Swine Feeding and Nutrient Management

Best Management Practices

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Odor is an (THE) Issue

- Production facilities under public scrutiny and regulation
- Unrealistic to operate without some odor
- Odor must be acceptable by neighbors and community (FIDO)
- Complex issue of strategies, technologies, and solutions

Environmental concerns with waste

- Of particular concern are nutrients N and Phos in waste
- Phos applied to soil may be carried to surface water and contribute to eutrophication
- Water soluble N can leach and move to ground and surface water raising ammonia and nitrates to toxic levels
- Some regions the available land base for waste nutrients to potential crop use is out of balance

Nutrient Excretion and Odor Management Through Feeding and Nutrition

- What and how we feed hogs impacts the composition of manure
  - Efficiency of digestion and nutrient utilization is not 100%
- Compounds in manure are related to potential odors during decomposition
  - Excess S>H2S, N>NH3, CHO>VFAs
- Reduced waste, nutrient levels in waste, and odor potential is possible

Strategies and Impacts

- Reduce feed waste
- More accurate nutrition
  - Phase/ split sex feeding
  - Reduced CP AA supplemented
- Improve digestibility of diet
  - Feed enzymes
  - Particle size
  - Feedstuffs
- Targeting ammonia and dust
  - Odor attaches to particles
  - Pelleting, liquid feeding and fat reduce dust

Reducing P and N in Manure

- Phos is required by pigs
  - Teeth and bone
  - Cell membranes, DNA
  - Energy metabolism
- N is essential in Protein Deposition
  - N containing amino acids build protein
  - 10 AA are dietary essential
  - 11 AA are semi essential or synthesized
  - Pigs have a requirement for AA not CP
  - CP used as an indicator of amino acid adequacy

Reduce Feed Waste

- Industry estimates 2-12% waste
- 83g P per pig, 327g N per pig
- Feeder design, adjustment, management
  - Only 50% of bottom covered
  - Difficult to push feed out
- Mash feeds typically greater waste
- Wet-dry feeders typically cut waste
- Adequate feeder space (9-16pigs/space)

Precision Feed Formulation

- Nutrient analysis
- Ingredient weighing and feed batching
- Formulate on bioavailability or digestibility
- Split sex/phase feeding
- Nutrients provided above animals requirement for maintenance and production are excreted
- Minimize the “safety margin”

Energy Sources	Nutrient								
Ingredient	ME/lb	CA, %	P, %	Lys, %	Met, %	Cys, %	Thr, %	Trp, %	Cp, %
Barley, 2 row	1323	0.06	0.35	0.41	0.20	0.28	0.35	0.11	11.30
Corn Gluten Feed	1184	0.22	0.83	0.63	0.35	0.46	0.74	0.07	21.50
Corn, grain	1555	0..03	0.28	0.26	0.17	0.19	0.29	0.06	8.30
Sorghum, grain	1518	0.03	0.29	0.22	0.17	0.17	0.31	0.10	9.20
Triticale, grain	1445	0.05	0.33	0.39	0.20	0.26	0.36	0.14	12.50
Wheat, hard red winter	1459	0.06	0.37	0.34	0.20	0.29	0.37	0.15	13.50
Wheat, soft red winter	1502	0.04	0.39	0.38	0.22	0.27	0.39	0.26	11.50
Wheat midds, <9.5% CF	1375	0.12	0.93	0.57	0.26	0.32	0.51	0.20	15.90

Nutrient	Weight class/lbs.				Breeding herd	
	20-50	50-110	110-175	175-260	Gestation	Lactation
Lysine	1.15	0.95	0.75	0.60	0.54	0.91
Methionine	0.30	0.25	0.20	0.16	0.14	0.23
Cystine	0.35	0.29	0.24	0.19	0.23	0.21
Threonine	0.74	0.61	0.51	0.41	0.45	0.58
Tryptophan	0.21	0.17	0.14	0.11	0.11	0.16

Ingredient	% Inclusion	% Lysine	Total Lysine
Barley	39.65	0.41	0.162
Corn	39.65	0.26	0.103
Soybean Meal	17.70	3.02	0.535
Vitamin/ Mineral	3.00	0	0
Total	100.00		0.800

Ingredient	Weight class/lbs.				Breeding Herd	
	20-50	50-110	110-175	175-260	Gestation	Lactation
Corn, grain	1273	1434	1585	1699	1715	1447
Soybean meal (High protein)	652	506	360	251	210	478
Vitamin-mineral Premix	75	60	55	50	75	75
Total	2000	2000	2000	2000	2000	2000
Lysine, %	1.15	0.95	0.75	0.60	0.54	0.91
Ca, %	0.70	0.60	0.50	0.45	0.75	0.75
P, %	0.60	0.50	0.45	0.40	0.60	0.60
ME, kcal/kg	3279	3307	3319	3329	3288	3282
Protein, %	20.8	18.0	15.1	13.0	12.1	17.4

Feedstuff Digestibility

- Particle size reduction
  - 600-800 microns
  - Increased surface area
- Heat processing
  - Gelatinizes starch and break bonds
  - Deactivates anti-nutritional compounds
  - Excess forms indigestible complexes
- Supplemental Enzymes
  - Beta-glucanases –dietary fiber in wheat and barley
  - Xylanases – in high fiber diet 10%<fecal
- Dietary Stabilizers of Gut Microflora
  - Antibiotic agents
  - Improve F/G 3% results in N and P < of 4.5%

Ingredient	Protein		Phosphorus	
	Digestibility %	Content %	Digestibility %	Content %
Corn	85	8.5	14	0.28
Soybean meal, 48% CP	87	49	23	0.69
Soybean meal, 44% CP	84	45.6	31	0.65
Wheat	89	13.3	50	0.37
Wheat bran	75	15.7	29	1.2
Barley	85	10.6	30	0.36
Sorghum	83	9.2	20	0.29
Meat and bone meal	84	49.1	95	4.98
Poultry byproducts	77	57.7	95	2.41
Fish meal	88	62.9	95	2.2
Dicalcium phosphate	-	-	100	18.5

Table 1. Typical content of protein and phosphorus in commonly used feed ingredients and their digestibility in swine. Adapted from NRC (1998).

Reducing P in Manure

- In past over-formulation to meet requirement
  - Bio-availability differences between feeds and supplements
  - Relatively cheap to feed dical-phosphate
  - Performance not hindered
- P in feed grains in phytate form
  - Adding phytase enzyme improves P digestibility 50%
  - low phytate corn 35%PP vs 86%PP
  - Incorporation of phytase gene in plants
  - Improved P retention with Vit D

Feedstuff	Total P, %	Phytate P, % of total	Bioavailable P*, %
Corn	0.26 - 0.28	66	12 - 29
Soybean Meal	0.61 - 0.69	51 - 61	23 - 36
Barley	0.34 - 0.37	51 - 66	28 - 30
Wheat	0.30 - 0.39	60 - 77	46 - 51
Wheat middlings	0.80 - 0.93	66	41
Canola meal	1.01 - 1.12	36	21
Sorghum	0.27 - 0.31	68 - 70	20
Meat & bone meal	4.98	---	67 - 90

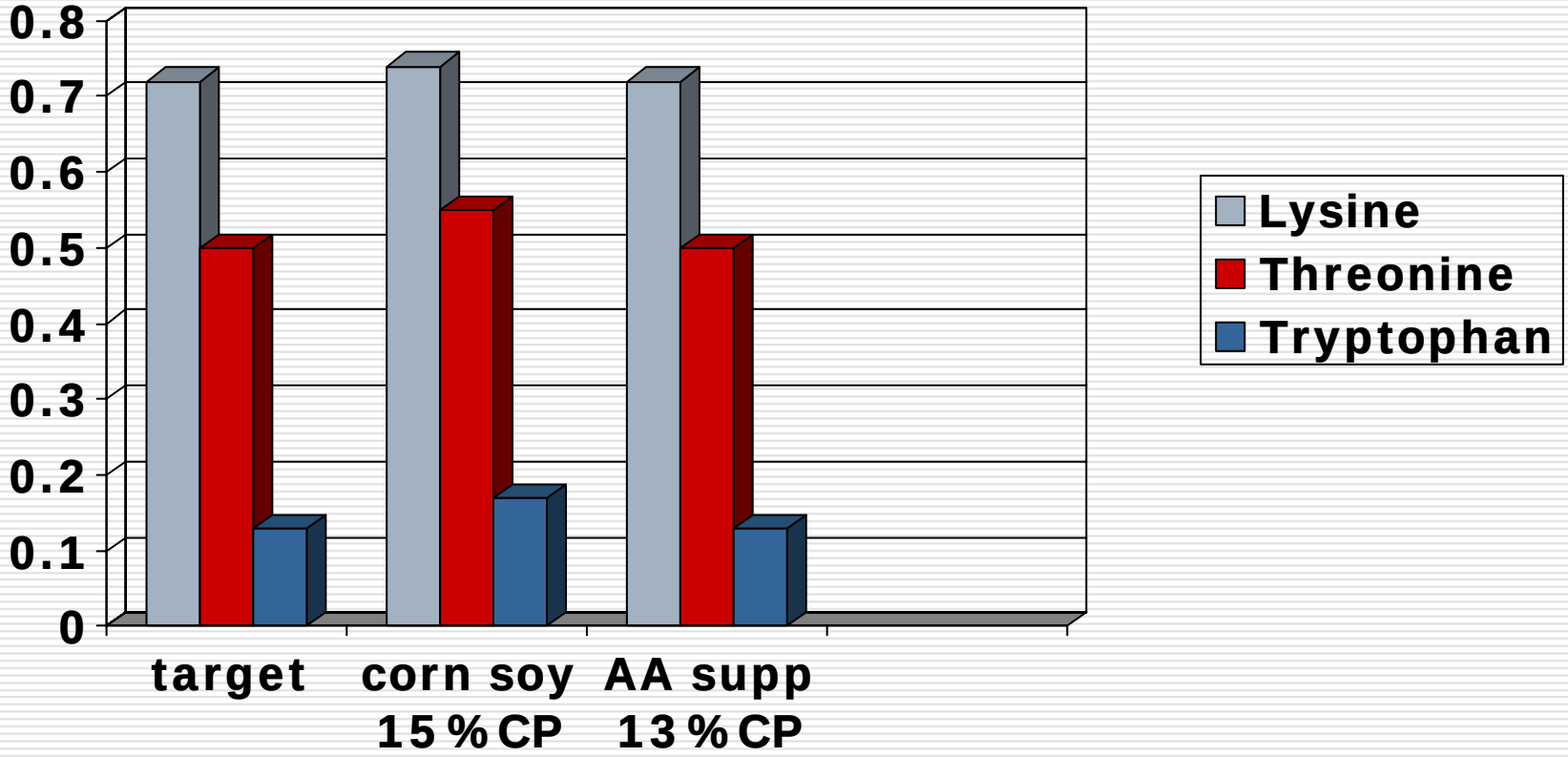
Minimizing N Emissions

- Reduce total protein level and balance with synthetic amino acids
  - Typically reduce crude protein 2-3 %
  - Synthetic AA available
    - L Lysine HCL 78.6% $.75/lb
    - DL Methinoine 99.0% $1.20
    - L Threonine 99.0% $1.35
    - L Tryptophan 98.5% $4.00
  - 1%< protein = 10%,< NH3
  - Replacing limestone with gypsum < NH3
    - Acidifies urine

Amino Acid	Ideal Pattern, % of lysine		
	10 to 45 lbs	45 to 110 lbs	110 to 240 lbs
Lysine	100	100	100
Threonine	65	67	70
Tryptophan	17	18	19
Methionine + Cystine	60	62	65
Isoleucine	60	60	60
Valine	68	68	68
Leucine	100	100	100
Phenylalanine + Tyrosine	95	95	95
Arginine	42	36	30
Histidine	32	32	32

Table 3. Ileal true digestible amino acid patterns for pigs in three different weight classes. Adapted from Baker (1996).

N is over fed in typical corn-soy ration balanced by soybean for lysine requirement



Diet Options	Manure N Excretion, lb N/yr	Available N After Losses, lb N/yr	Land Requirement for Managing N, acres
Systems that conserve nutrients (manure storage and incorporation during application)[5]			
C-SBM[2]	26,300	21,300	130
C-SBM + lysine[3]	22,900	18,500	113
C-SBM + lysine, tryptophan, threonine, and methionine[4]	16,600	13,400	82
Nutrient disposal system (anaerobic lagoon and pivot irrigation)[6]			
C-SBM[2]	26,300	4,000	25
C-SBM + lysine[3]	22,900	3,400	22
C-SBM + lysine, tryptophan, threonine, and methionine[4]	16,600	2,500	16

Table 4. Effect of adding crystalline amino acids to a corn-soybean meal (C-SBM) diet on the land application area required for a 1,000-head capacity pig-finishing facility. Nutrient use in crop production assumed a corn (170 bushels/acre) and soybean (50 bu/acre) rotation. [2] Dietary crude protein level was 17.9%, 16.5%, 15.1%, and 13.0% for 45-80lb, 80-130lb, 130-190lb, and 190-250lb pigs, respectively. [3] Dietary crude protein level was 16.4%, 14.9%, 13.6%, and 12.1% for 45-80lb, 80-130lb, 130-190lb, and 190-250lb pigs, respectively. [4] Dietary crude protein level was 14.0%, 12.6%, 11.1%, and 9.6% for 45-80lb, 80-130lb, 130-190lb, and 190-250lb pigs, respectively. [5] 80% of the nitrogen is conserved. [6] 20% of the nitrogen is conserved in the wastewater to be pumped. Source: Reese and Koelsch (1999).

Zinc and Copper

- Current practices to feed in excess
  - Enhanced growth in nurseries
  - Supplemented to gilt diets
- Decreased supplementation likely
  - Lower levels in waste by 50%
  - May impact performance
- Zn and Cu remain bound to soil and can potentially accumulate to levels toxic to plants or grazing animals
  - Excessive accumulation long term isolated
  - Long term repeated heavy applications

[a]Phytase product should be added to provide 227 units of phytase activity per lb of diet

Ingredient, lb/ton	Diet #1	2	3	6
Corn, yellow	1595	1619	1612	1680
Grain sorghum				
Soybean meal (44% CP)	362			272
Soybean meal, dehulled		328	328	
Fat, choice grease				
Lysine, 78% L-lysine				3
Phytase premixa			+	
Salt	7	7	7	7
Dicalcium phosphate	12	12	3	14
Limestone	19	19	23	19
Vitamin premix[b]	2	2	2	2
Trace mineral premix[c]	3	3	3	3
TOTAL	2000	2000	2000	2000
				Csis
Protein, %	14.55	14.75	15.00	13.07
Lysine, %	.72	.72	.74	.72
Tryptophan, %	.15	.15	.16	.13
Threonine, %	.54	.54	.56	.47
Methionine + cystine, %	.52	.53	.54	.48
Calcium, %	.55	.55	.55	.56
Total phosphorus, %	.45	.45	.38	.45
Available phosphorus, %	.17	.17	.19	.19
Metabolizable energy, kcal/lb	1498	1515	1518	1499

Table 10. Diets for barrows (110-175

Ingredient, lb/ton	Diet #1	2	3	4
Corn, yellow	1508	1543	1549	1399
Grain sorghum				
Soybean meal (44% CP)	445			452
Soybean meal, dehulled		410	410	
Fat, choice grease				100
Lysine, 78% L-lysine				2
Phytase premix[a]			+	
Salt	7	7	7	7
Dicalcium phosphate	16	16	5	17
Limestone	19	19	24	18
Vitamin premix[b]	2	2	2	2
Trace mineral premix[c]	3	3	3	3
TOTAL	2000	2000	2000	2000
				Calculate
Protein, %	16.00	16.00	16.16	15.80
Lysine, %	.82	.82	.82	.90
Tryptophan, %	.18	.18	.18	.18
Threonine, %	.60	.60	.60	.59
Methionine + cystine, %	.56	.57	.57	.55
Calcium, %	.61	.60	.60	.60
Total phosphorus, %	.50	.50	.40	.50
Available phosphorus, %	.22	.21	.21	.23
Metabolizable energy, kcal/lb	1490	1510	1515	1591

Table 11. Diets for gilts (110-175lb) using cor

Summary of Potential Reductions of Nutrient Excretion by Nutritional Strategies

Strategy	Reduction
Precision formulation	10-15% N,P
Reduced waste	1.5% per 1% reduction
Pelleting	5% N,P,Zn,Cu
Fine grind	5% N,P
Reduce protein +AA	9% N per 1%cp
Phytase	20-30% P
Phytase + Vit D	20-60% P
Enzymes (xylanases …)	5% N,P in some diets
Phase feed	5-10% N,P
Split sex feed	5-8% N
Reduced organic micromin	50% Cu, Zn, Mn

Questions - Comments