Feeding the grow-finish pig and managing their increasing carcass weight

Mike Tokach and Annie Lerner
Kansas State University

www.KSUswine.org

Kansas State University | applied swine nutrition

Feeding the grow-finish pig and managing their increasing carcass weight

- Right pig
  - Genetics, health, etc
- Right diets
  - Ingredients, formulation, processing, delivery
- Right facilities
  - Temperature, space, feeders, water, etc.
- Right management
  - Daily chores, pig care, marketing

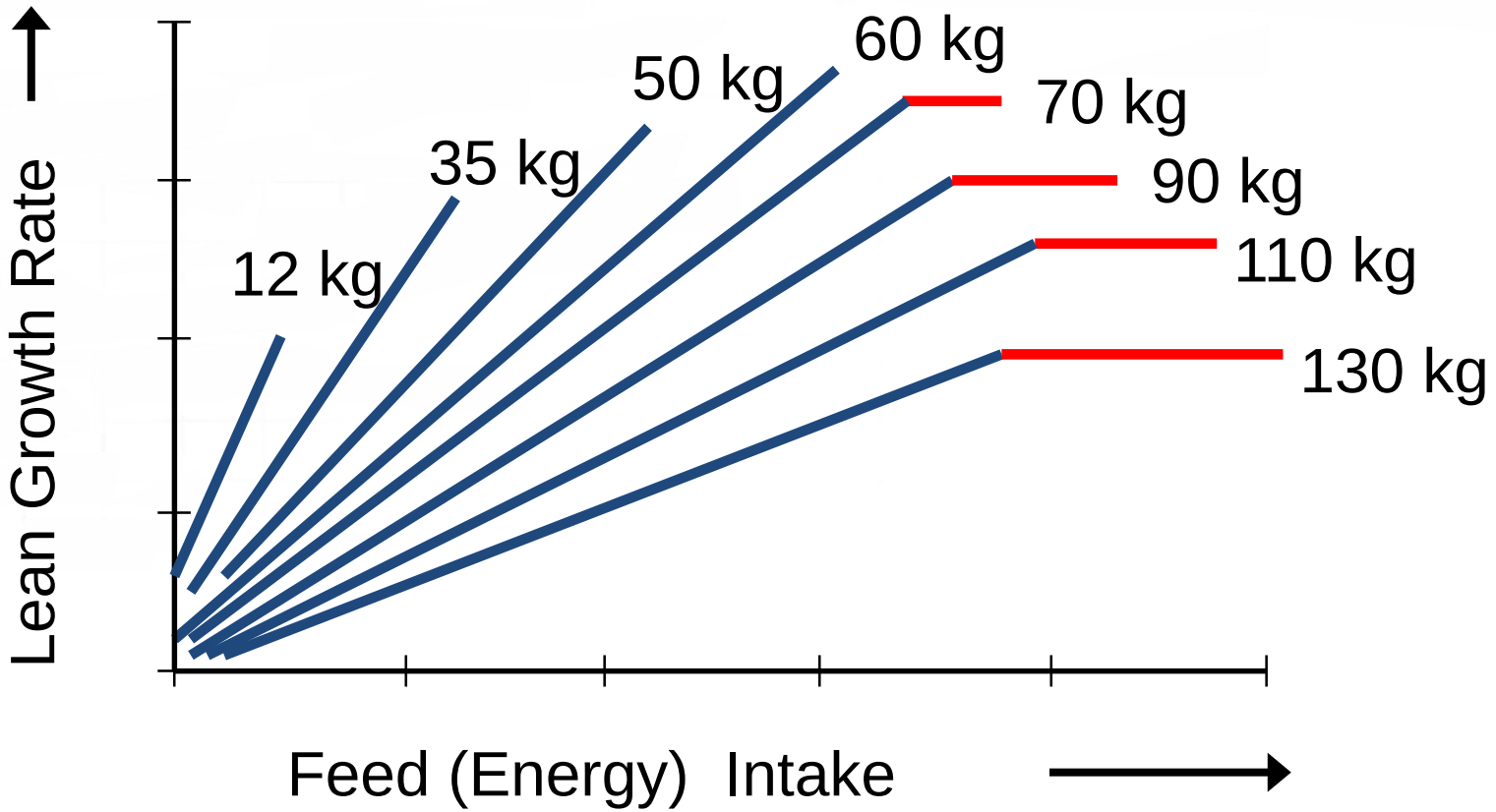
Diet formulation for grow-finish pigs

1) Energy density
2) Lysine:calorie ratio
3) Amino acid:Lys ratios
4) STTD P:calorie ratio
5) Ca:P ratio
6) Vitamins & minerals
7) Feed additives

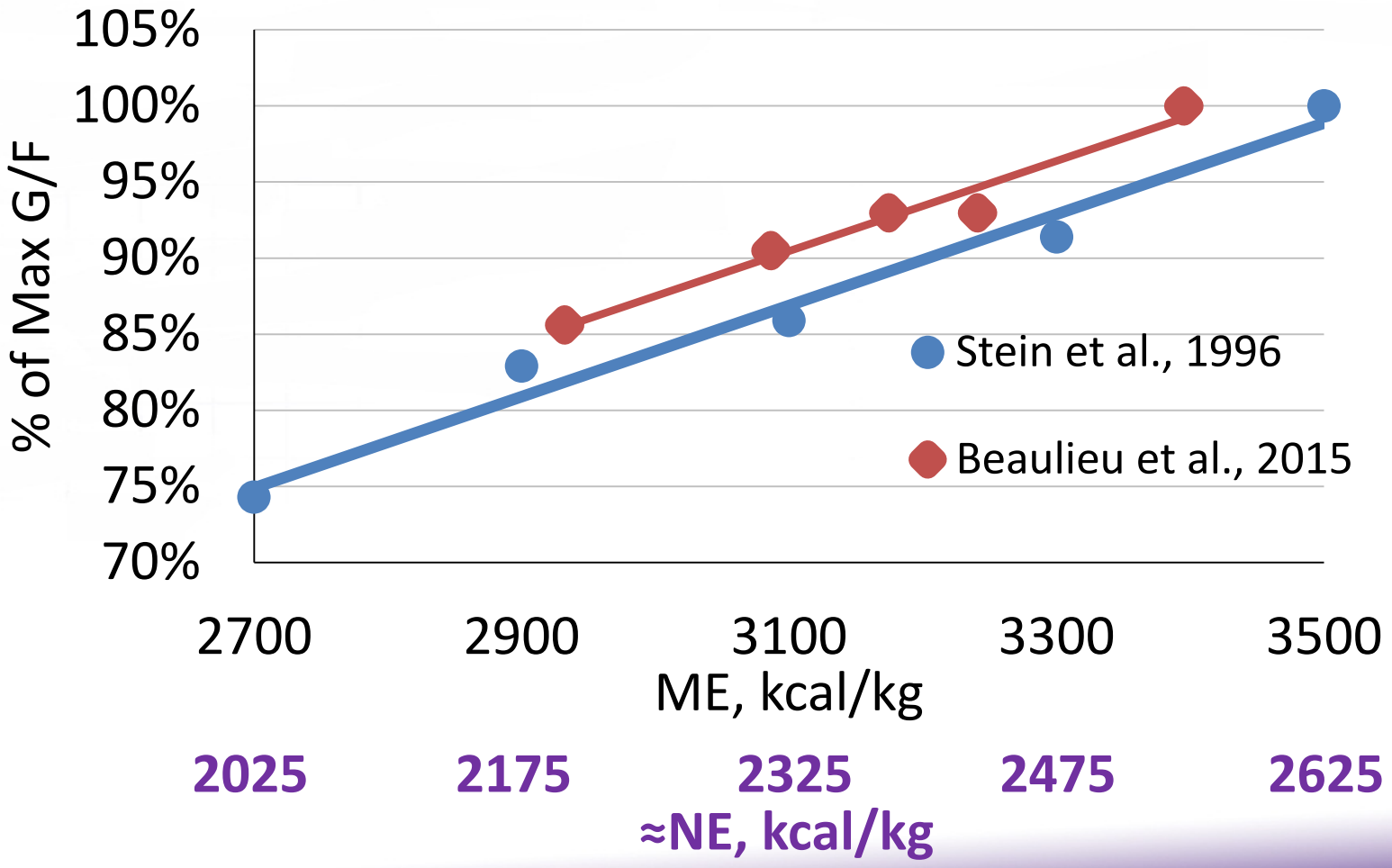
Setting dietary energy level

- Must know how in incremental change in dietary energy influences:
  - Diet cost
  - Pig performance (ADG, F/G)
  - Carcass criteria (dressing %, lean %, other)
- Value of change in pig performance
  - Market price if days to market are limited
  - Cost of space if days to market are not limited

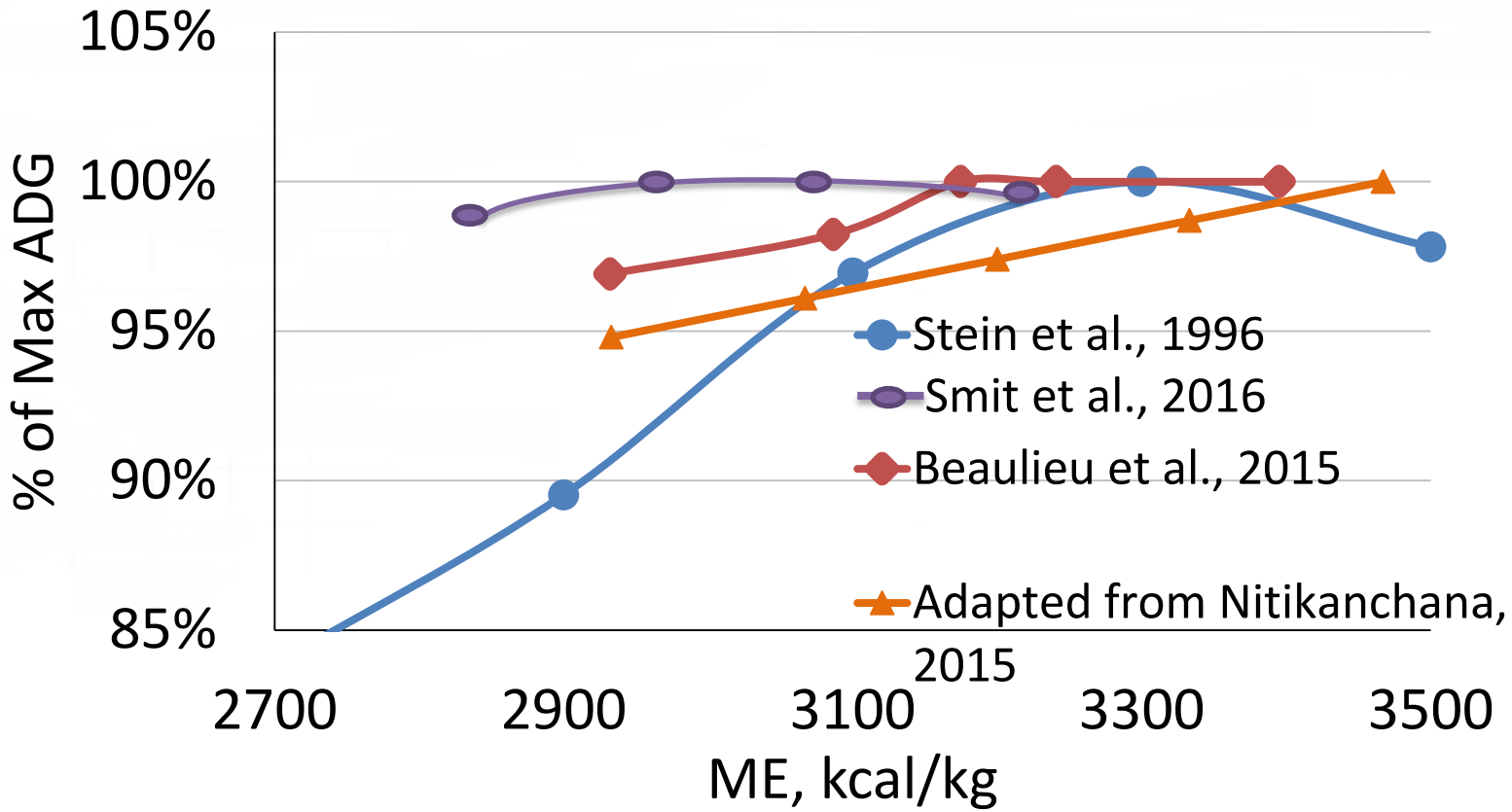
Influence of energy intake on lean growth



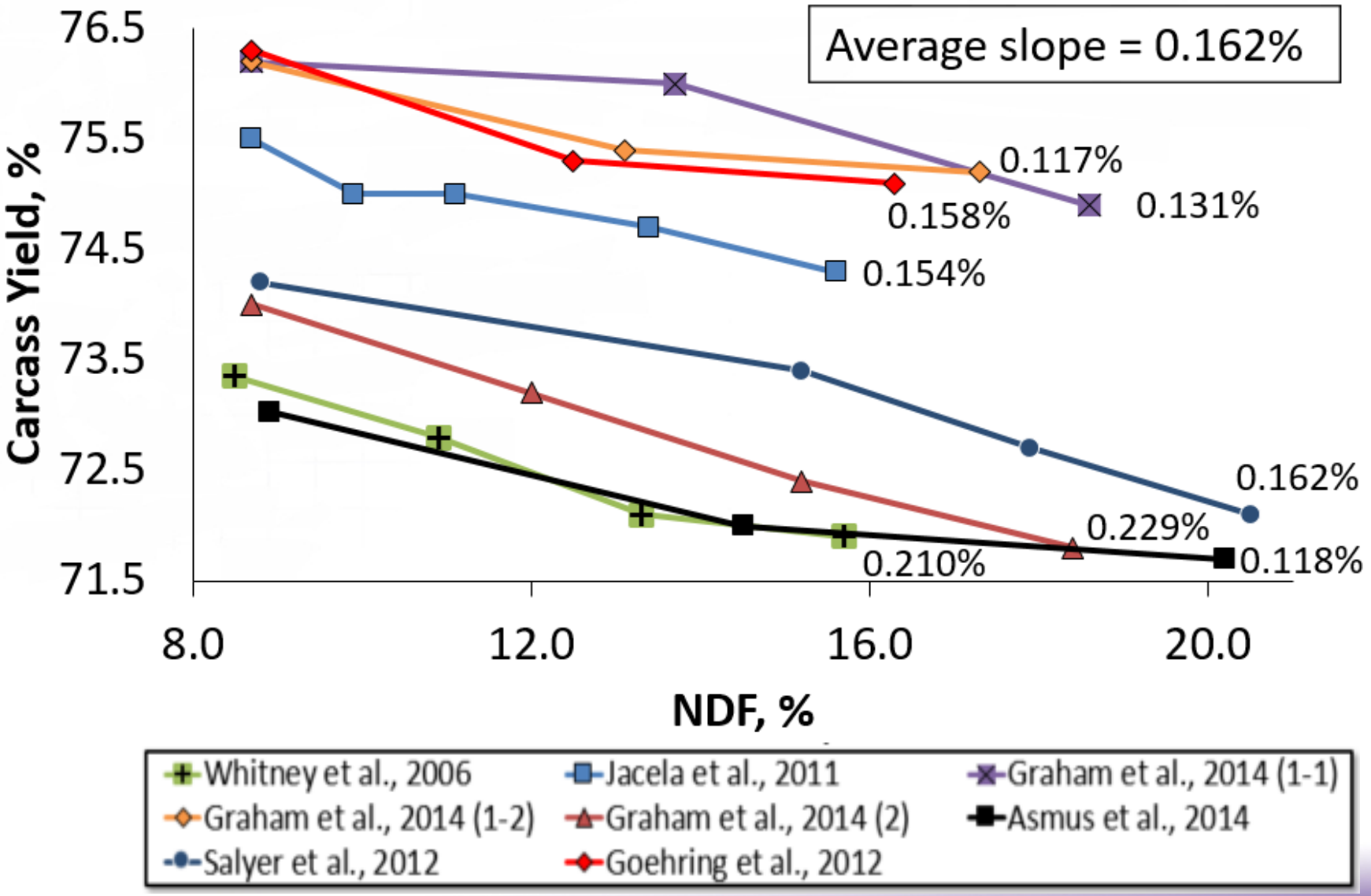
Influence of energy intake on feed efficiency



Influence of energy intake on ADG



Impact of increasing NDF on Carcass Yield

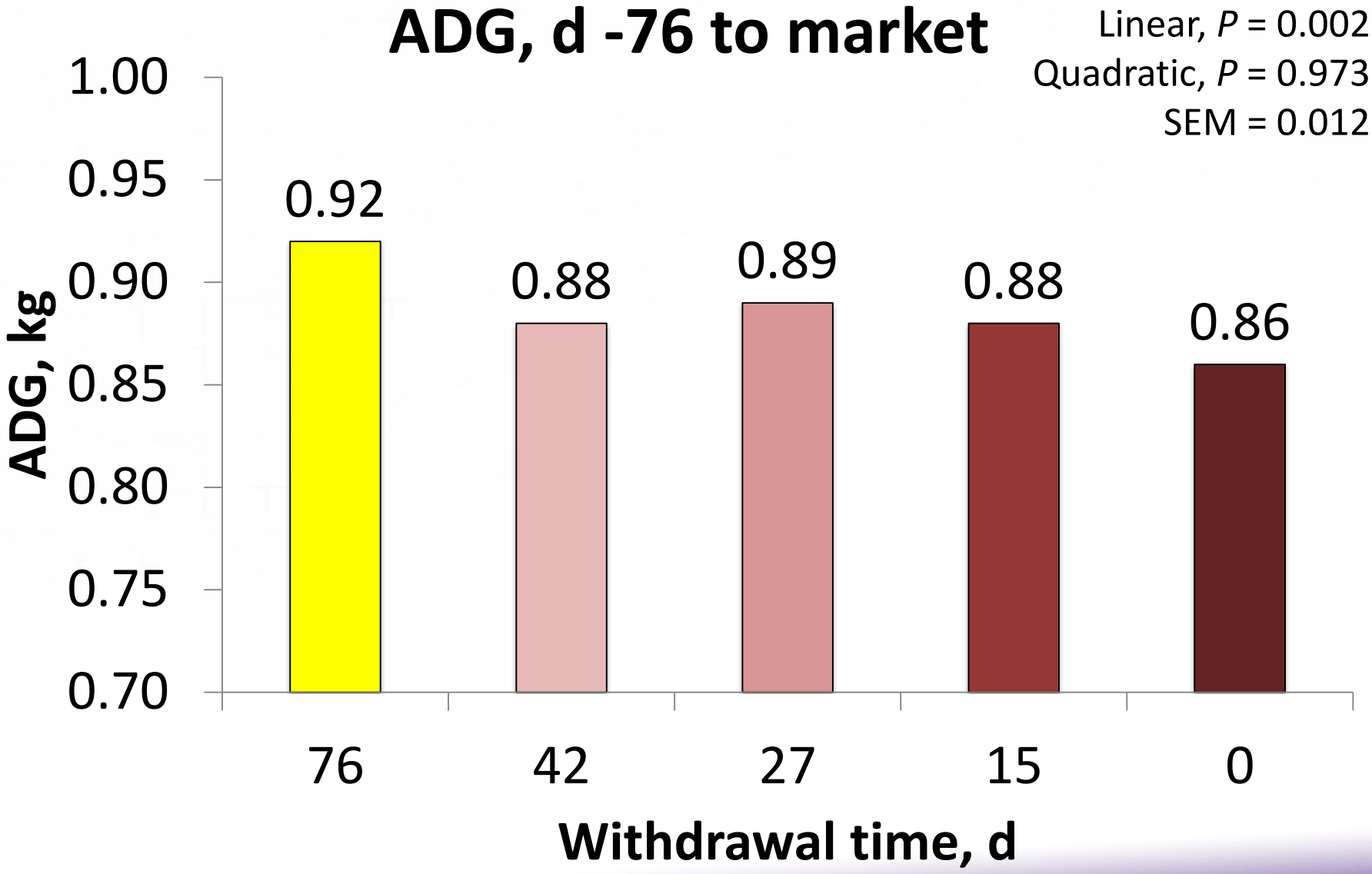


Coble et al., 2015

Will pigs consume more energy for short period when switching them from low to high energy diet?

- Ex. Withdrawing high fiber ingredients from the diet
  - With or without adding fat
- Usually pigs will increase energy intake
  - Usually will increase growth rate

Influence of DDGS withdrawal time on ADG, d -76 to market

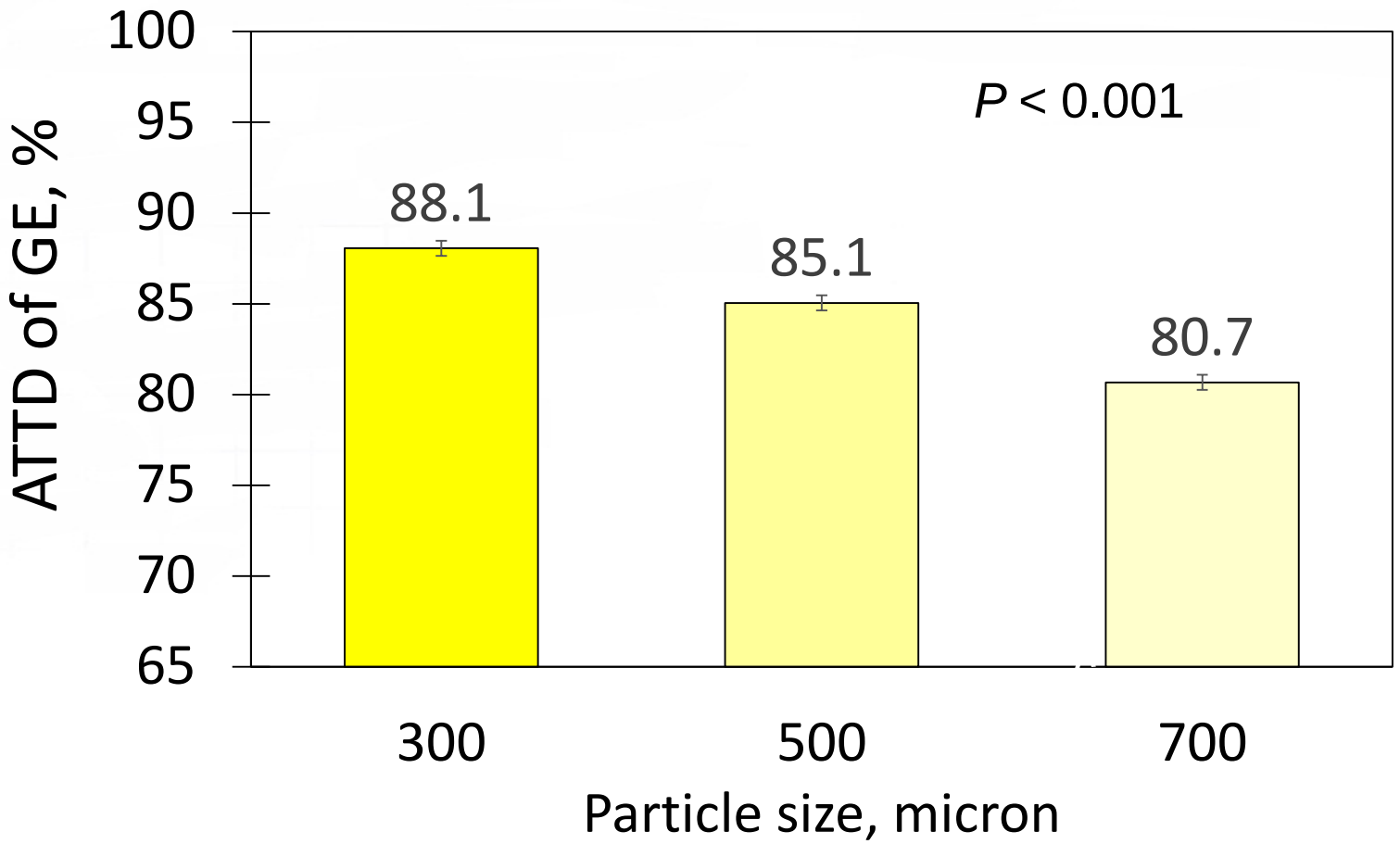


Lerner et al., 2019

How do you increase dietary energy?

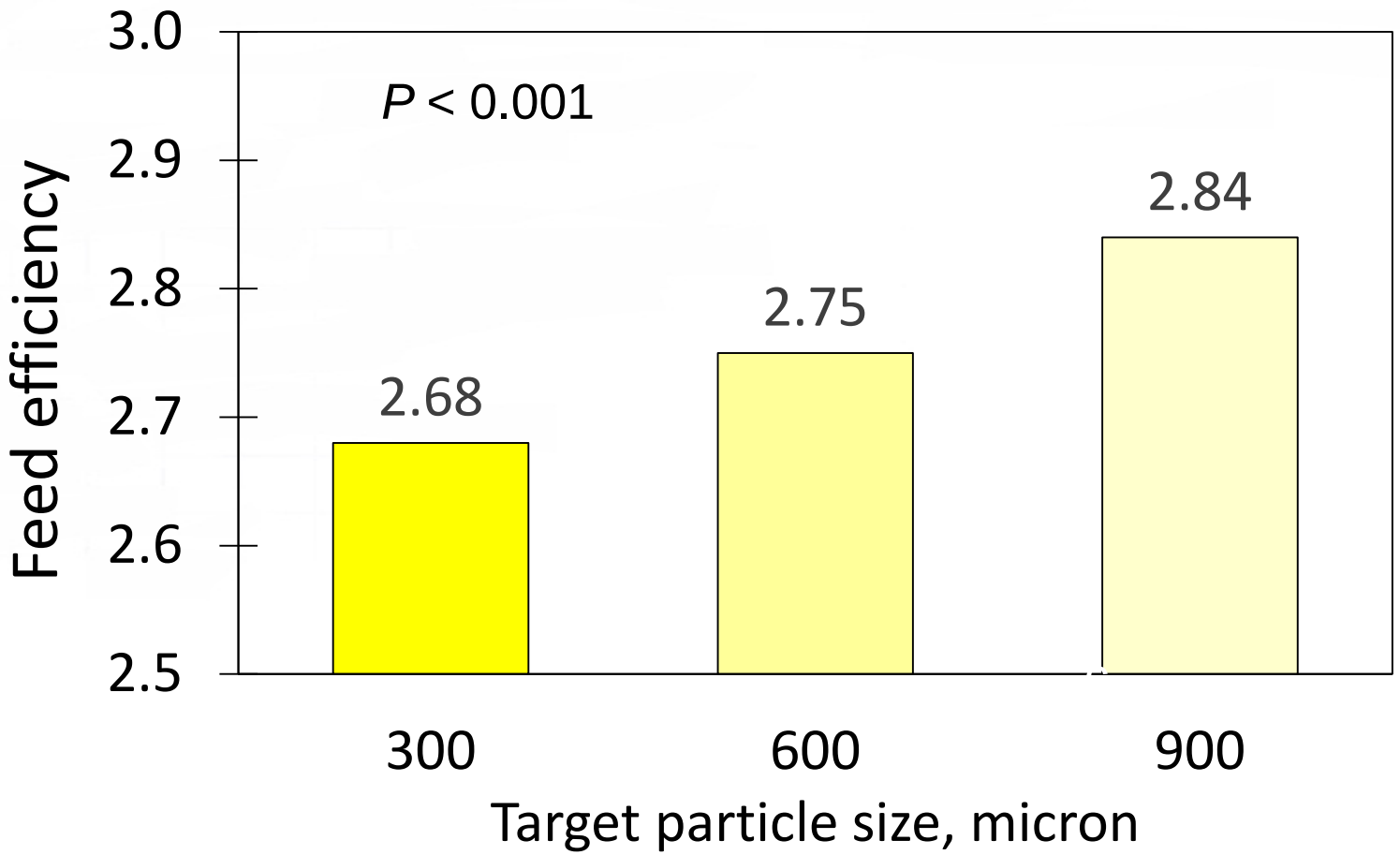
- Ingredients
  - Grain source (corn > sorghum > wheat > barley)
  - Increase inclusion of high energy ingredients
    - Dietary fat
    - Bakery byproduct?
  - Lower inclusion of low energy/high fiber ingredients
- Feed processing
  - Particle size
  - Pelleting

Influence of particle size on digestibility of gross energy in corn



Adapted from Acosta et al., 2019

Influence of particle size of corn on feed efficiency of finishing pigs (110 to 290 lb)



Adapted from Williams et al., 2019

Diet formulation for grow-finish pigs

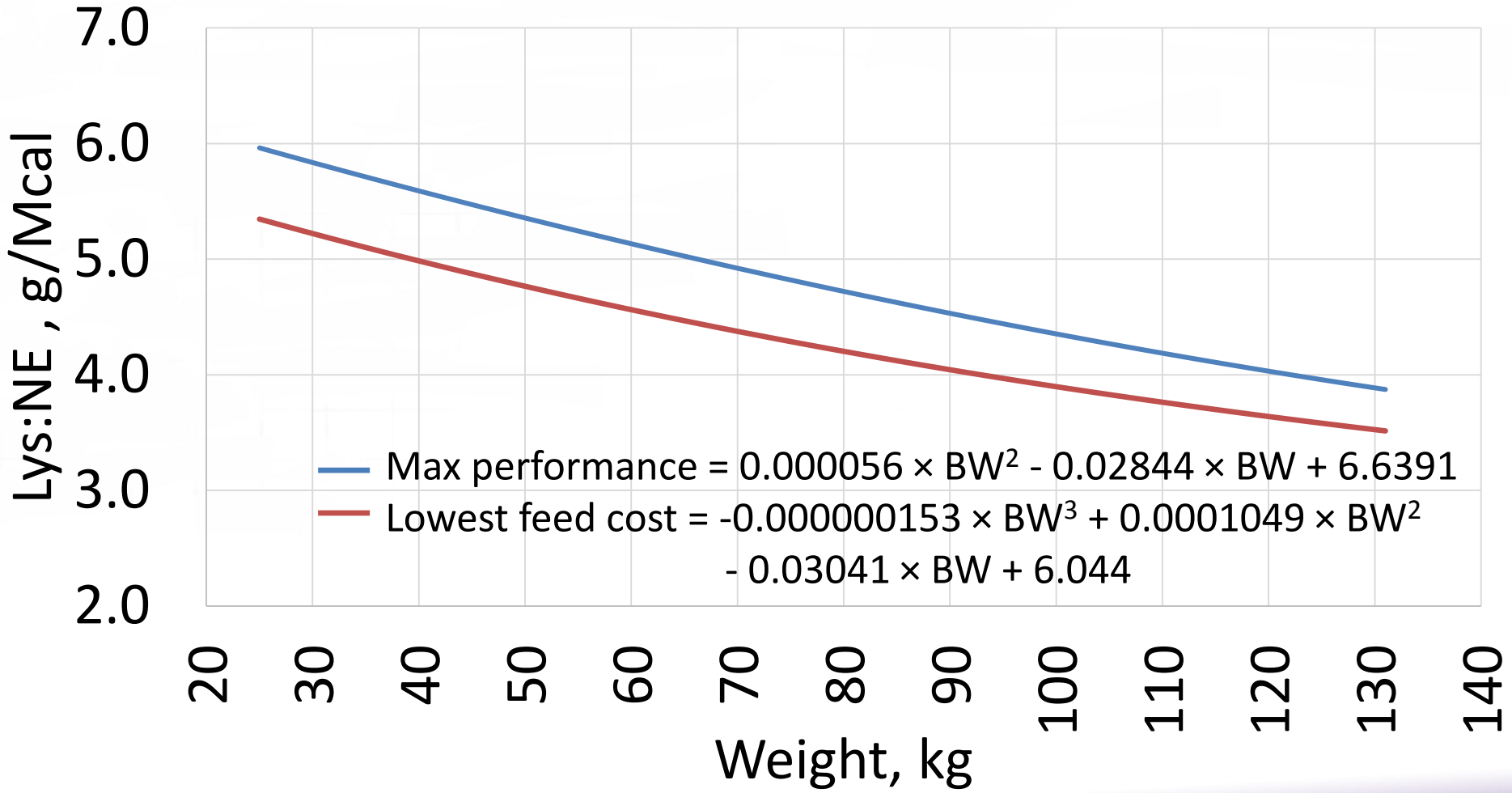
1) Energy density
2) **Lysine:calorie ratio**
3) **Amino acid:Lys ratios**
4) **STTD P:calorie ratio**
5) **Ca:P ratio**
6) Vitamins & minerals
7) Feed additives

SID Lysine requirement of finishing pigs

	Exp.	Weight, kg	g/kg gain
• Main et al., 2008	7	35 to 120	20
• De La Llata et al., 2001	2	27 to 120	20
• Bergstrom et al. 2010	4	37 to 129	20 to 21
• Srichana et al., 2004	4	34 to 100	20
• Shelton et al., 2009	1	55 to 80	20

18 experiments = 20 g/kg gain

SID lysine estimates for PIC gilts from 20 to 120 kg

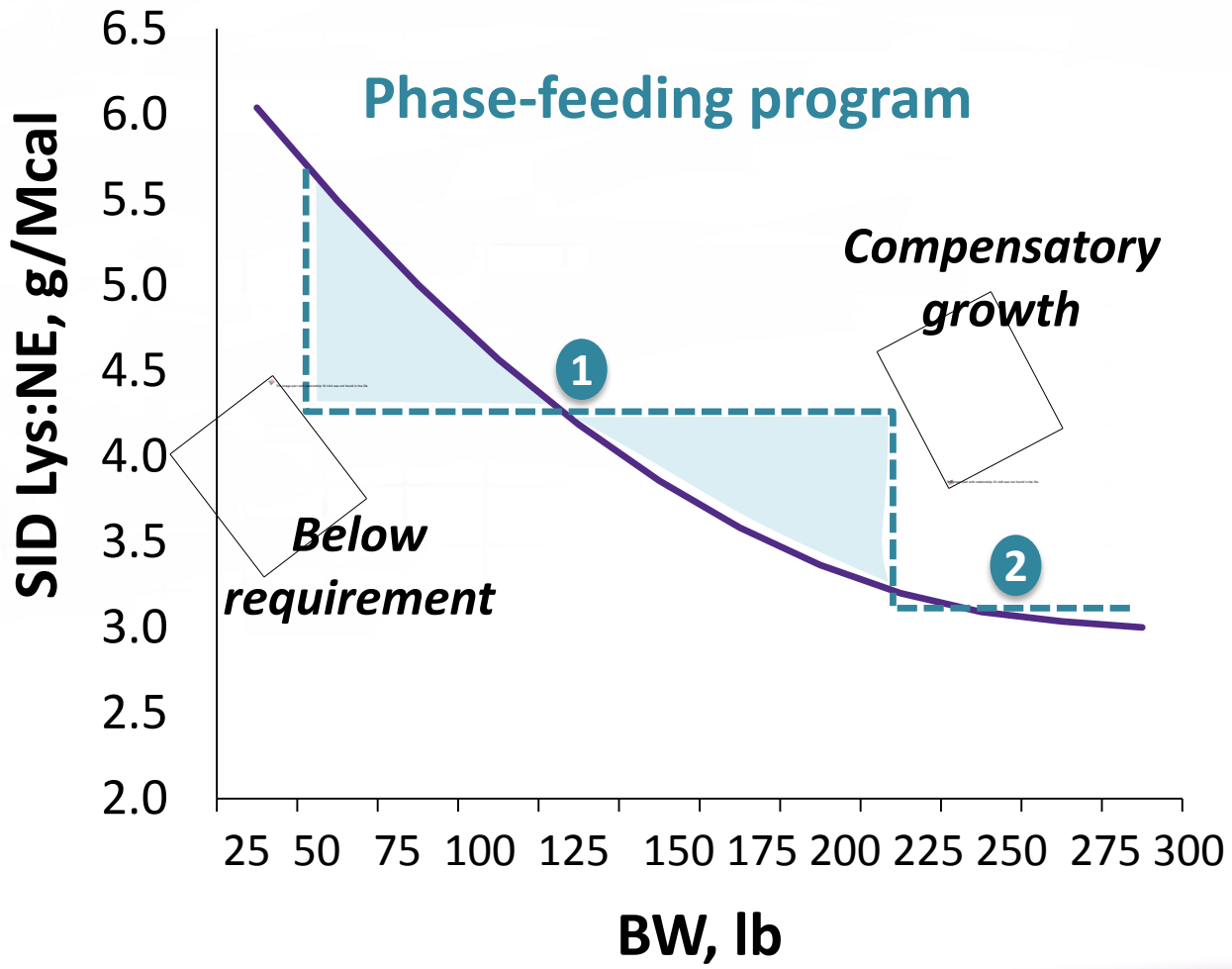


Minimum ratios for other amino acids relative to lysine

	Weight range, kg			
	25 to 50	50 to 75	75 to 100	100 to 135
Isoleucine[a]	52	52	52	52
Leucine	100	100	100	100
Met & Cys	56	56	56	58
Threonine	61	62	63	65
Tryptophan[b]	18 - 21	18 - 21	18 - 21	19 - 21
Valine	68	68	68	70

[a]Diets with high leucine (ex. > 140% of Lys) require higher isoleucine (ex. > 60% of lysine) and valine (ex > 72% of lysine).
[b]Optimal tryptophan:lysine ratio depends on value of weight gain.

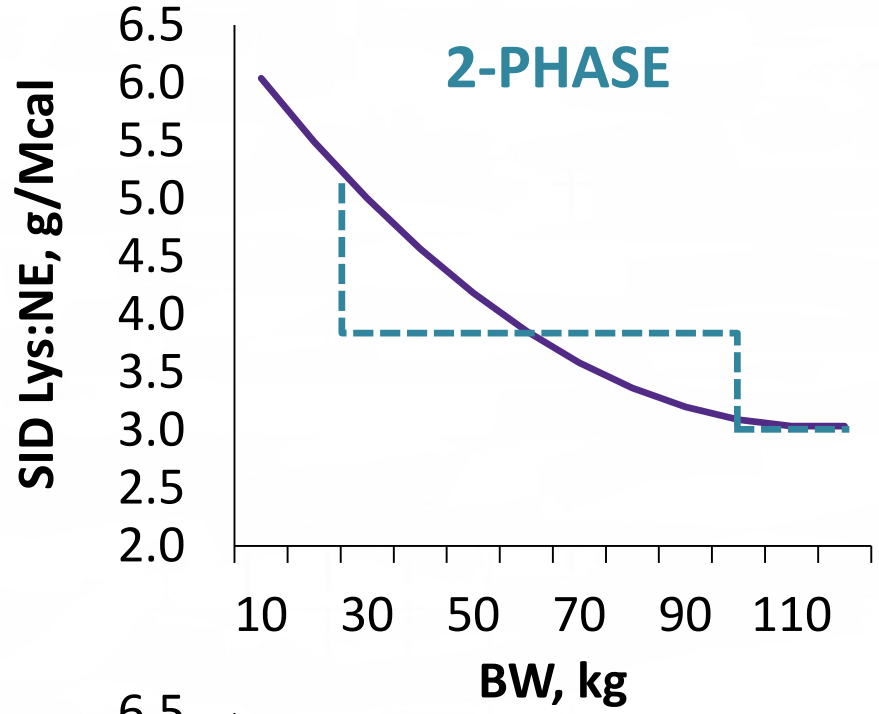
How many dietary phases?



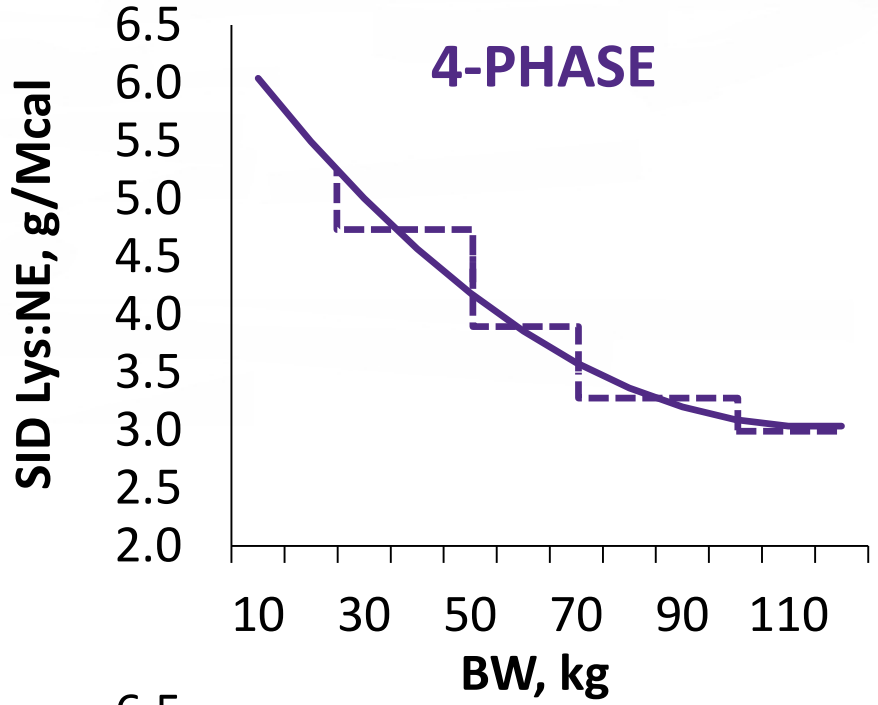
- Simplification of phase-feeding strategies induces compensatory growth
- As long as restriction:
  - Too great;
  - Too long; and
  - Dietary lysine is high enough and time is long enough to allow for compensation.

Menegat et al., 2019

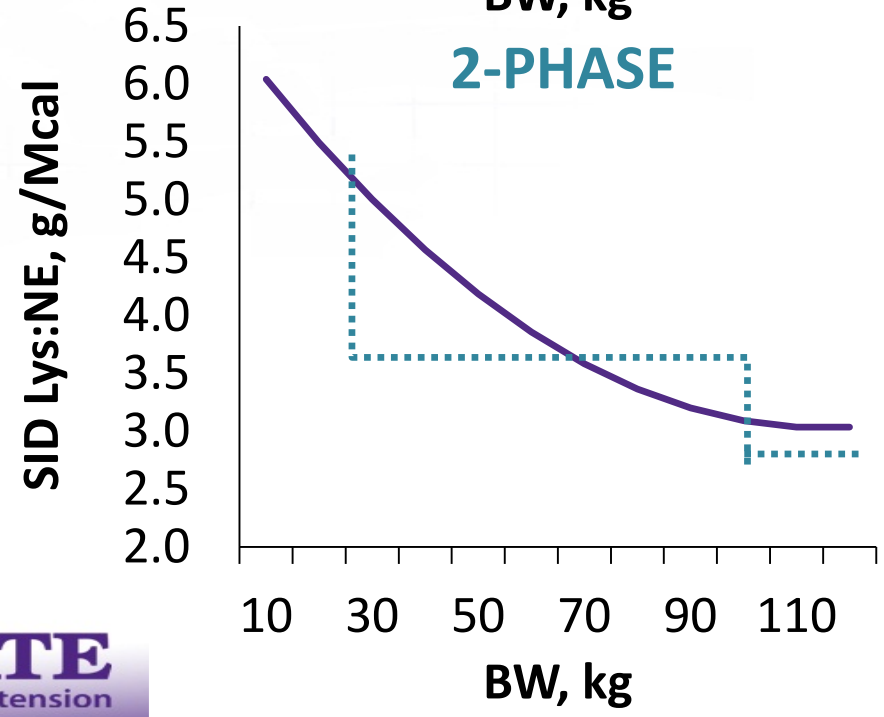
Max performance



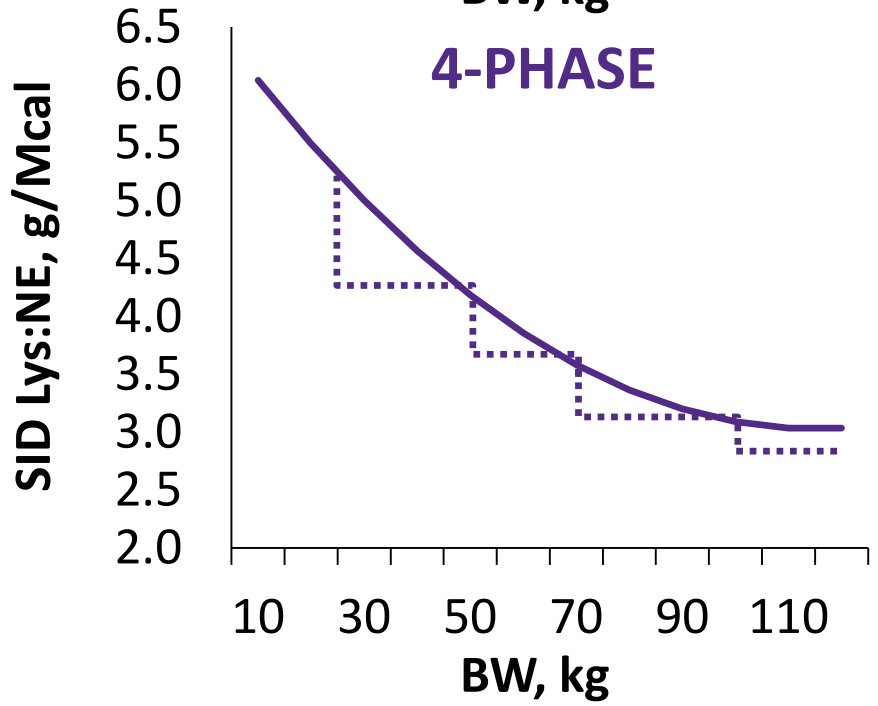
=



Lowest cost

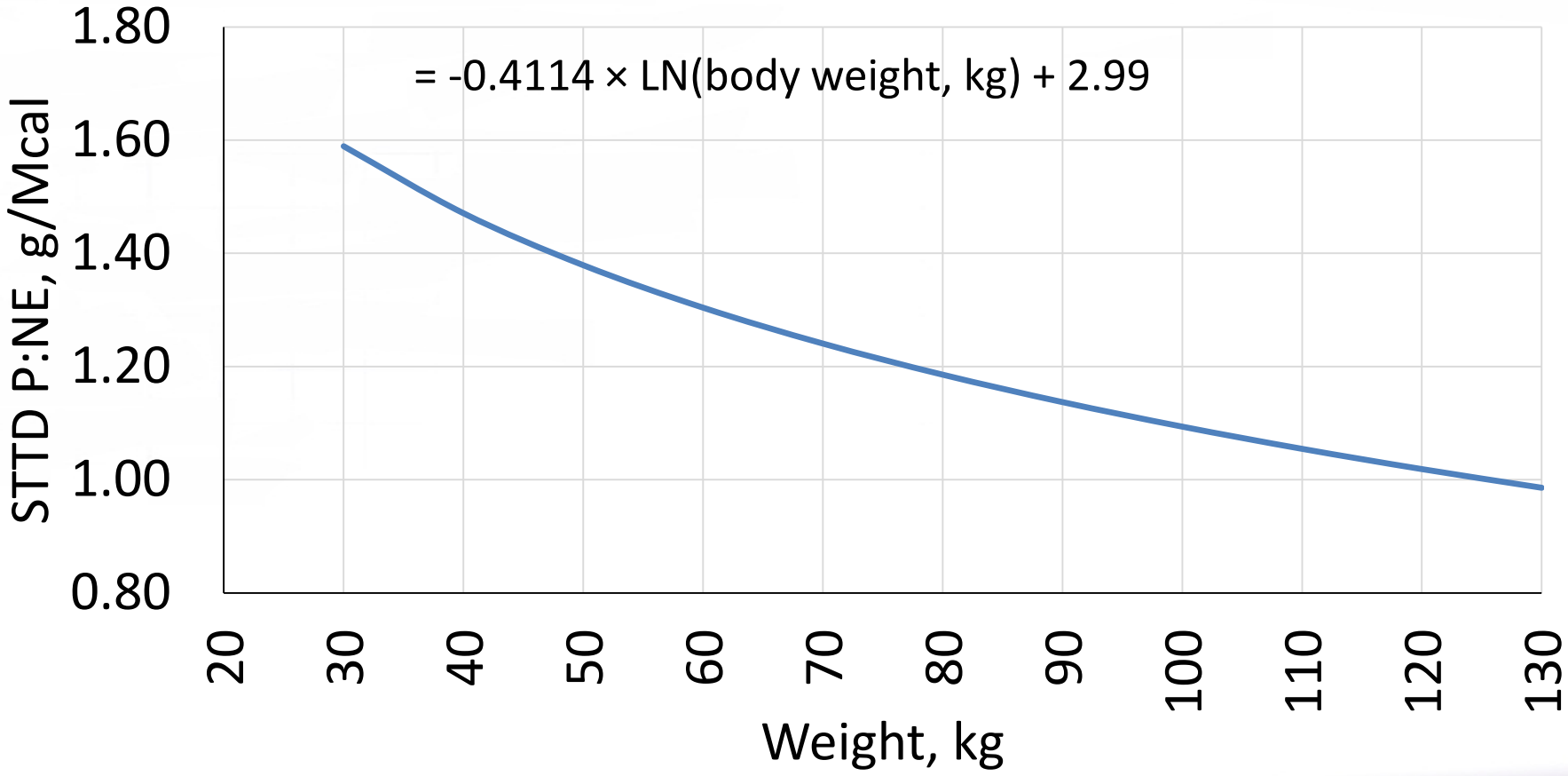


≠



K-STATE Research and Extension

STTD P requirement of finishing gilts for maximum growth and feed efficiency (Includes use of high phytase levels)



Vier et al., 2017

Calcium:phosphorus ratios

- Total Ca:Total P
- Analyzed Ca:STTD P
- Total Ca: STTD P
- Analyzed Ca:Analyzed P
  - 1.25:1
- STTD Ca: STTD P
  - 1.4 to 1.65:1

Diet formulation for grow-finish pigs

1) Energy density
2) Lysine:calorie ratio
3) Amino acid:Lys ratios
4) STTD P:calorie ratio
5) Ca:P ratio
6) Vitamins & minerals
7) Feed additives

Vitamins and minerals

- Recommended levels vary considerably (Flohr et al., 2015)
- Lower margins of safety for increased profitability do not lower performance (Del Tuffo et al., 2018)
  - www.KSUswine.org for current recommendations
- Copper added at growth promoting levels, especially in early finishing

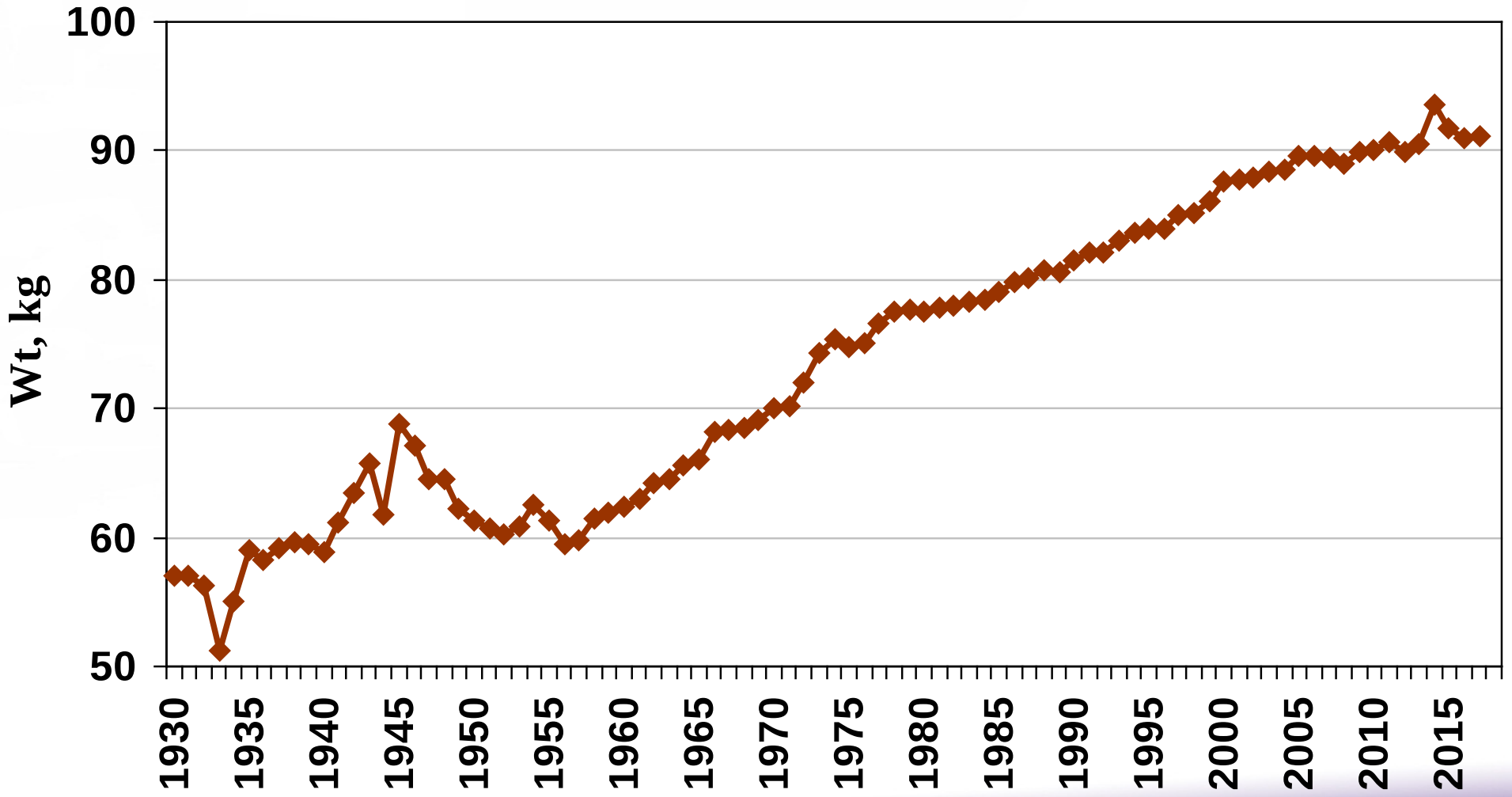
Practical diet considerations to optimize profit in growing-finishing pigs

- Grow-finish feed ≈ 80% of feed use!
- Determining the most economical energy level
  - Influence of dietary fiber and fat on dressing percentage and fat quality.
  - A consistent method to estimate net energy or productive energy for individual ingredients.
- Lysine:calorie ratio and number of diet phases
  - Amino acid ratios to lysine
- Phosphorus:calorie ratio and Ca:P ratio
- Vitamins, trace minerals, and salt
- Feed additives
  - Thoroughly evaluated before using

How is this impacted by increased market weights?

K-STATE Research and Extension

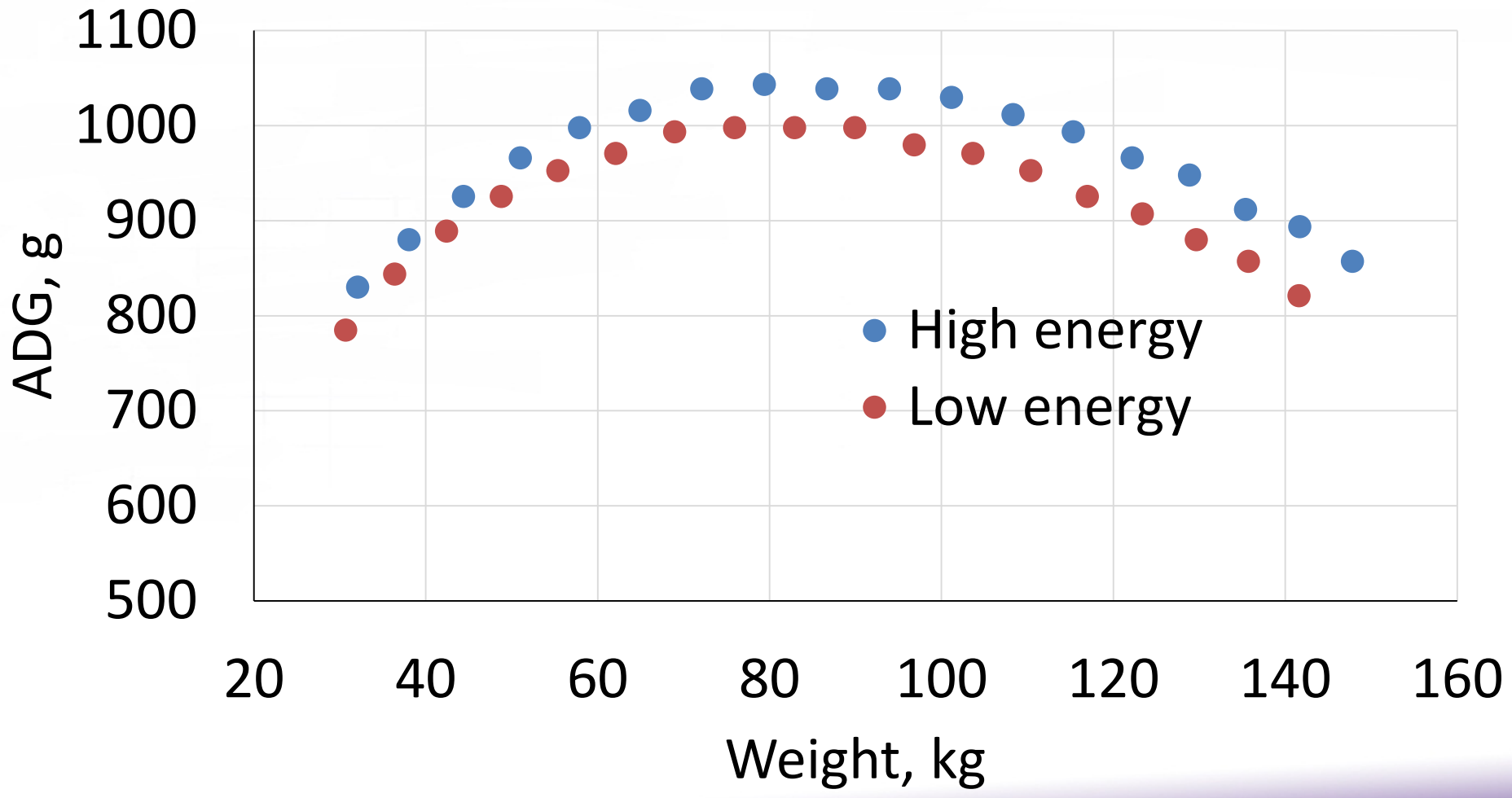
Average U.S. Hog Carcass Weight



Marketing weight is an important economic variable in finishing pig production

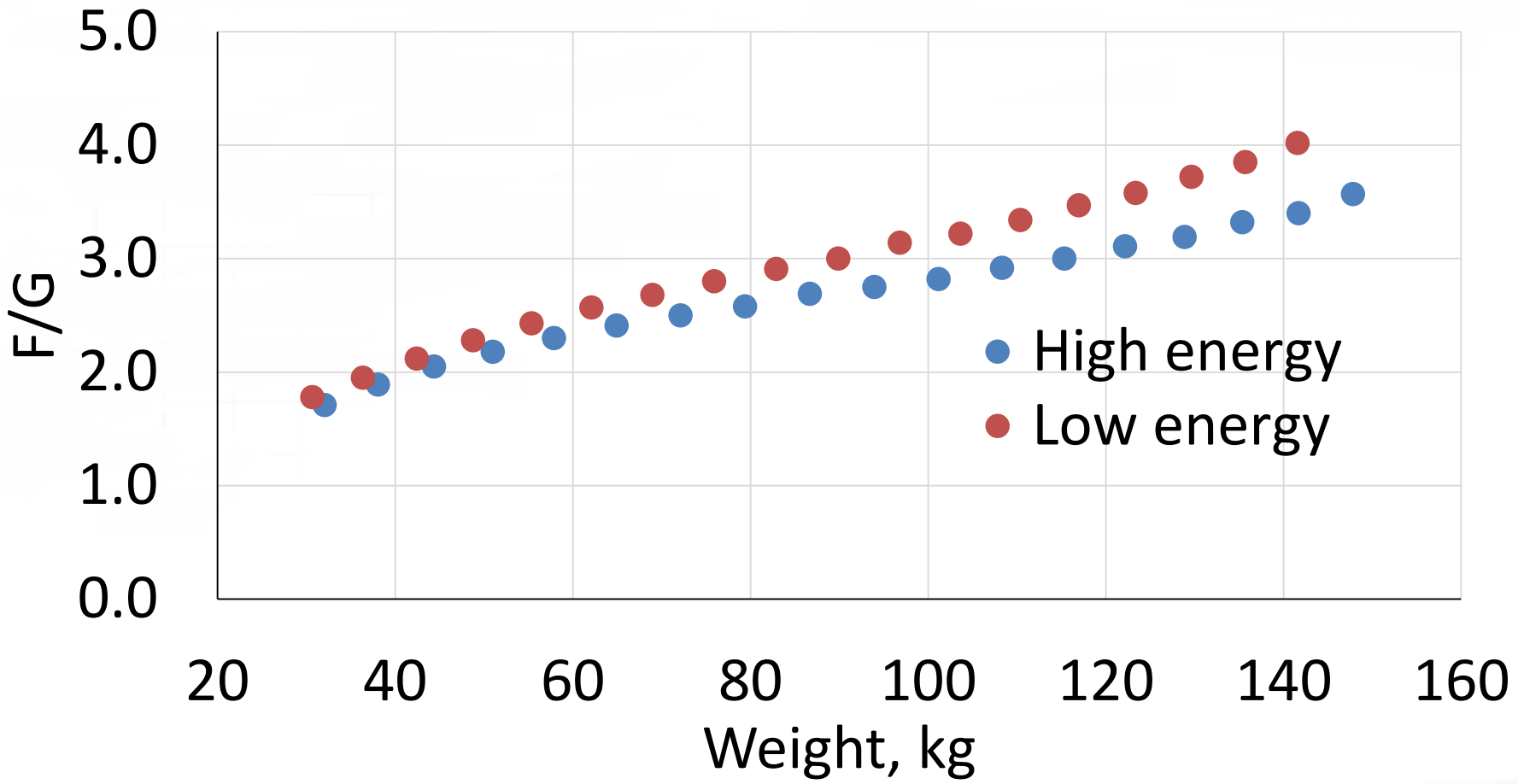
- Reasons for increasing marketing weight
  - Dilute fixed production cost and processing cost
  - Genetic improvement
- Discussion for heavier pigs
  - Growth efficiency
  - Nutritional requirement
  - Health/immune status
  - Farm facility and equipment adjustments
  - Carcass processing
  - Meat quality

Performance of pigs to heavy weights



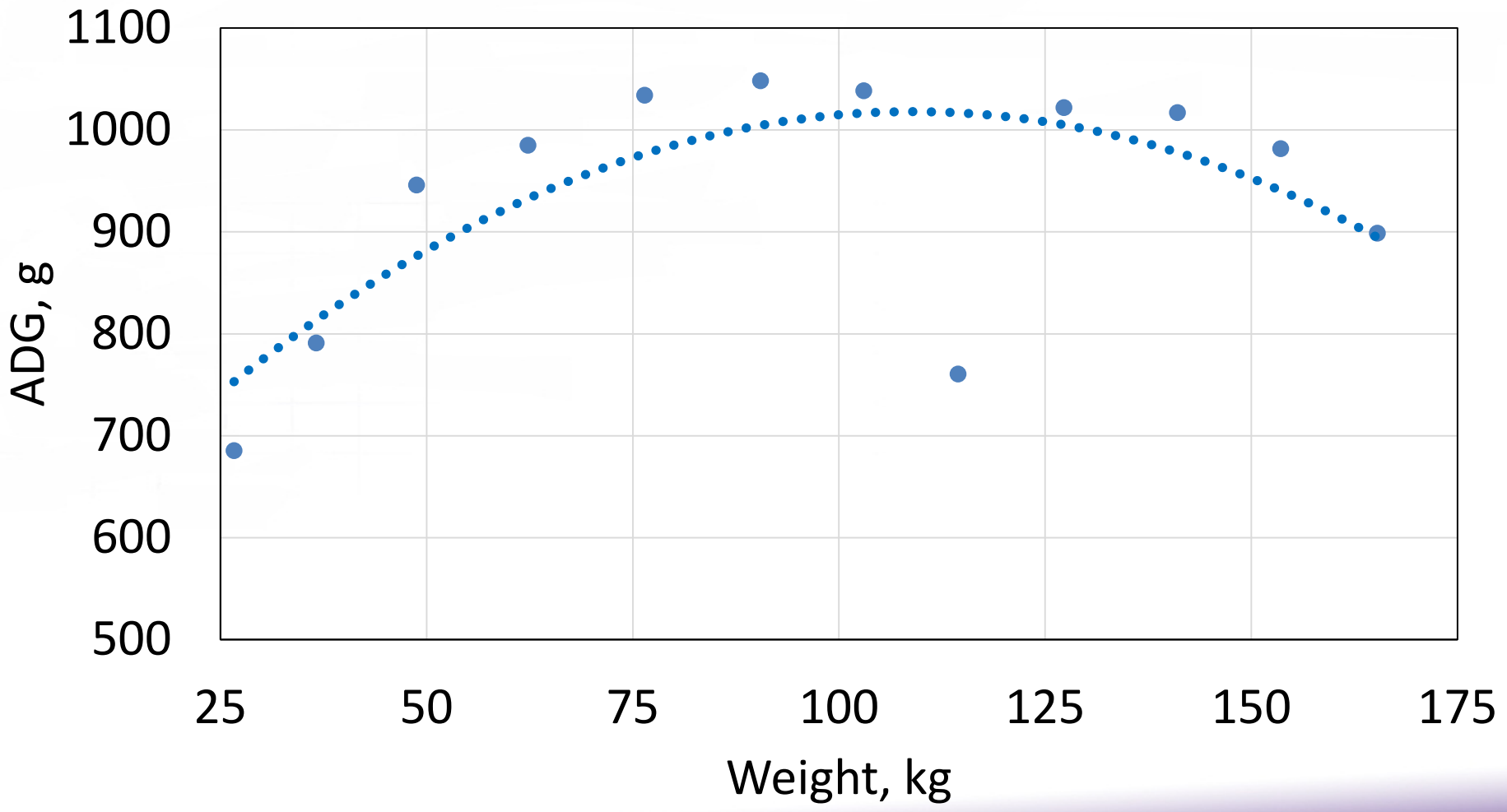
PIC (2015)

Performance of pigs to heavy weights



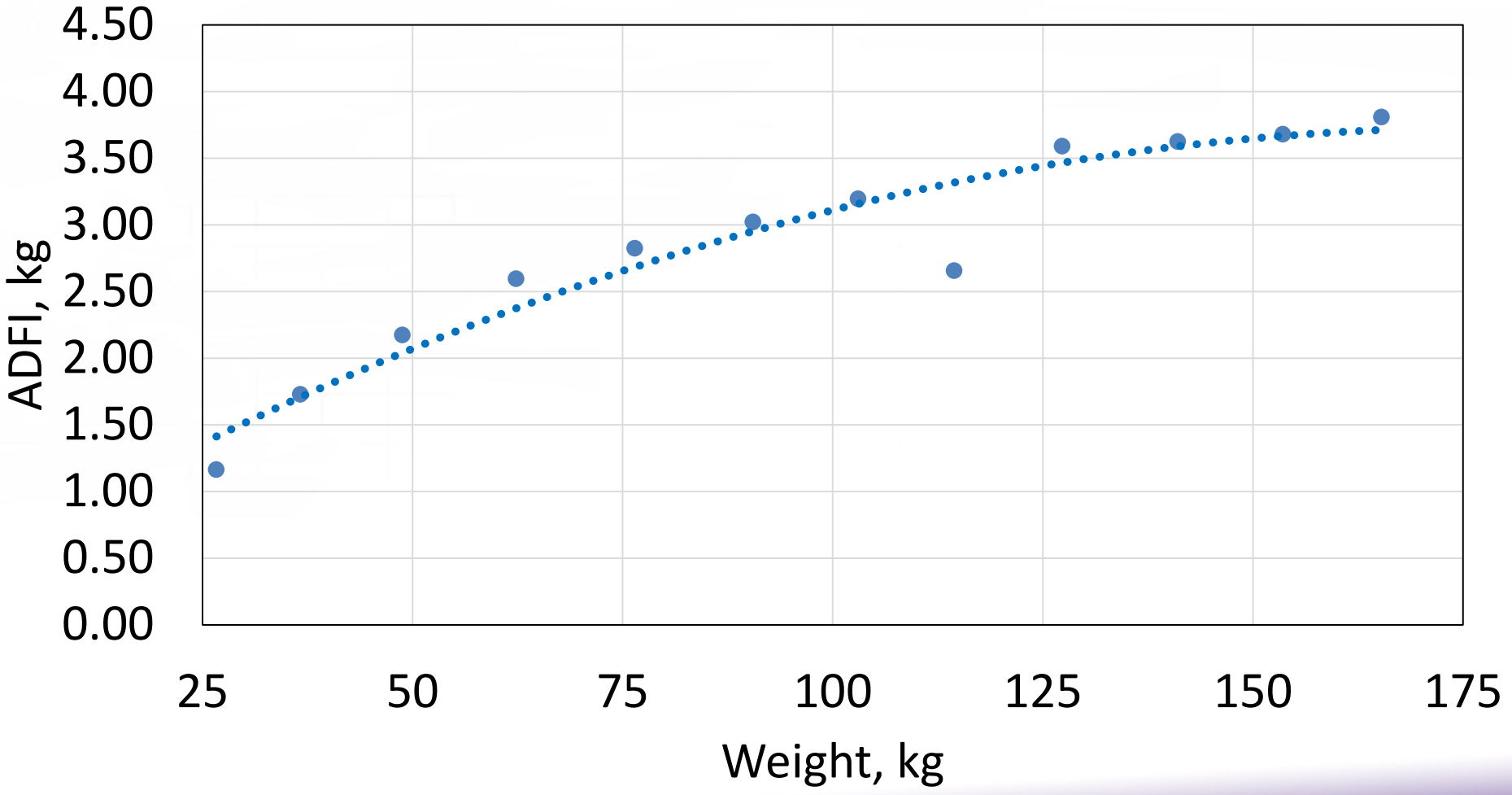
PIC (2015)

Performance to heavy market weights



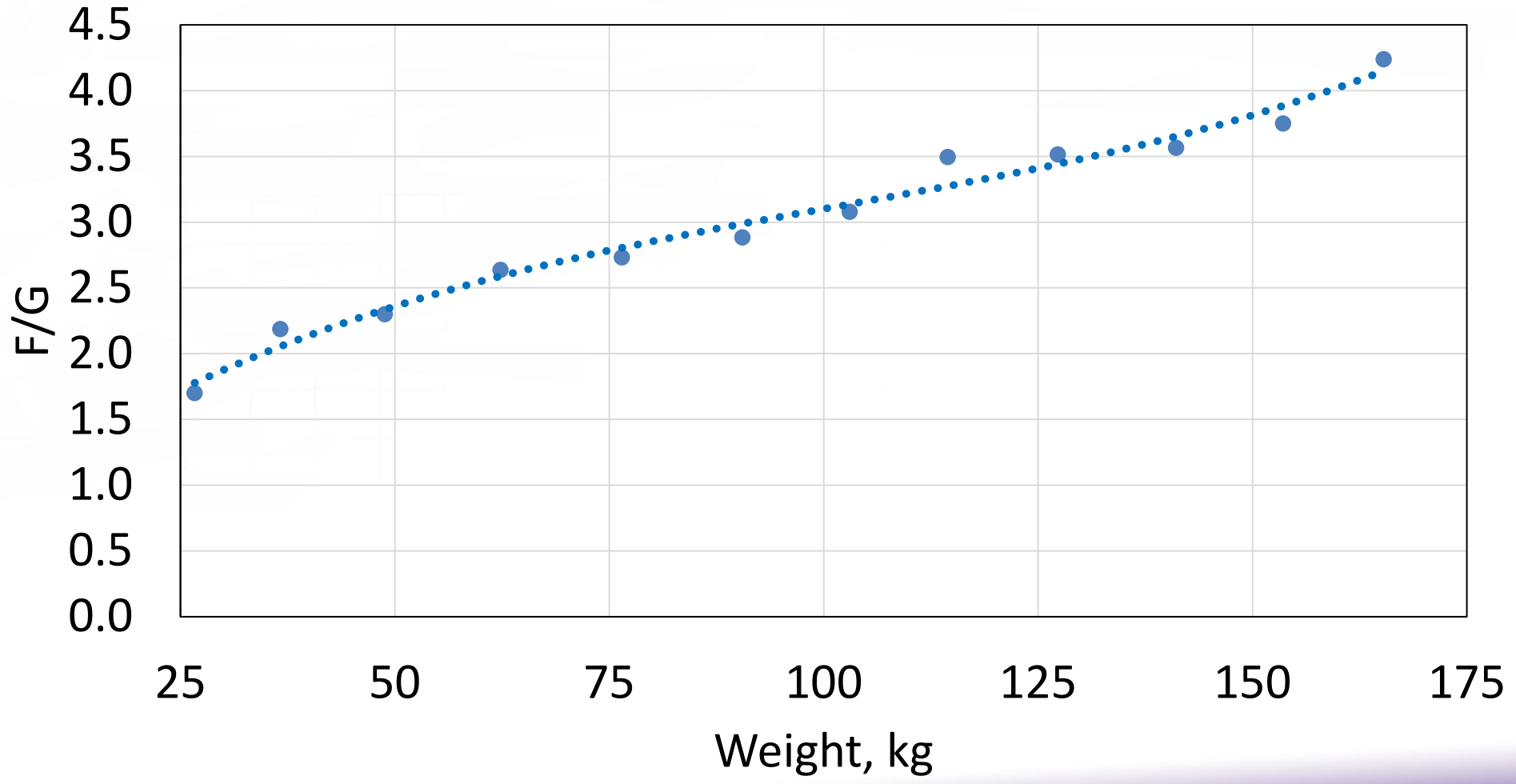
Lerner et al. (2018)

Performance to heavy market weights



Lerner et al. (2018)

Performance to heavy market weights



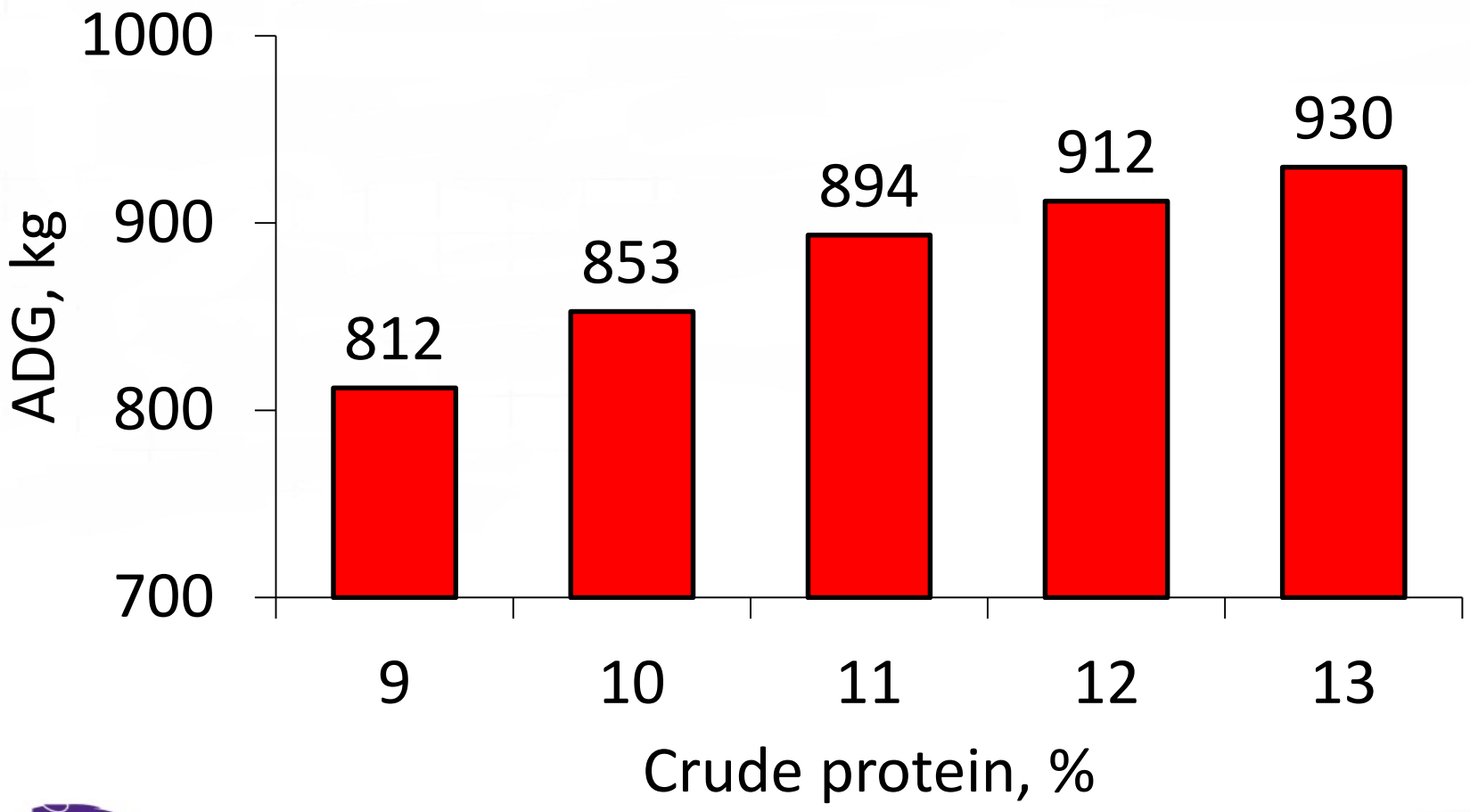
Lerner et al. (2018)

Factors to consider when increasing marketing weight

Nutrition

- Pigs with greater marketing weight have different nutritional requirements
  - Decreased lean gain rate
  - Increased maintenance needs
- SID Lys - 20 g/kg of gain = still good rule of thumb
  - 0.55 to 0.70% SID Lys depending on genetics and feed intake
- Threonine, methionine, and tryptophan to lysine ratios are greater in older pigs than in younger pigs
- Maintain minimum crude protein?

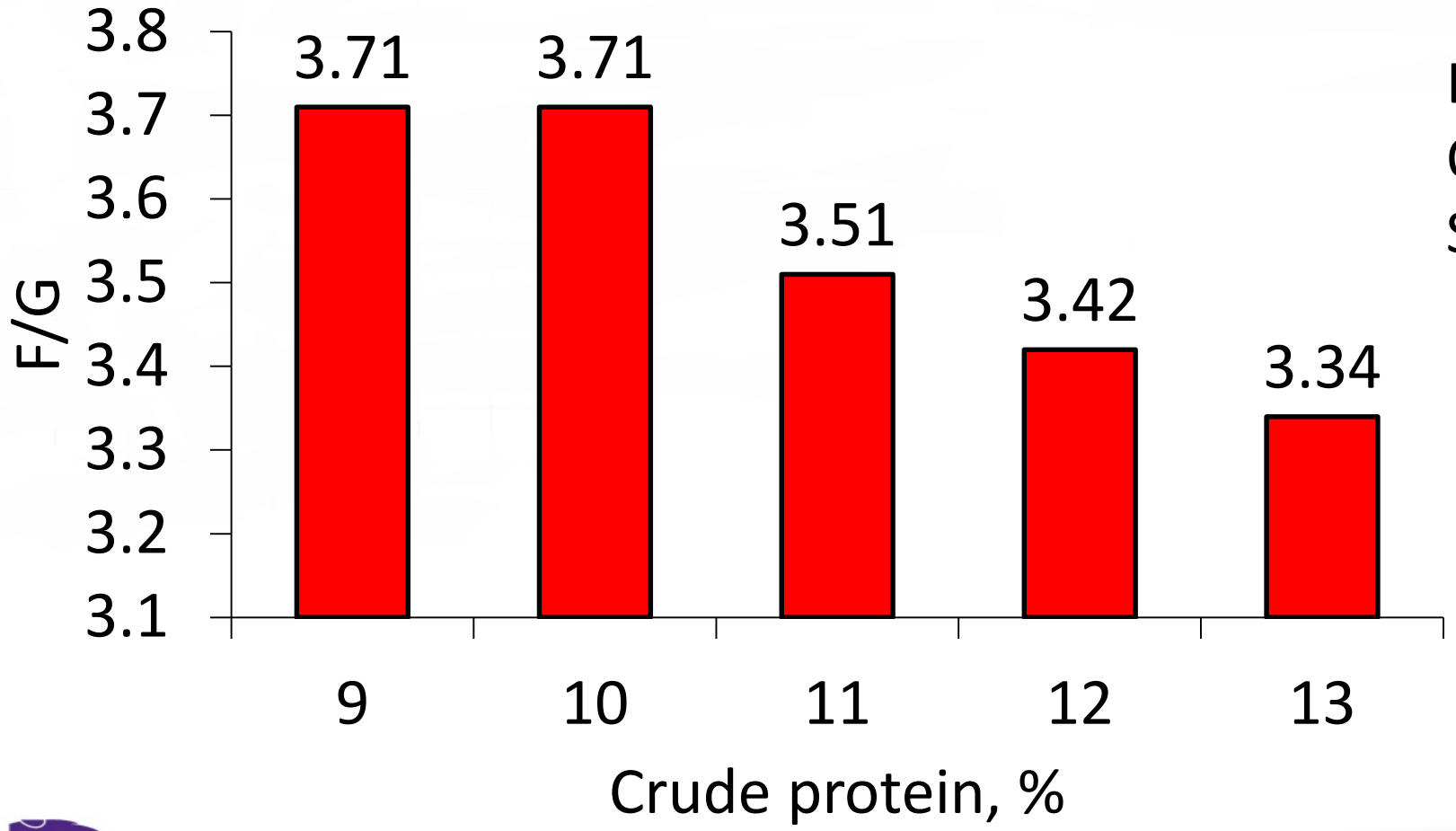
Optimum levels of crude protein in finishing pigs from 110 to 135 lb



Linear, $P = 0.508$
Quadratic, $P < 0.001$
SEM = 0.050

Soto et al., 2017

Optimum levels of crude protein in finishing pigs from 110 to 135 kg



Linear, $P = 0.336$
Quadratic, $P < 0.001$
SEM = 0.057

Soto et al., 2017

Floor space

- Greater floor space is needed for heavy pigs
  - Floor space allowance, $m^2 = k \times (BW, kg)^{0.667}$
    - Critical k = 0.0336 (Gonyou et al., 2006)
    - ~ 0.02 m^2 increase/5 kg increase in BW

BW, kg	125	130	135	140	145	150
Floor space, m^2	0.84	0.86	0.89	0.91	0.93	0.95

- Removal strategy

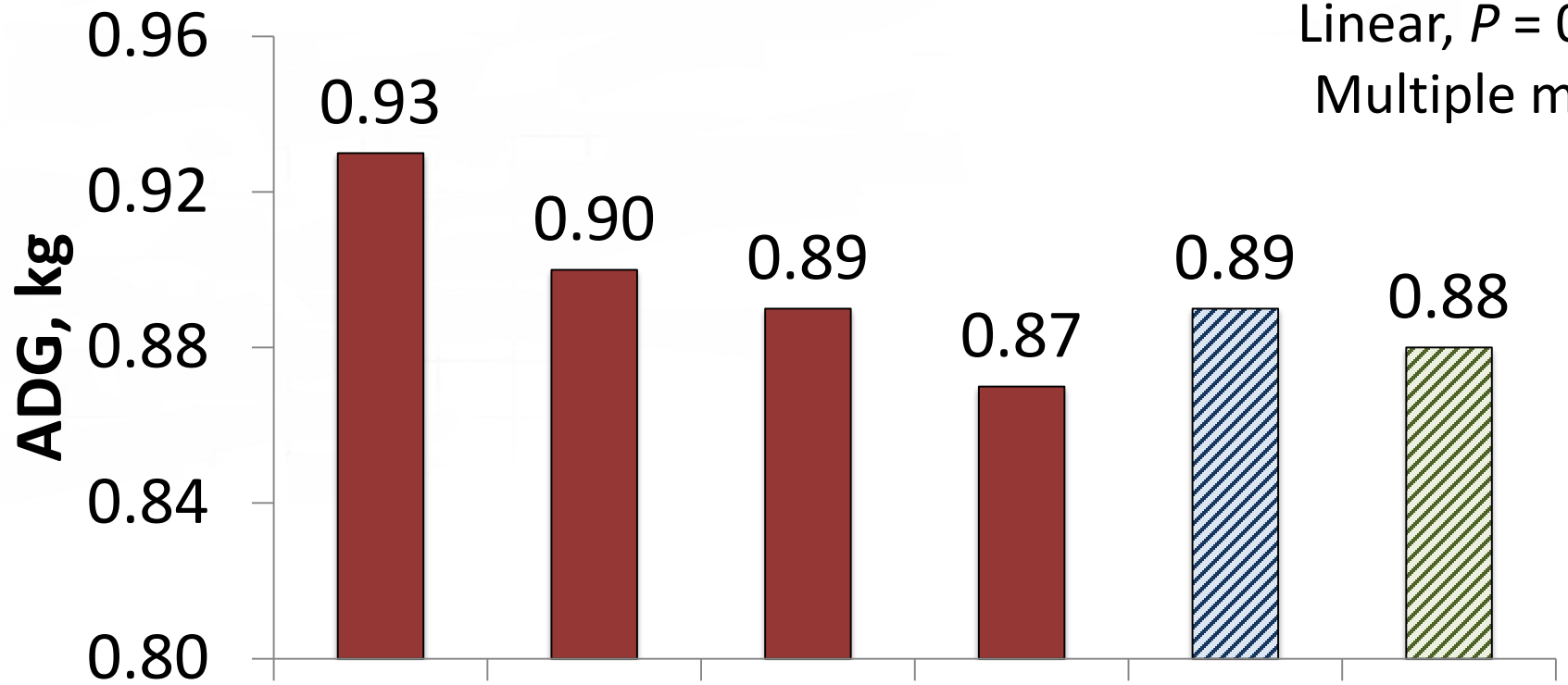
Floor space with heavy weight pigs

ADG, d 0 to 160

SEM = 0.008

Linear, *P* = 0.001; Quad, *P* = 0.713

Multiple market vs trt 4, *P* > 0.05



Initial Space, M²:	1.17	0.97	0.92	0.71	0.66	0.71
Final space, M²:	1.17	0.97	0.92	0.71	0.97	0.97

Lerner et al., 2018

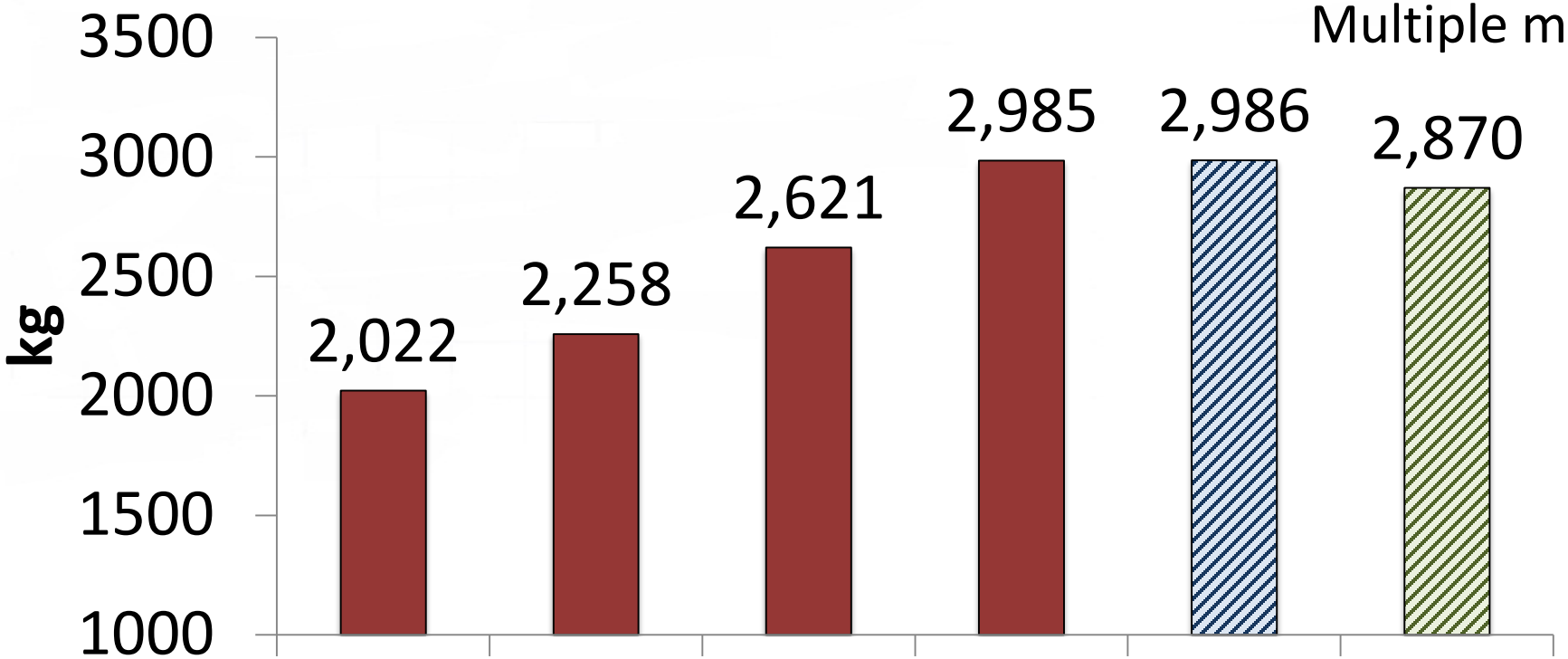
Floor space with heavy weight pigs

Total weight marketed per pen

SEM = 95.4

Linear, *P* = 0.001; Quad, *P* = 0.081

Multiple market vs trt 4, *P* > 0.05



Initial Space, M²:	1.17	0.97	0.92	0.71	0.66	0.71
Final space, M²:	1.17	0.97	0.92	0.71	0.97	0.97

Lerner et al., 2018

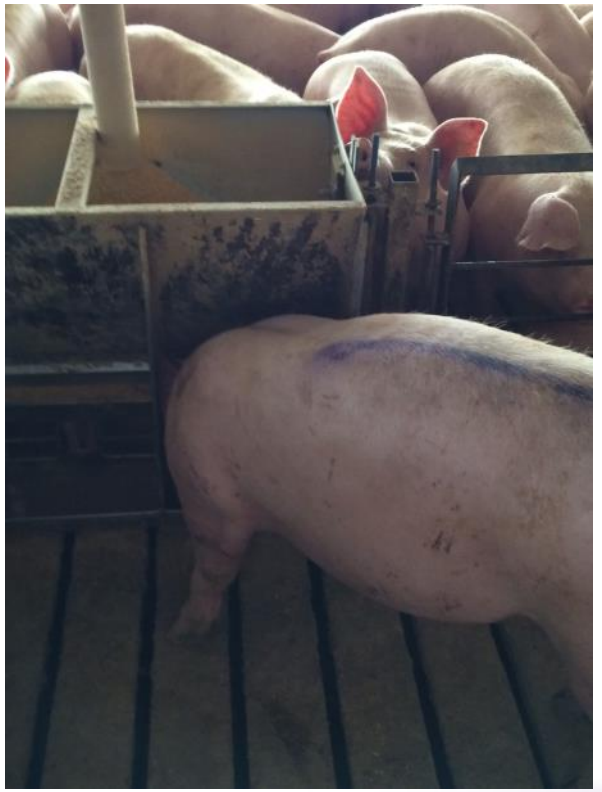
Barn design

- Feeder space
  - Feeder hole size = 1.1 × shoulder width (Brumm, 2014)
    - Shoulder width, mm = $64.0 \times (\text{BW, kg})^{0.33}$ (Petherick, 1983)
- Water (Gonyou, 1996)
  - Nipples pointed straight out: height, cm = $15 \times (\text{BW, kg})^{0.33}$
  - Nipples pointed downwards: height, cm = $18 \times (\text{BW, kg})^{0.33}$
  - Water pipe size
- Ventilation
  - Heat production, W/kg = $14.11 \times (\text{BW, kg})^{-0.38}$ (Brown-Brandt et al., 2004)

Feeder Space

- Is current feeder design functional / optimal?
  - New feeders should have 38 cm space width

Shoulder width



Angled stance to eat

Courtesy of Jason Hocker, AMVC

Challenges to Loading Out

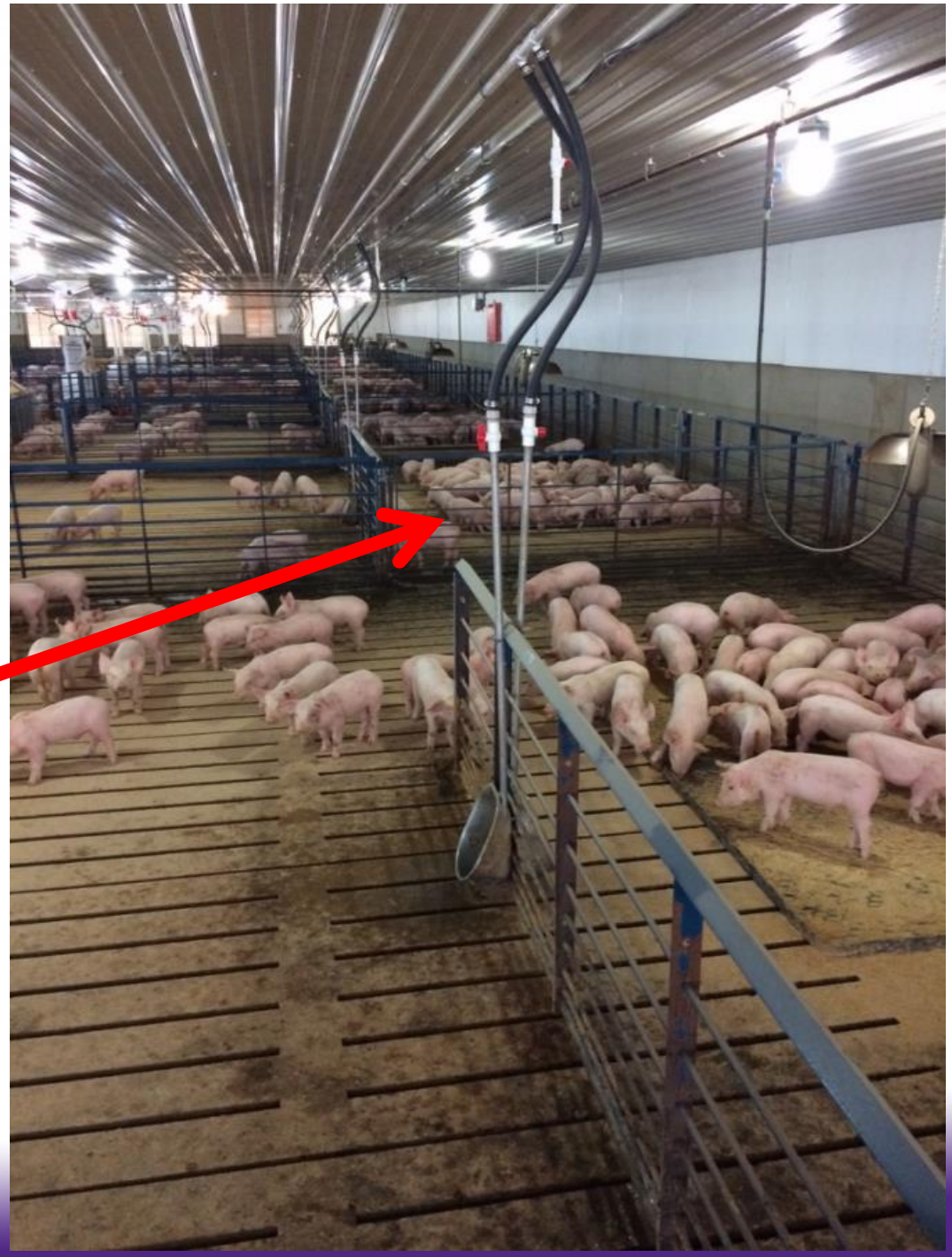
- Physical labor – injuries due to inexperienced people
- Late evening to early morning hours
- The culture of “hurry, we have to be done ASAP”
- Narrow alleyways
- Poor lighting
- Structural damage due to heavier pigs

All of these issues are exacerbated with heavier pigs

Are alleys wide enough?

Courtesy of Jason Hocker, AMVC

New Pen Layout



Courtesy of
Jason Hocker, AMVC

Wide 3 meter alleyway

Courtesy of Jason Hocker, AMVC

Funneling Pigs Out

Courtesy of Jason Hocker, AMVC

Funneling Pigs Out

Courtesy of Jason Hocker, AMVC

Transportation

- More transportation loss was observed for heavier pigs (Fitzgerald et al., 2009)
- Greater truck space is needed

Body weight, kg	125	130	135	140	145	150
Truck space, m^2	0.43	0.44	0.45	0.47	0.48	0.50
Pigs/truck	163	156	151	145	140	136

Grandin (2012)

- Trailer design
  - 15° or less ramp angle is recommended for pigs > 125 kg

Considerations for packing plants

- Reduce line speed
  - CO_2 chamber capacity
  - Carcass handling
- Increased carcass length/weight
  - Height of ceiling - proper exsanguination
  - Depth of scalding tanks – de-hairing and scalding
  - Manual operation on carcass splitting, spinning, handling
  - Rail strength
  - Storage capacity

Effect of pork carcass weight on trained sensory panel rating of boneless loin chops

Hot carcass weight class	Tenderness 1=extremely tough 10=extremely tender	Juiciness 1=extremely dry 10=extremely juicy
< 112 kg	5.9[a]	5.6[a]
112-119.3 kg	6.2[b]	5.8[b]
119.3-125.7 kg	6.3[bc]	6.1[c]
≥ 125.7 kg	6.5[c]	6.1[c]

Shackelford et al., 2019

Summary

- Marketing weight will continue to increase
- Genetic selection of lean genotype is the driving force for increasing marketing weight
- Limited information is available about nutritional requirements of pigs > 140 kg, but requirements to 130 kg are well known
- Facility design and packing plant equipment need to be adjusted for biological and physical requirements of heavy pig

Announcing the

International Conference on Pig Survivability

October 28-29, 2020 | Omaha, Nebraska

Bringing the swine industry together to discuss solutions and motivate change toward improving pig survivability.

IOWA STATE UNIVERSITY

KANSAS STATE UNIVERSITY

PURDUE UNIVERSITY

Kansas State University | applied swine nutrition

Questions?

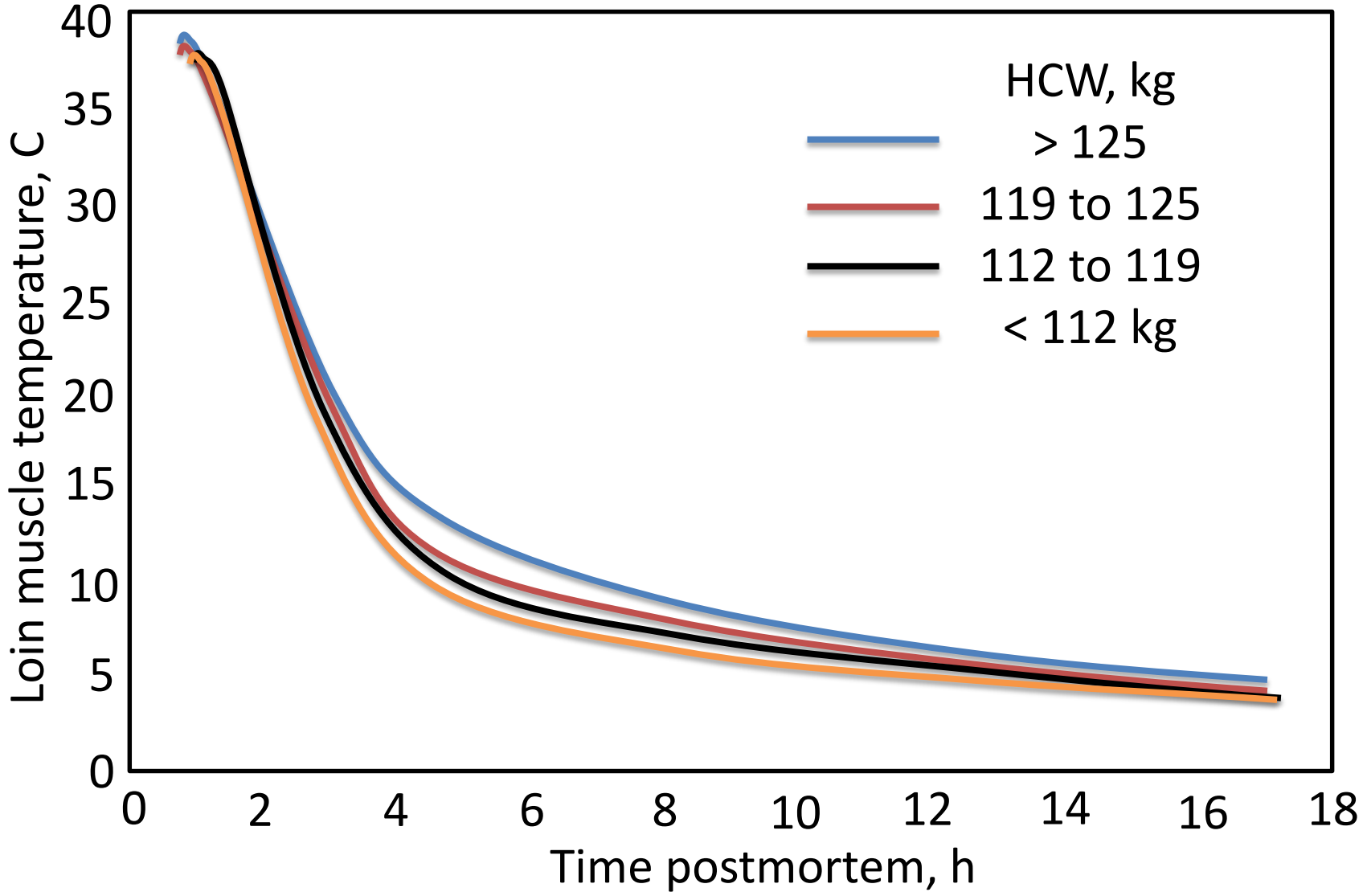
Carcass parameters to heavy weights

Criteria	Slope	P <	R2
Loin depth, mm	0.25	0.0001	0.13
Backfat depth, mm	0.14	0.0001	0.21
Lean, %	-0.075	0.0001	0.24
Iodine value, mg/g	-0.0922	0.0001	0.07

Slope = change to 1 kg change in carcass weight.
No changes in any early loin quality measurements

Dilger et al., 2019

Influence of pork carcass weight on loin muscle temperature change

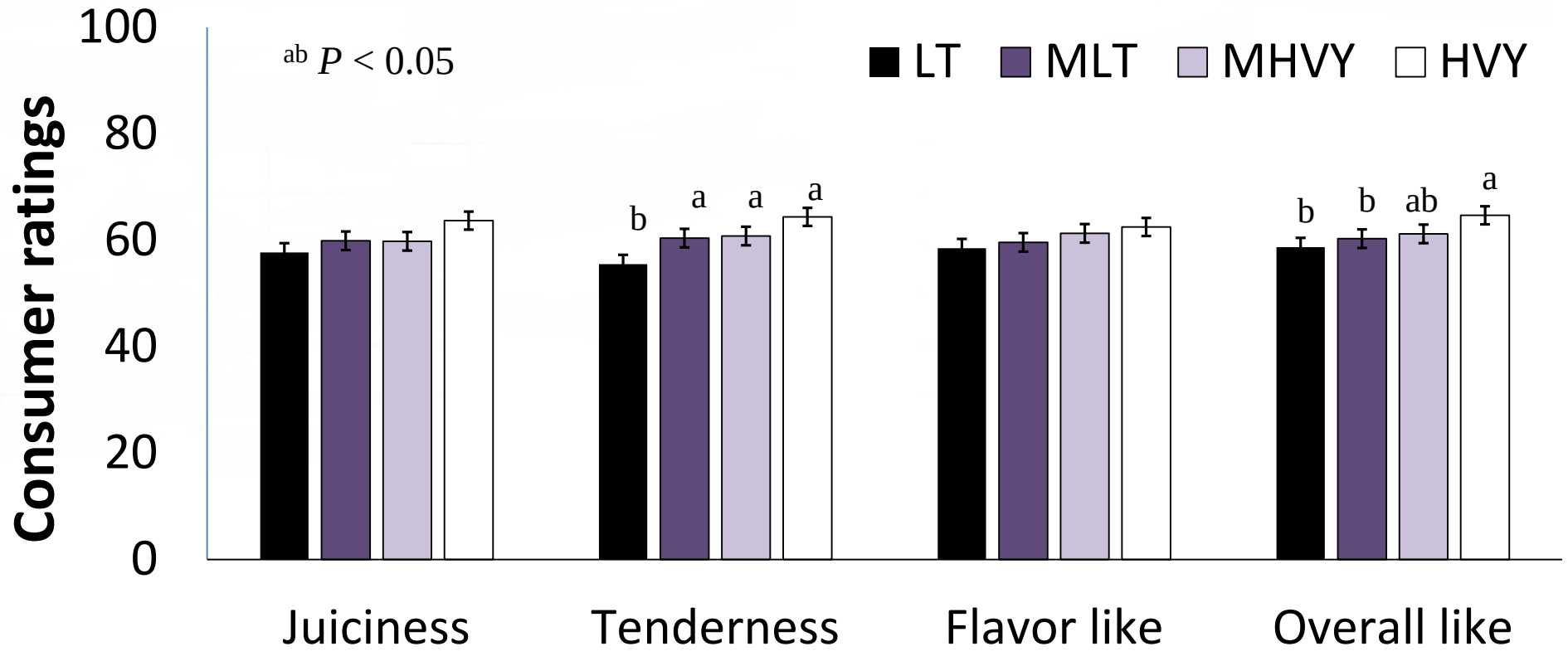


Effect of pork carcass weight on cooking loss (%) of boneless loin chops

Hot carcass weight class	Cooked to 160°F (71°C)	Cooked to 145°F (63°F)
< 112 kg	18.7[a]	12.8[a]
112-119.3 kg	18.3[a]	12.5[b]
119.3-125.7 kg	17.7[b]	12.3[b]
≥ 125.7 kg	17.7[b]	12.4[b]

Shackelford et al., 2019

Consumer palatability ratings for chops of varying hot carcass weights



Rice et al., 2019