

Curry County, NM from 25,000 m

150 mi²

11 large dairies



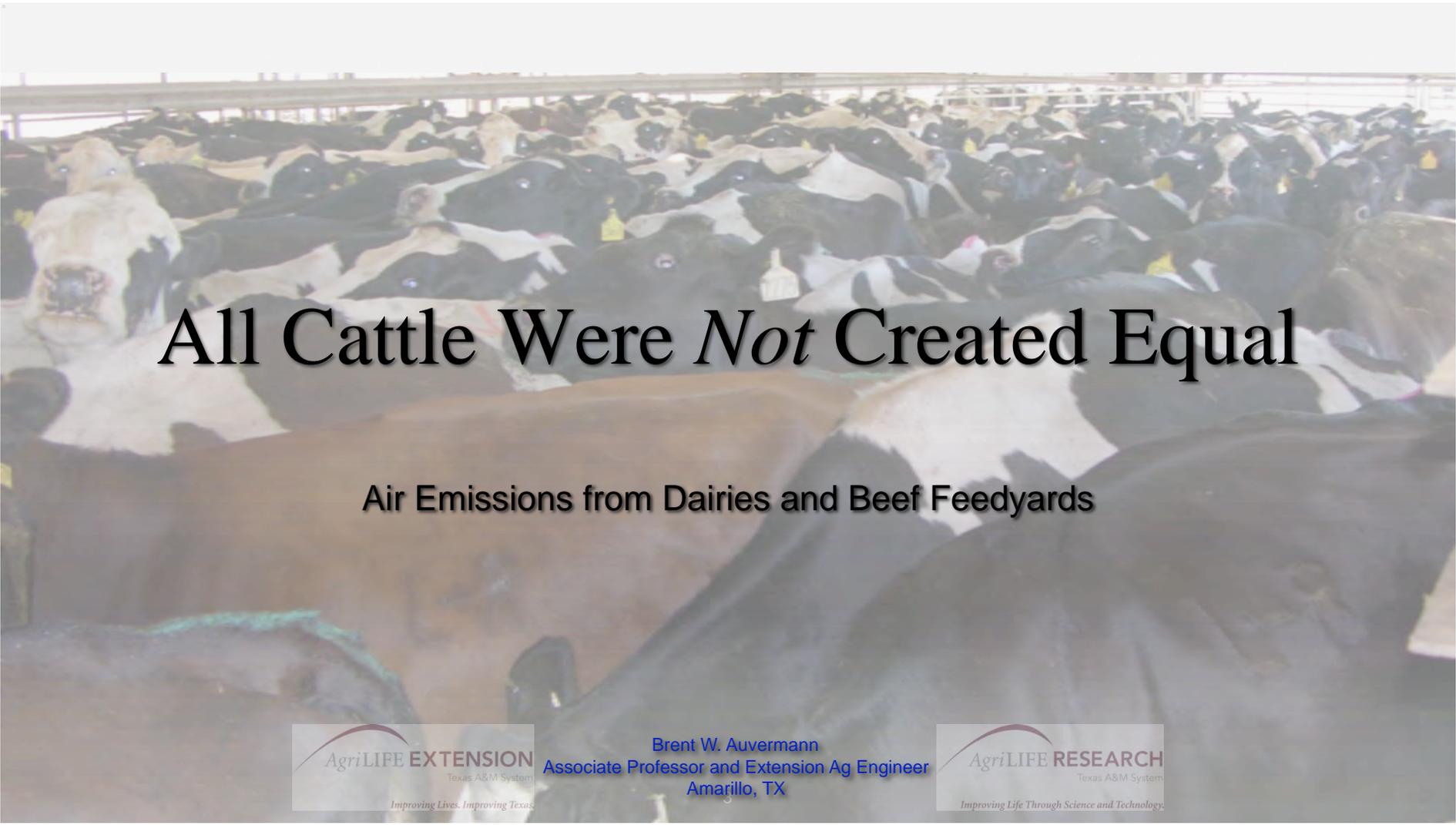
Curry County, NM from 25,000 m

150 mi²

11 10 large dairies

1 large feedlot





All Cattle Were *Not* Created Equal

Air Emissions from Dairies and Beef Feedyards



Brent W. Auvermann
Associate Professor and Extension Ag Engineer
Amarillo, TX



What We Need to Accomplish

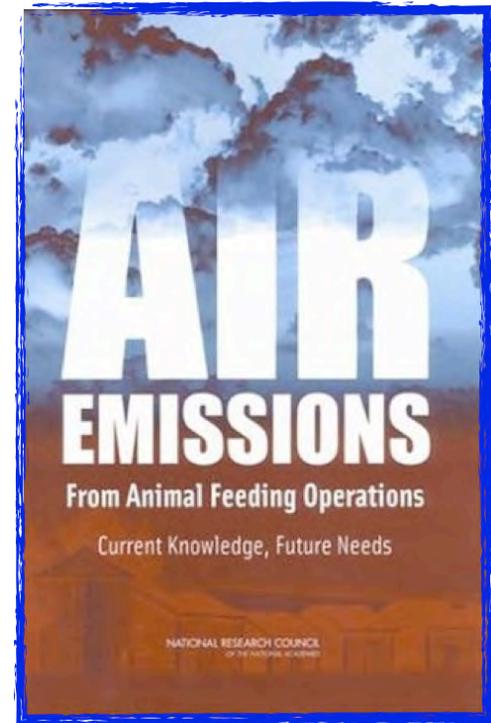
- Emission factors for dairies: should they be derived from those for cattle feedyards?
 - If so, what are the limitations?
 - If not:
 - Why not?
 - What are the implications of doing it anyway?

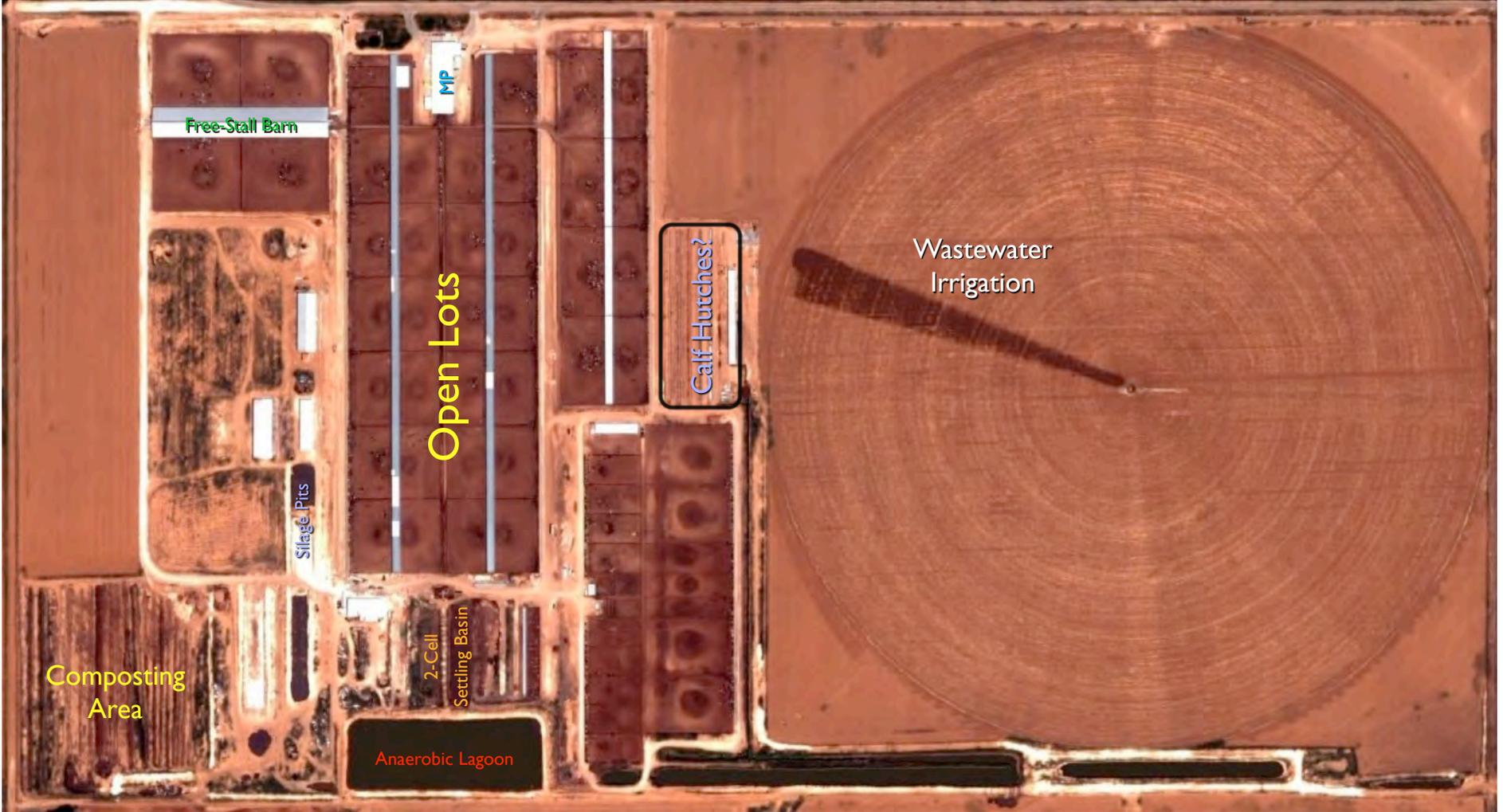
Emission Terms, Defined

- Emission RATE
 - how much NET MASS is released per unit time?
 - applies to point sources, whole sources, or whole facilities
- Emission FLUX
 - how much net mass is released per unit time per unit area?
 - applies to area sources
- Emission FACTOR
 - how much net mass is released per unit throughput or capacity?

It's Time to Move On

- An EMISSION FACTOR paradigm implies (to the uninitiated, at least) that **all cattle are created equal**
- “pounds per thousand head per day” does not account explicitly for the **wide variety of emissions processes**
- The NRC has been calling for “**process-based modeling**” to supplant the EF paradigm





Free-Stall Barn

MP

Open Lots

Calf Hutches?

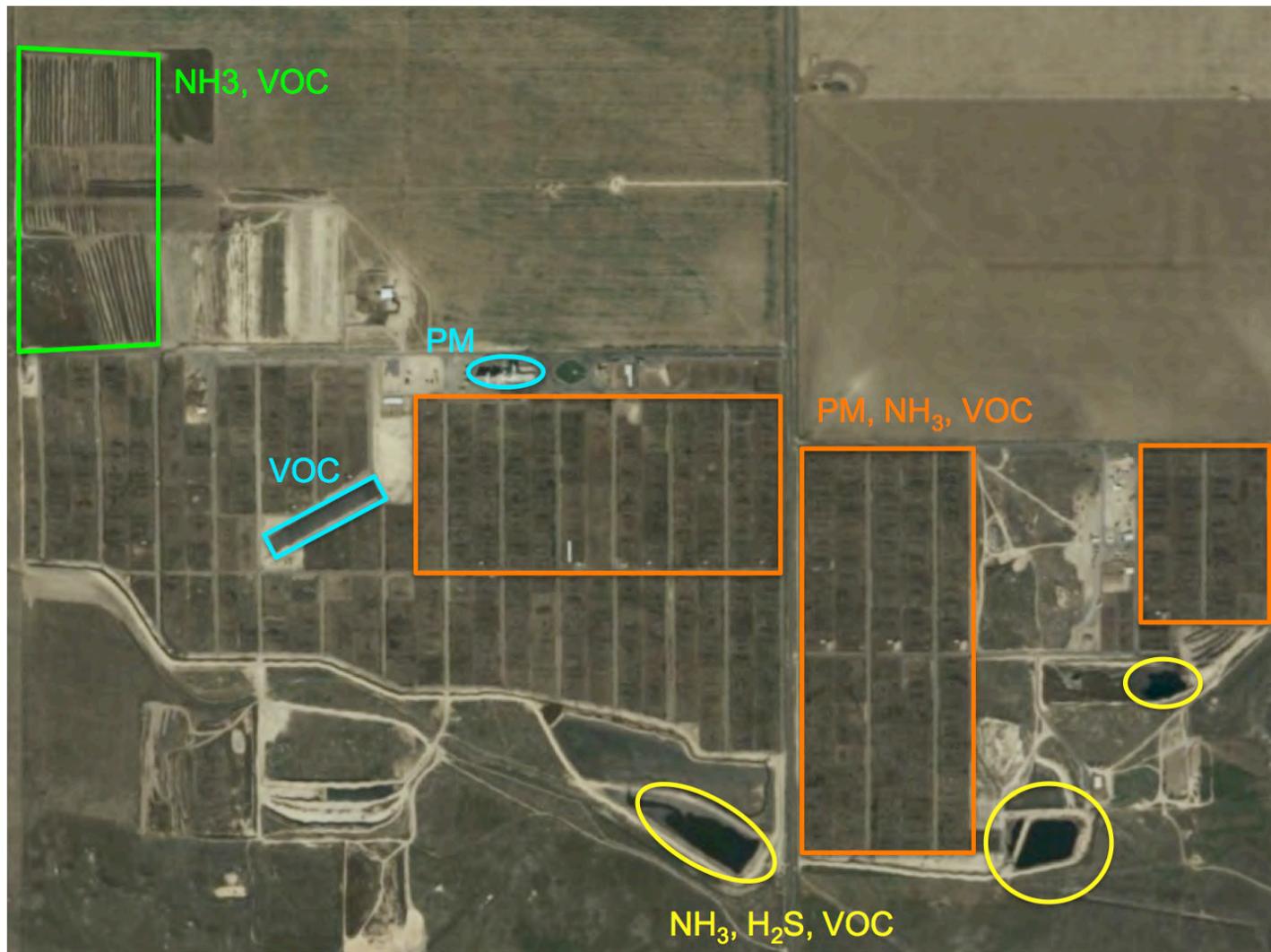
Wastewater Irrigation

Silage Pits

2-Cell Settling Basin

Anaerobic Lagoon

Composting Area



Emission Factors: Guiding Principles

- EFs should be expressed in units that correspond to the most process-congruent way of normalizing (or scaling) emissions

SOURCE/ QUANTITY	NO (and why not)	YES
Feed Mill PM ₁₀	lb PM ₁₀ /hd-d (multiple diet formulations)	lb PM ₁₀ per ton of grain handled
Open-Lot NH ₃	lb NH ₃ -N/ft ² -d (multiple diets; varying stocking density)	% of nitrogen fed
Lagoon H ₂ S	lb H ₂ S/hd-d (multiple diets; varying stocking density)	lb H ₂ S/ac-d or % of sulfur fed
Open-Lot PM ₁₀	lb PM ₁₀ /ac-d (varying stocking density)	lb/hd-d
Whole-AFO PM ₁₀	(dissimilar source types - roads, corrals, feed handling)	don't do it at all

Emission Factors: Guiding Principles

- EFs should be expressed in units that correspond to the most process-congruent way of normalizing (or scaling) emissions
- Process-level EFs enable discrimination of source types to account for process-specific abatement measures and BMPs

It Depends

- Q: “We’ve got an air-pollution problem along the border. How much _____ is coming from the dairies in that area?”
- Sometimes ya just gotta say it: IT DEPENDS
- “Let’s just assume the beef feedlot numbers” is NEVER the right answer

	Beef	Dairy	Net Effect
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Feed DM Conversion	~ 6-8 lb DM intake/ lb gain	~1.4 lb milk/lb DM intake	Affects excretion and accumulation rate of manure total solids

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Dairy

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Typical DM, H₂O
Intake

22-25 lb/hd/d;
10-14 gpd/hd

40+ lb/hd/d; 20-24
gpd/hd

Manure accumulation
and water balance
affected via stocking
density

Beef

Dairy

Net Effect

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~ 6-8 lb DM intake/lb gain

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Typical DM, H₂O Intake

22-25 lb/hd/d; 10-14 gpd/hd

40+ lb/hd/d; 20-24 gpd/hd

Manure accumulation and water balance affected via stocking density

NRC Dietary CP*

12.5-14.0%

17-19%

NH₃ emissions highly sensitive to N-use efficiency, which is sensitive to “insurance” protein

	Beef	Dairy	Net Effect
N Use Efficiency	~10%	23-27%	Dairy emits less NH ₃ per unit N fed

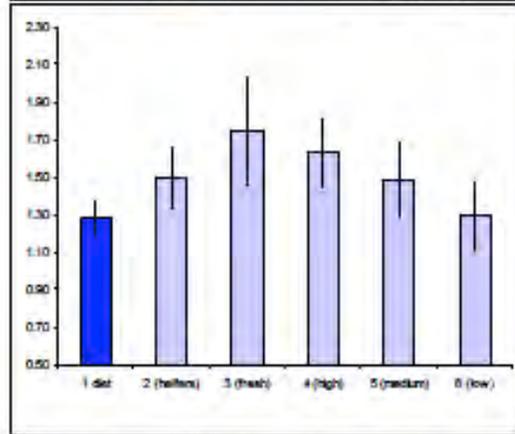
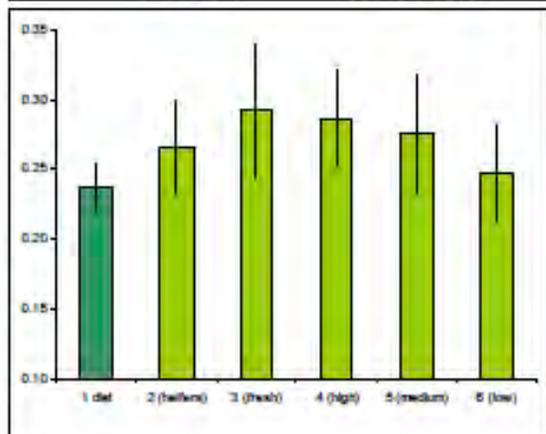
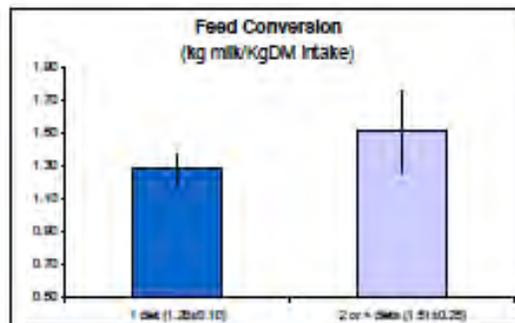
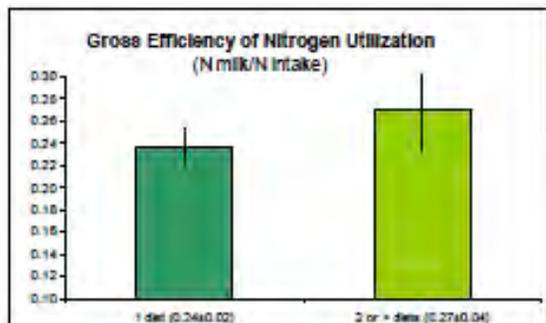


Figure 1: Relationship between the number of diets for lactating animals and gross efficiency of N utilization

Figure 2: Relationship between the number of diets for lactating animals and feed conversion

Castillo, Santos, and Kirk
(2005)
J. Dairy Sci. 83 Suppl. 1

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Demonstrated Efficacy of Precision Diet Formulation	YES	YES	More pervasively used in dairy

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Bovine?	YES	YES	n/a

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Process Wastewater	Minimal	May be considerable	Chronically wet manure has greater odor, H ₂ S, RVOC potential
Hydraulic Manure Handling	Not pervasive	Pervasive; effluent may be recycled	

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Open-Lot Shading	Not pervasive	Pervasive	

What Does the Research Say?

POLLUTANT	Beef	Dairy	Notes
<p>PM₁₀ (lb/1,000 hd-d)</p>	<p>9-70 (numerous sources)</p>	<p>4.4 (TAMU); 6.7 (CARB); 11.5 (SJVAPCD, FSB); 26.5 (SJVAPCD, OL)</p>	<p>EPA vacated the AFO emission factors in AP-42 in the most recent revision; SJVAPCD recognizes differences between FSBs and open lots; no interspecies difference in PM₁₀/TSP ratio</p>
<p>NH₃-N</p>	<p>40-55% of N fed (numerous sources)</p>	<p>0.047 lb/hd-d (Mukhtar et al., 2008) 0.098 lb/hd-d (Flesch et al., 2009)</p>	<p>Dairy range 0.0074-0.258 across multiple authors; most dairy results not expressed in terms of % of N fed; beef values appear to be less variable (due to fewer permutations of sources?)</p>
<p>H₂S (lb/1,000 hd-d)</p>	<p>~9 (Casey, 2008)</p>	<p>0.07 to 60</p>	<p>Oregon DEQ chose 15.7 for dairy; dairy estimates span 3 orders of magnitude; open lot emission fluxes are low, but aggregate rate is >75% of total; per-head basis not satisfactory for open lots</p>

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- “pounds per thousand head per day” does not account explicitly for the **wide variety of emissions processes**
- The NRC has been calling for “**process-based modeling**” to supplant the EF paradigm
- EFs may be **OK for inventories, but not permitting!**

