MANURE MANAGEMENT
CHALLENGES OF LIQUID
SYSTEMS AND AN OVERVIEW
OF THE COMPOST
BEDDED PACK SYSTEM

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Challenges That Milk Producers Confront

- **Cost of production** (particularly for small herd)
  - Feed
  - Energy
  - Capital
  - Bedding

- **Cow Productivity**

- **Environmental impacts**
  - Water quality
  - Air quality (odor and GHG)

- **Animal welfare**
  - Quality of life
  - Health

- **Milk quality**
  - Reduced somatic cell counts
Dairy facilities in KY are a significant source of water pollution.

-- Ky DOW
Animal Waste Management Systems

Total Systems

A total system accounts for all the waste associated with an agricultural enterprise throughout the year from production to utilization. It is the management of all the waste, all the time, all the way.
Manure Handling Systems

The best system is a compromise that depends on:
- Personal preferences
- Available labor
- Available capital
- Soil type
- Cropping practices
- Amount of manure produced
- Applicable regulations
- Etc.
Discharge from Waste Storage
Discharge Elimination
Discharge Elimination
Discharge Elimination

Feedlot
Unguttered roof

Overgrazed exercise lots
Discharge Elimination

Storage Runoff
Discharge Elimination

Cow cooling
sprinkler water
Water Pollution Sources on Dairy Farm?

- Concrete alleyway
- Feedlot runoff
- Pasture heavy use area runoff
- Silage leachate
- Semi-solid/solid manure (w/wo sand)
- Liquid parlor wastes
- Covered solid manure stack pad
- Concrete alleyway feedlot runoff
- Pasture heavy use area runoff
- Liquid parlor wastes
- Covered solid manure stack pad
The site can be more complicated to manage waste streams
The site can be simpler to manage waste streams
Storage Ponds
Bedding Type Impact On Waste System
berm erosion

inadequate free board

tree growth on berm

Storage Ponds - Maintenance
Impact of Injection Tool on Residue Coverage
Manure Application
Nitrogen Losses

Because of microorganisms without oxygen

- Manure organic-N
  - Ammonia-N
    - Nitrogen Gas-N$_2$

Lost to Atmosphere
Nutrient Levels in Dairy Manures Are Highly Variable

<table>
<thead>
<tr>
<th>Manure Type</th>
<th>Total Nitrogen N</th>
<th>Ammonium NH₄-N</th>
<th>Phosphorus P₂O₅</th>
<th>Potassium K₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot-scraped manure (lb/ton)</td>
<td>10</td>
<td>3</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>range</td>
<td>(3 to 20)</td>
<td>(2 to 15)</td>
<td>(0.6 to 13)</td>
<td>(2 to 20)</td>
</tr>
<tr>
<td>Liquid manure slurry (lb/1,000 gal)</td>
<td>22</td>
<td>9</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>range</td>
<td>(8 to 50)</td>
<td>(4 to 13)</td>
<td>(0.2 to 38)</td>
<td>(0.7 to 50)</td>
</tr>
<tr>
<td>Anaerobic lagoon sludge* (lb/1,000 gal)</td>
<td>15</td>
<td>6</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>range</td>
<td>(3 to 42)</td>
<td>(1 to 12)</td>
<td>(2 to 64)</td>
<td>(2 to 20)</td>
</tr>
<tr>
<td>Anaerobic lagoon liquid (lb/acre-inch)</td>
<td>137</td>
<td>88</td>
<td>77</td>
<td>195</td>
</tr>
<tr>
<td>range</td>
<td>(17 to 268)</td>
<td>(22 to 130)</td>
<td>(10 to 233)</td>
<td>(13 to 571)</td>
</tr>
</tbody>
</table>

Source: Biological & Agricultural Engineering Department, North Carolina State University, 1980 to 1990.

For planning purposes, yearly manure testing will give you the nutrient content trend of your operation if there is no significant changes.
## Compare Crop Nutrient Needs to Nutrients Supplied by Manure

<table>
<thead>
<tr>
<th>Corn Crop Need</th>
<th>Fresh Dairy Manure</th>
<th>Stack Pad</th>
<th>High Solids Liquid</th>
<th>Lagoon</th>
<th>Compost Bed</th>
</tr>
</thead>
<tbody>
<tr>
<td>#/Ac</td>
<td>#/Ac</td>
<td>Ratio to P</td>
<td>Ratio to P</td>
<td>% loss</td>
<td>Ratio to P</td>
</tr>
<tr>
<td>N</td>
<td>150</td>
<td>N</td>
<td>150</td>
<td>11.5</td>
<td>6</td>
</tr>
<tr>
<td>P</td>
<td>30</td>
<td>P</td>
<td>13</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>K</td>
<td>50</td>
<td>K</td>
<td>42</td>
<td>3.2</td>
<td>2.7</td>
</tr>
</tbody>
</table>
Costs and Economics of Manure Handling System

- A complete economic analysis may not support the selection of the lowest capital MANURE MANAGEMENT SYSTEM.
- Manure handling system should be viewed as a COST CENTER not a PROFIT CENTER.
- Do not limit your ability to expand a system or that you can afford now to the system that is ideal.
New Concept in Dairy Cow Housing

Compost Bedded Loose Housing Dairy Barn
The **COMPOST BEDDED LOOSE HOUSING BARN** and the solid composted waste is an important alternative manure management practice to allow flexibility in utilization of plant nutrients and organic matter for soil fertility.

**OTHER ENVIRONMENTAL BENEFITS:**
- Improved air quality – odor, GHGs (?)
- Reduced fly populations
Non-Confinement Grazing
Confinement - Freestalls
Confinement - Bedded Pack
Loose Housing Barn
Success for the dairyman is based on both the management of the bed and the interaction of the bed and the surrounding managed environment within the structural envelope.

Compost Bedded Pack
Loose Housing Dairy Barn
General
Compost
Barn Layout

- compost pack resting area
  - $200' \times 50' = 10,000 \text{ ft}^2$
  - $100 \text{ ft}^2$ per cow = 100 cows

- concrete wall
  - 4' high, 2 waterers

- walkway
- feed alley
- drive-by feed manger with 6' roof overhang
History of the Compost Bedded Pack

- Concept introduced in Virginia in late 1980s by producers
- Kentucky’s first barn built in 2002 in Monroe County
- In 2008 there were approximately 30 barns in Kentucky, in Feb 2011 there were 60
- Today we know of 80 barns in Kentucky
This cow is in deep sleep

Is this good or bad?
This is hottest day in 2012

Is this good or bad?
Potential Benefits

- Improved cow comfort
- Lower somatic cell count
- Less clinical mastitis
- Increased milk production
- Reduced lameness
- Improved hoof health
- Less hairy heel warts?
- Increased cow longevity
- Reduced culling rates
- Improved heat detection
- Reduced odor
- Reduced fly population
- Improved consumer acceptance?
Potential Liabilities

- Mastitis
- Availability of sawdust
  - Considered the best type bedding
- Only for small producers (??)
- Heat production in hot weather that increases heat stress
- Poor understanding of bed and barn management leading to significant costs to operation
The “Ideal” Composting Process

Carbon
Nitrogen
Inorganics
Water
Microorganisms

Water
Heat
CO₂

NH₃
N₂O

O₂

Organic Matter
Inorganics
Microorganisms
Temperature Dynamics

Adding feces, urine and bedding continuously changes static bed composting process.
Stirring the Bed

2 x per day religiously

Rototiller tillage depth 6-8”

10-12” stirring depth with deep tillage
Compost Bedded Pack

- Aerobic Zone
- Aerobic/Anaerobic Transition Zone
- Anaerobic Zone

- Ventilation/Circulation Air

- Depth of Compost Bed:
  - 24 to 48"
  - 10 to 12"

- Temperature, °F
  - Ambient
  - 120 - 140 F
Pack Moisture Control

- Biological activity generates heat which helps to dry the bedding material.
- Bedding cannot absorb all the water from urine and manure without evaporation of water.
- Too wet of a bedded pack reduces aeration, slows biological activity, slow heat generation and water evaporation. Unless area per cow more than doubles in winter.
COMPOSTING BED MATERIAL INCREASES WATER EVAPORATION

INCREASING AIR VELOCITY OVER BED MATERIAL INCREASES WATER EVAPORATION
Heat Losses from Compost Bedded Pack

- Radiation
- Ventilation/Circulation Air
- Evaporation and Convection
- Conduction
Questions?
Good bedding choices:

- Cow comfort
  - Cow spend time to lie down and ruminate
  - Bedding must to be comfortable to lie on
- Farmer comfort
  - Nonabrasive bedding
  - Reduced infection of mastitis organisms
  - Reduced pathogen growth
  - Keep the cows clean
  - Limit growth of pathogens
  - Bedding must to be comfortable to lie on
The Composting Process

Water

Heating

CO₂

CH₄  N₂O

--Greenhouse Gases

Feces
Urine
Bedding

Micro-organisms

Raw Materials

Compost Pile

Finished compost

Organic matter, minerals, water, microbes

O₂
Cow Comfort Issues in Freestall Barns

- Lamps
- Fans
- Headlocks
- Feed driveway
- Stall
- Waterers
- Sand
- Inadequate positioning of stall hardware
- Hard lying surface
- Limited space
- Skin wounds
- Digital dermatitis
- Hock lesion
Irrigation
• outside lot runoff
• milking center waste water
• silage leachate
• building wash down water
• stock trailer and manure equipment wash down water