IOWA STATE UNIVERSITY

Department of Animal Science

What do we need to know about energy to optimize performance and maximize net income

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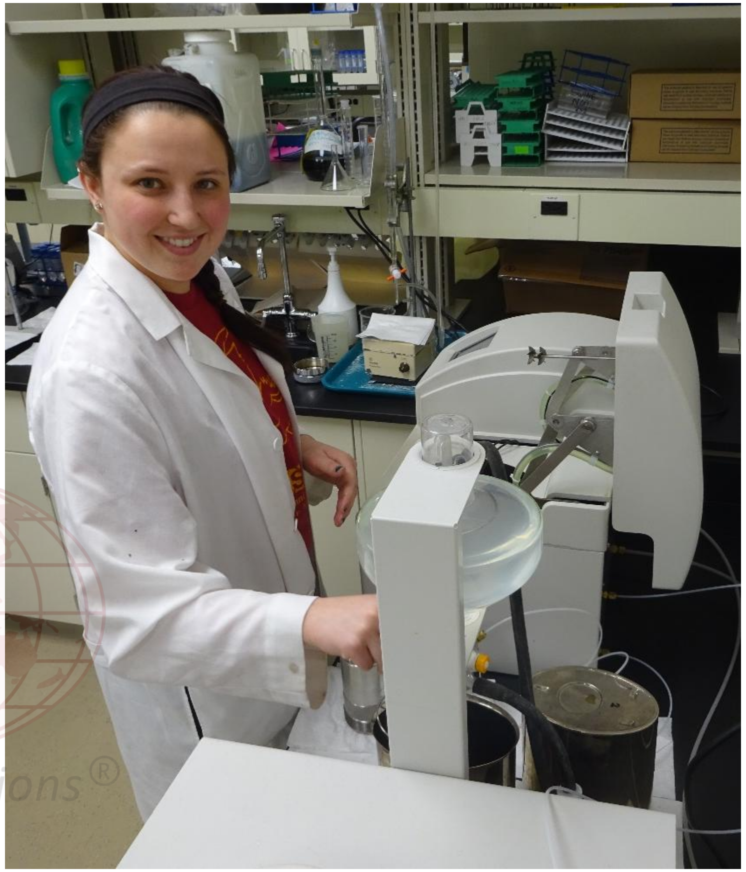
Increasingly, success in pork production will depend, in part, on:

- ➢ who can buy/produce dietary calories the cheapest
- ➢ who can convert those calories most efficiently into meat protein

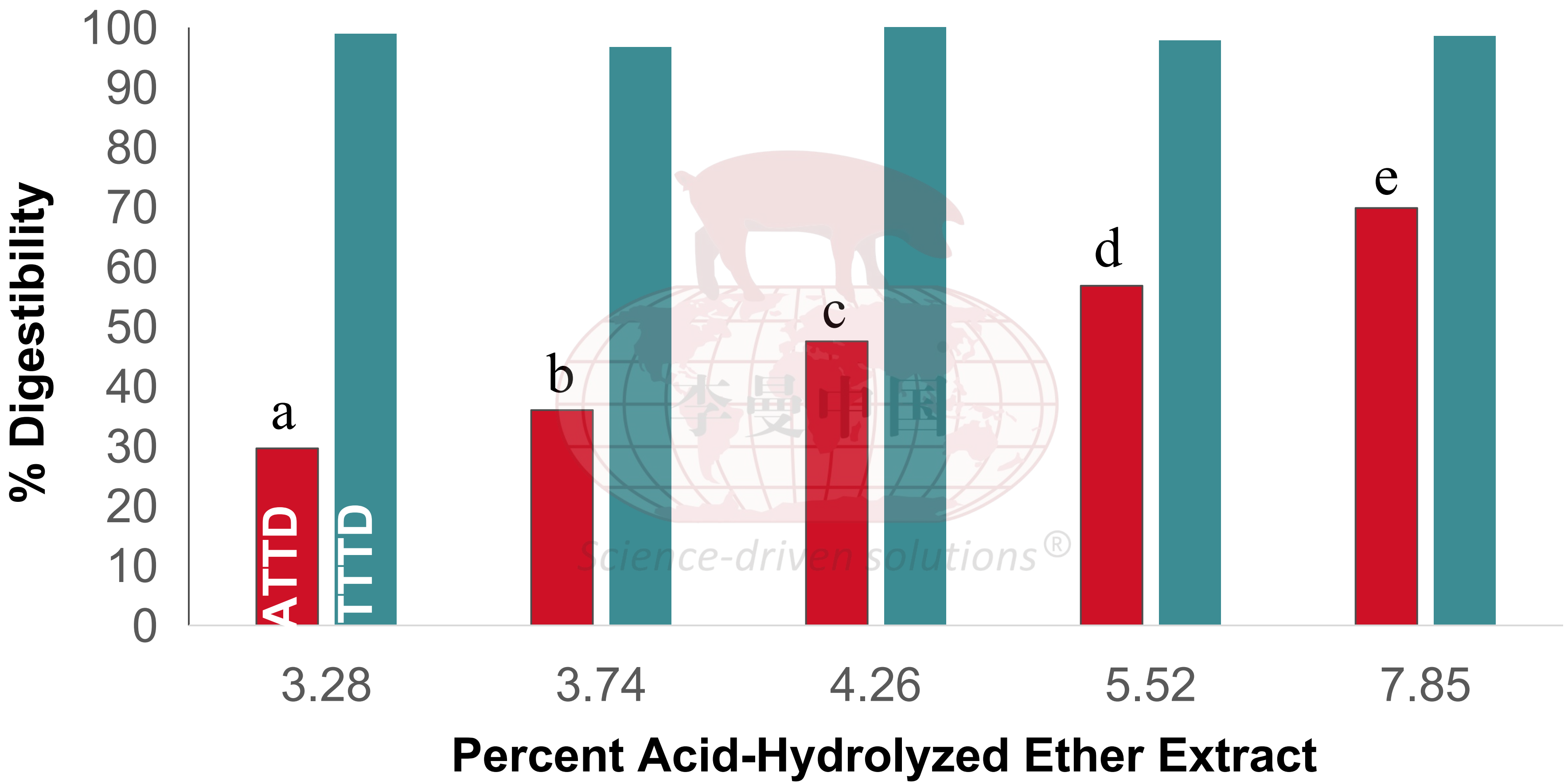
Outline

1. Ingredient energy values: how much confidence can we have in them?
2. Energy systems: where do we go next?
3. How the pig uses energy
4. Feed efficiency is not as tightly correlated to dietary energy as we might think
5. Use of models as a tool to identify optimal feeding and management strategies

To use energy values, we need to understand where they came from, how accurate they are, what their weaknesses are and what their limitations are



Are we underestimating the digestibility of dietary fat? Yes.



[a,b,c,d,e] Means within ATTD differ, P<0.05

Source: Acosta et al., 2021

Differences in digestibility and fermentability between corn samples selected for high or low energy content

	Corn Energy Level					
	High-1	High-2	Low-1	Low-2	SEM	*P* value
ME, Mcal/kg DM	3.68	3.67	3.56	3.49	0.04	0.299
App. ileal digestibility, %	79.1	80.2	80.2	79.7	1.63	0.744
App. fermentation, %	5.6	5.5	2.8	3.8	1.80	0.092
App. total tract, % of GE	84.4	85.7	83.2	83.6	0.86	<0.001

Source: Newman et al., 2016

Losses of energy via feces, urine and heat increment, % of gross energy

Ingredient	Fecal losses	Urinary losses	Heat increment losses
Barley	20	2	24
Corn	**12**	**1**	19
Corn DDGS	24	4	23
Corn germ meal	28	4	22
Soybean hulls	**52**	2	23
Soybean meal	15	**8**	**28**
Wheat	21	2	20
Wheat bran	40	2	**17**
Wheat midds	21	3	22
Ave	**26**	**3**	**22**
Range	40	7	11
Range, % of ave	155	233	50

Heat increment is a "thing."

Many methods available to determine ingredient/diet energy values

METHOD	GE	DE	ME	NE
Primary				
Direct assay	X			
Metabolism study		X	X	
Comparative slaughter				X
Indirect calorimetry				X
Secondary				
"Book" values	X	X	X	X
Regression equations	X	X	X	X
NIR		X	X	X
Growth titration		X	X	X

Mcal ME or NE per kg of carcass gain on diets formulated using ME or NE

Treatment	ME	NE
Control	13.26[a]	9.94
ME-D	13.57[b]	10.01
NE-D	13.54[b]	10.02
ME-DC	13.45[ab]	9.94
NE-DC	13.41[ab]	9.93
SEM	0.1	0.1
P-value	0.048	0.640

Source: Acosta et al., 2016

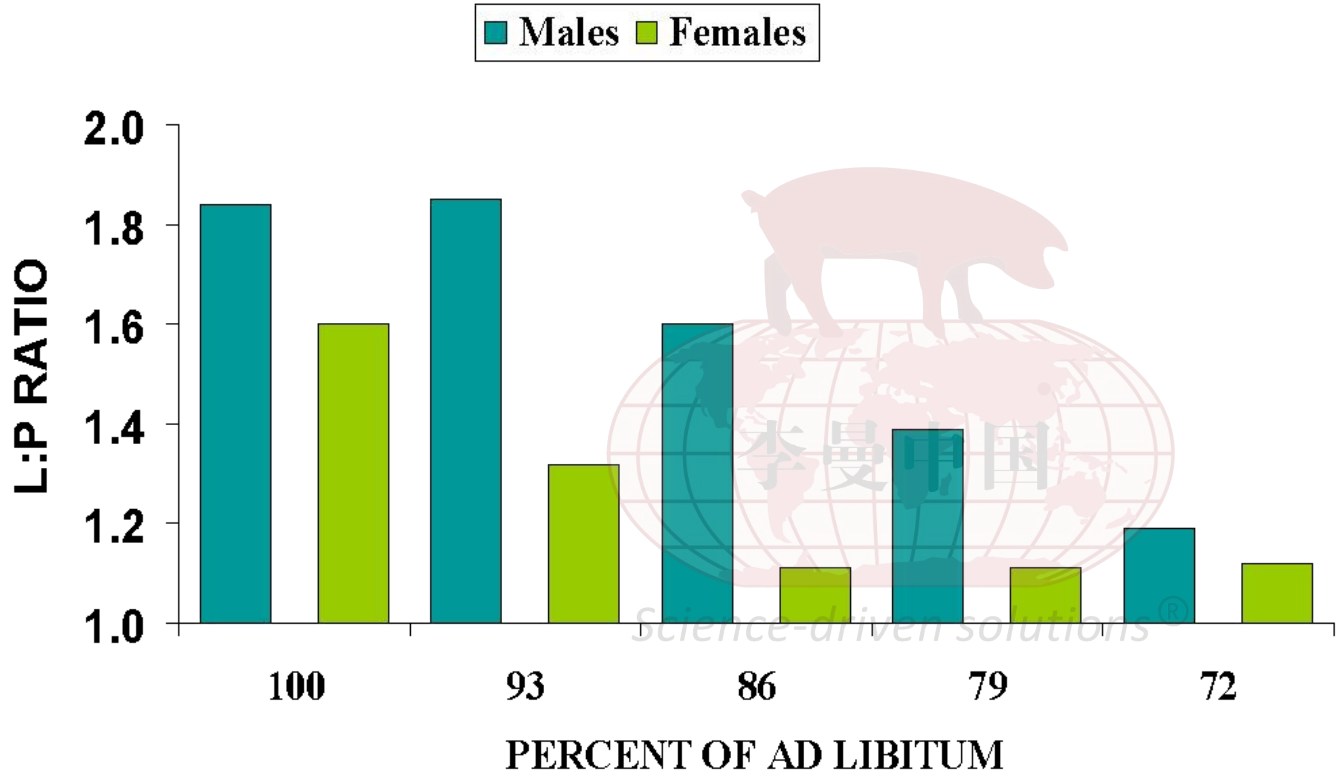
A few things to keep in mind…..

- Metabolism studies measure what was not digested, not what was digested.
- Sample drying results in ~5% loss of fecal energy but no loss in urine (Jacobs et al., 2011)
- Risky to apply regression equations beyond the original parameters (eg INRA NE equation derived from data ranging in CP from 3% to 27%)

A few more things to keep in mind…..

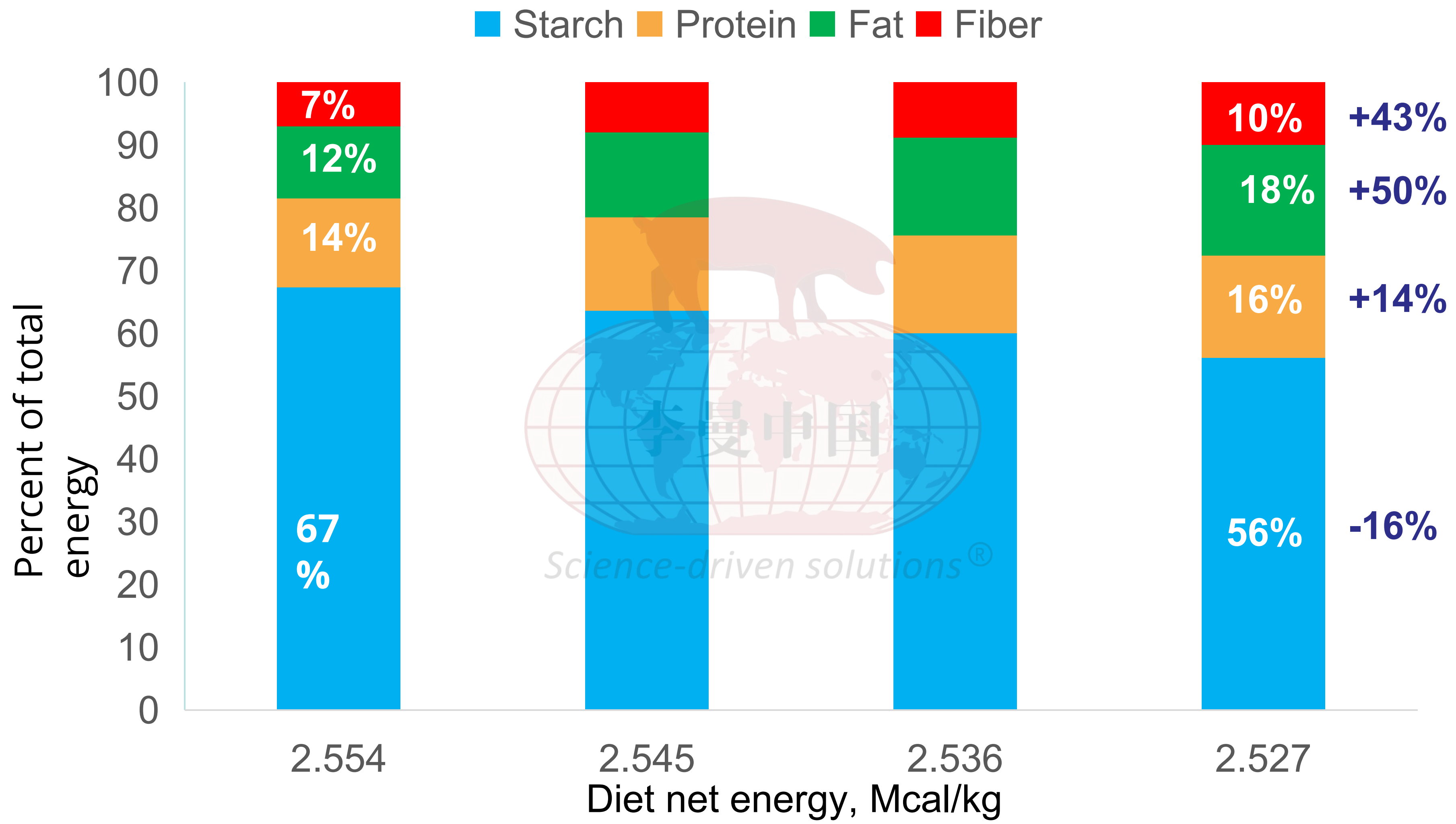
- Must not combine energy systems (eg NE from comparative slaughter vs NE from indirect calorimetry)
- Maintenance energy is a function of time, not growth rate as in protein or fat gain
- Maintenance energy is not a constant

Impact of decreasing energy intake on carcass lipid:protein ratio at 120 kg

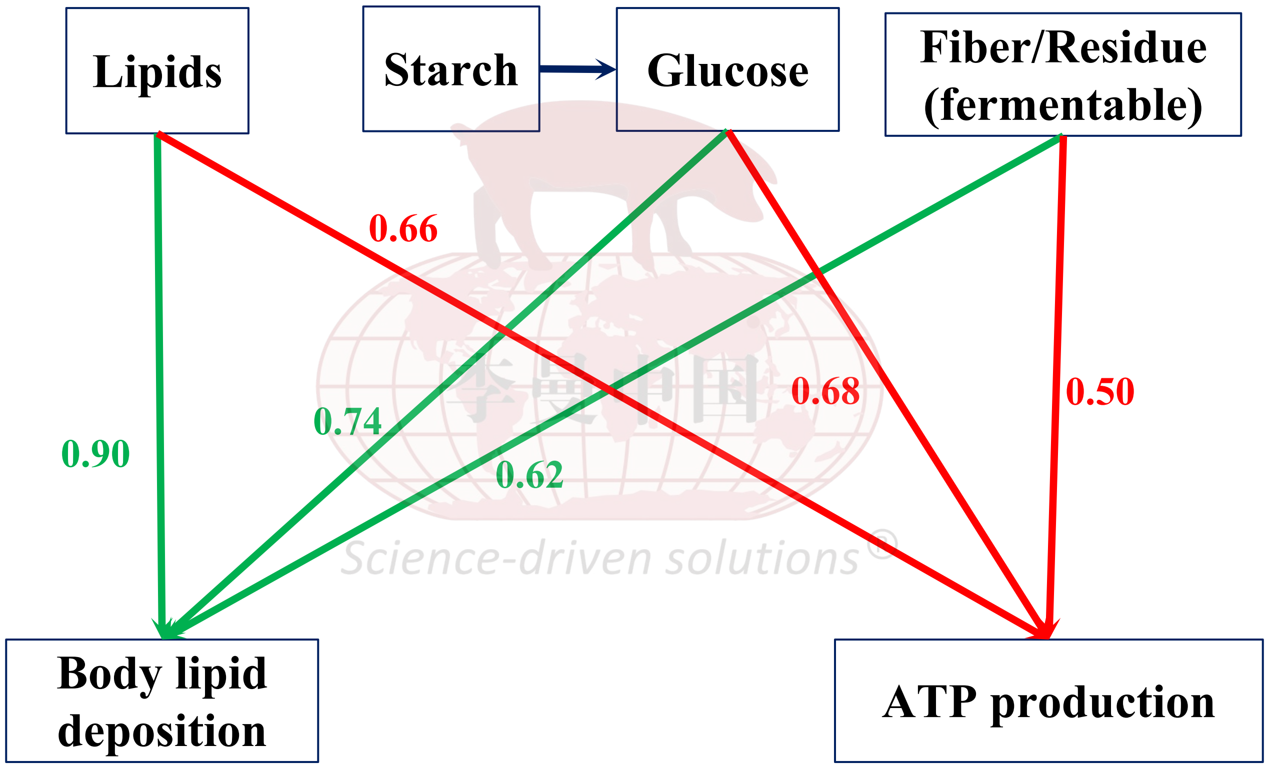


Source: Patience et al., 2002

Consequences of altering diet composition on the profile of energy sources



The efficiency with which the pig uses dietary energy depends on both the source of that energy and the purpose for which it is used



Daily ME intake observed across grow-finish trials, Mcal/d

	1	2	3	4	5
Trial 1	7.35	7.32	7.56	7.47	-
Trial 2	8.21	8.20	8.38	8.45	8.38
Trial 3	8.68	8.92	9.04	-	-

Correlation coefficient between DE_i & NE_i and weanling pig performance

	Correlation	
	DE_{intake}	NE_{intake}
Daily gain	0.92	0.90
Feed conversion	-0.14	-0.12
Protein deposition rate	0.92	0.90
Lipid deposition rate	0.80	0.85
LD:PD ratio	0.60	0.67

Source: Oresanya et al., 2005

Comparing performance of pigs from 25 to 135 kg across 5 diets differing in net energy and DDGS content: ~constant final weight

Weighted NE, Mcal/kg	% DDGS	Days to mkt.	ADG, kg/d	ADF, kg/d	F:G	Carcass weight, kg
2.45	0	**121**	**0.910**	2.55	**2.81**	**102.7**
2.43	10	122	0.903	2.57	2.85	102.3
2.41	20	123	0.900	2.58	2.87	102.3
2.38	30	123	0.897	2.60	2.89	101.4
2.34	40	125	0.887	**2.62**	2.96	101.3

Ingredient prices: corn, 14.55¢/lb; SBM, 26¢/lb; DDGs, 110% of corn
Pig price: $100/cwt

Comparing financial return of pigs from 25 to 135 kg across 5 diets differing in net energy and DDGS content: ~constant final live weight

Weighted NE, Mcal/kg	% DDGS	Carcass wt, kg	Feed cost, $/hd	Return over feed cost, $/hd
2.45	0	102.7	117.29	109.15
2.43	10	102.3	116.27	109.31
2.41	20	102.3	115.43	110.05
2.38	30	101.4	114.07	109.55
2.34	40	101.3	116.08	107.15

Ingredient prices: corn, 14.55¢/lb; SBM, 26¢/lb; DDGs, 110% of corn
Pig price: $100/cwt

Comparing financial return of pigs from 25 to 135 kg across 5 diets differing in net energy and DDGS content at two market prices: $65/cwt and $100/cwt

Weighted NE, Mcal/kg	Mkt Price, $/cwt	Carcass wt, kg	Feed cost, $/hd	Return over feed cost, $/hd
2.45	100	**102.7**	117.29	109.15
2.43	100	102.3	116.27	109.31
2.41	100	102.3	115.43	**110.05**
2.38	100	101.4	**114.07**	109.55
2.34	100	101.3	116.08	107.15
2.45	65	**102.7**	117.29	29.89
2.43	65	102.3	116.27	30.36
2.41	65	102.3	115.43	31.13
2.38	65	101.4	**114.07**	**31.28**
2.34	65	101.3	116.08	29.02

Comparing performance of pigs from 25 to 135 kg at two different growth curves

Weighted NE, Mcal/kg	Growth Curve	Days to mkt.	ADG, kg/d	ADF, kg/d	F:G	Carcass weight, kg
2.45	Fast	**121**	**0.910**	2.55	**2.81**	**102.7**
2.43	Fast	122	0.903	2.57	2.85	102.3
2.41	Fast	123	0.900	2.58	2.87	102.3
2.38	Fast	123	0.897	2.60	2.89	101.4
2.34	Fast	125	0.887	**2.62**	2.96	101.3
2.45	Slow	**127**	**0.872**	2.54	**2.92**	**102.9**
2.43	Slow	**127**	0.869	2.55	2.94	102.2
2.41	Slow	128	0.860	2.57	2.98	102.0
2.38	Slow	129	0.852	2.58	3.02	101.5
2.34	Slow	130	0.842	**2.61**	3.06	101.2

Comparing financial returns of pigs from 25 to 135 kg at two different growth curves

Weighted NE, Mcal/kg	Growth Curve	Carcass weight, kg	Feed cost, $/hd	Return over feed cost, $/hd
2.45	Fast	**102.7**	117.29	109.15
2.43	Fast	102.3	116.27	109.31
2.41	Fast	102.3	115.43	**110.05**
2.38	Fast	101.4	**114.07**	109.55
2.34	Fast	101.3	116.08	107.15
2.45	Slow	**102.9**	122.58	104.36
2.43	Slow	102.2	120.29	105.12
2.41	Slow	102.0	119.42	**105.44**
2.38	Slow	101.5	**119.11**	104.60
2.34	Slow	101.2	120.08	102.92

Even more things to keep in mind…..

- Determine actual energy content of diets used in trials
  - Report energy concentration and energy intake

- We feed groups of pigs, not average pigs or individual pigs

Last things to keep in mind…..

- Models can serve many roles
  - Save time and expand options
  - Identify optimal feeding/mgmt. strategies
  - Prioritize research
- Use empirical data to confirm model outcome
- May supplant NE in the future

Increasingly, success in pork production will depend, in part, on:

- who can buy/produce dietary calories the cheapest
- who can convert those calories most efficiently into meat protein