings for more efficient plant growth

Mix castings with compost for agriculture application

Introduce fungi and other ingredients into castings to make a better casting

Use worm castings to make a worm tea
SUMMARY

After BIDA we have Clean Water to irrigate with through our circles

We have Castings and Compost to work with to advance our farming practices

We reduce our greenhouse gasses and odor
QUESTIONS???

https://vimeo.com/214224089

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