

Ammonia Emissions Estimator (Daily Version)

Rick Koelsch and Rick Stowell, University of Nebraska

Farm name: Make-a-Steak Ranch, South-Central Nebraska

Animal species and production stage ¹	Capacity (number of animals)
<u>Beef cattle, finishing</u>	Max.: <u>1,000</u> Average: <u>950</u>

Step 1: Estimate % ammonia loss from:

Animal housing: Describe housing: Open dirt lots Insert range from Table 1: 40-60%

Manure storage: Describe storage: Temporary stockpiles (for solids) Insert range from Table 2: 10-20%
Runoff holding ponds 2-3%

Step 2. Estimate % ammonia loss from the animal housing and storage system (use high and low values from Step 1):

$$\text{Ammonia loss (\%)} = \text{Housing \% loss} + [(100 - \text{Housing \% loss}) \times \text{Storage \% loss} / 100]$$

$$\text{Ammonia loss (\%)} = \underline{60} \quad \underline{40} + [(100 - \underline{60} \quad \underline{40}) \times \underline{20} \quad \underline{10} / 100]$$

$$\text{Ammonia loss (\%)} = \underline{60} + \underline{8} = \underline{68} \% \text{ [w/high-end values]} \quad = \underline{40} + \underline{6} = \underline{46} \% \text{ [w/low-end values]}$$

Made a simplifying assumption that remaining N from the lots all came off in the solids, which maximizes storage NH₃ losses.

Step 3. Identify the animal species row in Table 3 (along left side) that is most relevant to this estimation, and the ammonia loss (%) column that best matches the estimated ammonia loss from Step 2. Find where this row (appropriate species) and this column (appropriate ammonia loss) intersect and record this value:

$$\text{Unit ammonia loss} = \underline{0.30} \text{ lbs/animal/day [w/high-end value]} = \underline{0.20} \text{ lbs/animal/day [w/low-end value]}$$

Step 4. Estimate the upper bound of daily herd/flock ammonia loss.

$$\text{Daily herd ammonia loss} = \text{Max. (permitted) capacity} \times \text{Unit ammonia loss (Step 3)}$$

$$\text{Daily herd ammonia loss} = \underline{1,000} \text{ animals} \times \underline{0.30} \text{ lbs/animal/day}$$

$$\text{Peak ammonia loss} = \underline{300} \text{ lbs ammonia per day}$$

Step 5. Estimate the lower bound of daily herd/flock ammonia loss. Repeat Steps 2-3 using the low-end values.

$$\text{Daily herd ammonia loss} = \text{Average capacity} \times \text{Unit ammonia loss (new Step 3 value)}$$

$$\text{Daily herd ammonia loss} = \underline{950} \text{ animals} \times \underline{0.20} \text{ lbs/animal/day}$$

$$\text{Minimum ammonia loss} = \underline{190} \text{ lbs ammonia per day}$$

Table 1. Typical ammonia losses from animal housing facilities expressed as a percentage of excreted manure nitrogen.²

Facility Description	Applicable Species	% Loss	Facility Description	Applicable Species	% Loss
<u>Open dirt lots (cool, humid region)</u>	Beef	30 - 45	Roofed facility (stacked manure under floor...includes storage loss)	Egg producing birds	25 - 50
<u>Open dirt lots (hot, arid region)</u>		<u>40 - 60</u>			
Open dirt lots (cool, humid region)	Dairy	15 - 30	Roofed facility (bedded pack)	Swine, beef, and dairy	20 - 40
Open dirt lots (hot, arid region)		30 - 45			
Roofed facility (flushed or scraped)	Dairy	5 - 15	Roofed facility (litter)	Meat producing birds	25 - 50
Roofed facility (daily scrape and haul)	Swine				
Roofed facility (shallow pit under floor)	Swine Dairy	10 - 20	Roofed facility (deep pit under floor...includes storage loss)	Swine, beef, dairy	30 - 40

¹ If more than one species, production stage, housing system or manure handling system is present on a given site, perform Steps 1-5 for each species, stage and/or system and add resulting emissions together.

² Estimates from USDA NRCS Agricultural Waste Management Field Handbook and LPES Lesson 21: Manure Storage Structures.

Table 2. Typical ammonia losses from manure storage as a percentage of nitrogen entering facility.²

Facility Description	% Loss	Facility Description	% Loss
Temporary stacked manure (no turning)	10-20	Pit below slatted floor (included in Table 1 values)	0
Composted manure (no carbon amendment)	30 to 40	Earthen storage pit (minimal treatment)	20 – 35
Composted manure (significant carbon amendment)	5 to 10	Formed manure storage (bottom loaded)	10
Bedded Pack Manure (included in Table 1 values)	0	Formed manure storage (top loaded)	30
Runoff holding pond (precipitation runoff only) ³	2 - 3	Anaerobic Lagoon (significant treatment)*	65-75

² Estimates from USDA NRCS Agricultural Waste Management Field Handbook and LPES Lesson 21: Manure Storage Structures.

* Much of the lagoon loss can be due to denitrification (N₂ and N₂O), so the ammonia loss may only be half of what is shown.

Table 3. Estimates of ammonia nitrogen losses. Excretion estimates based upon 2005 ASABE Standard for typical animals.

Livestock and Poultry Species	Typical Nitrogen Excretion (lbs per animal per day)	Ammonia Loss (% of excreted nitrogen)								
		10%	20%	30%	40%	50%	60%	70%	80%	90%
--Estimated Ammonia Loss (lbs per animal per day)...converts N to NH ₃ by multiplying by 1.21--										
Beef - Finishing Cattle	0.36	0.044	0.087	0.13	0.18	0.22	0.26	0.31	0.35	0.39
Beef - Cow (confinement)	0.42	0.051	0.10	0.15	0.20	0.26	0.31	0.367	0.41	0.46
Beef - Growing Calf (confinement)	0.29	0.035	0.070	0.11	0.14	0.18	0.21	0.25	0.28	0.32
Dairy - Lactating cow - 100 lbs milk/day	1.04	0.13	0.25	0.38	0.51	0.63	0.76	0.88	1.0	1.1
Dairy - Lactating cow - 88 lbs milk/day	0.99	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.1
Dairy - Lactating cow - 70 lbs milk/day	0.83	0.10	0.20	0.30	0.40	0.50	0.60	0.71	0.81	0.91
Dairy - Lactating cow - 50 lbs milk/day	0.66	0.080	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72
Dairy - Dry cow	0.5	0.061	0.12	0.18	0.24	0.30	0.36	0.43	0.49	0.55
Dairy - Milk fed calves	0.017	0.0021	0.0041	0.0062	0.0083	0.010	0.012	0.014	0.017	0.019
Dairy - Calf	0.14	0.017	0.034	0.051	0.068	0.085	0.10	0.12	0.14	0.15
Dairy - Heifer	0.26	0.032	0.063	0.095	0.13	0.16	0.19	0.22	0.25	0.28
Dairy - Veal	0.033	0.0040	0.0080	0.012	0.016	0.020	0.024	0.028	0.032	0.036
Horse - Sedentary	0.2	0.024	0.049	0.073	0.097	0.12	0.15	0.17	0.19	0.22
Horse - Intense exercise	0.34	0.041	0.083	0.12	0.17	0.21	0.25	0.29	0.33	0.37
Poultry - Broiler	0.0025	0.00031	0.00061	0.00092	0.0012	0.0015	0.0018	0.0021	0.0024	0.0027
Poultry - Turkey (male)	0.0090	0.0011	0.0022	0.0033	0.0044	0.0055	0.0066	0.0077	0.0088	0.0099
Poultry - Turkey (females)	0.0054	0.00066	0.0013	0.0020	0.0026	0.0033	0.0040	0.0046	0.0053	0.0059
Poultry - Duck	0.0036	0.00044	0.00087	0.0013	0.0017	0.0022	0.0026	0.0031	0.0035	0.0039
Poultry - Layer	0.0035	0.00043	0.00085	0.0013	0.0017	0.0021	0.0026	0.0030	0.0034	0.0038
Swine - Nursery Pig(27.5 lb)	0.025	0.0031	0.0061	0.0092	0.012	0.015	0.018	0.021	0.025	0.028
Swine - Grow-finish (154 lb)	0.083	0.010	0.020	0.030	0.040	0.051	0.061	0.071	0.081	0.091
Swine - Gestating sow	0.071	0.0086	0.017	0.026	0.034	0.043	0.052	0.060	0.069	0.078
Swine - Lactating sow	0.19	0.023	0.046	0.069	0.092	0.12	0.14	0.16	0.18	0.21
Swine - Boar	0.061	0.0074	0.015	0.022	0.030	0.037	0.044	0.052	0.059	0.067