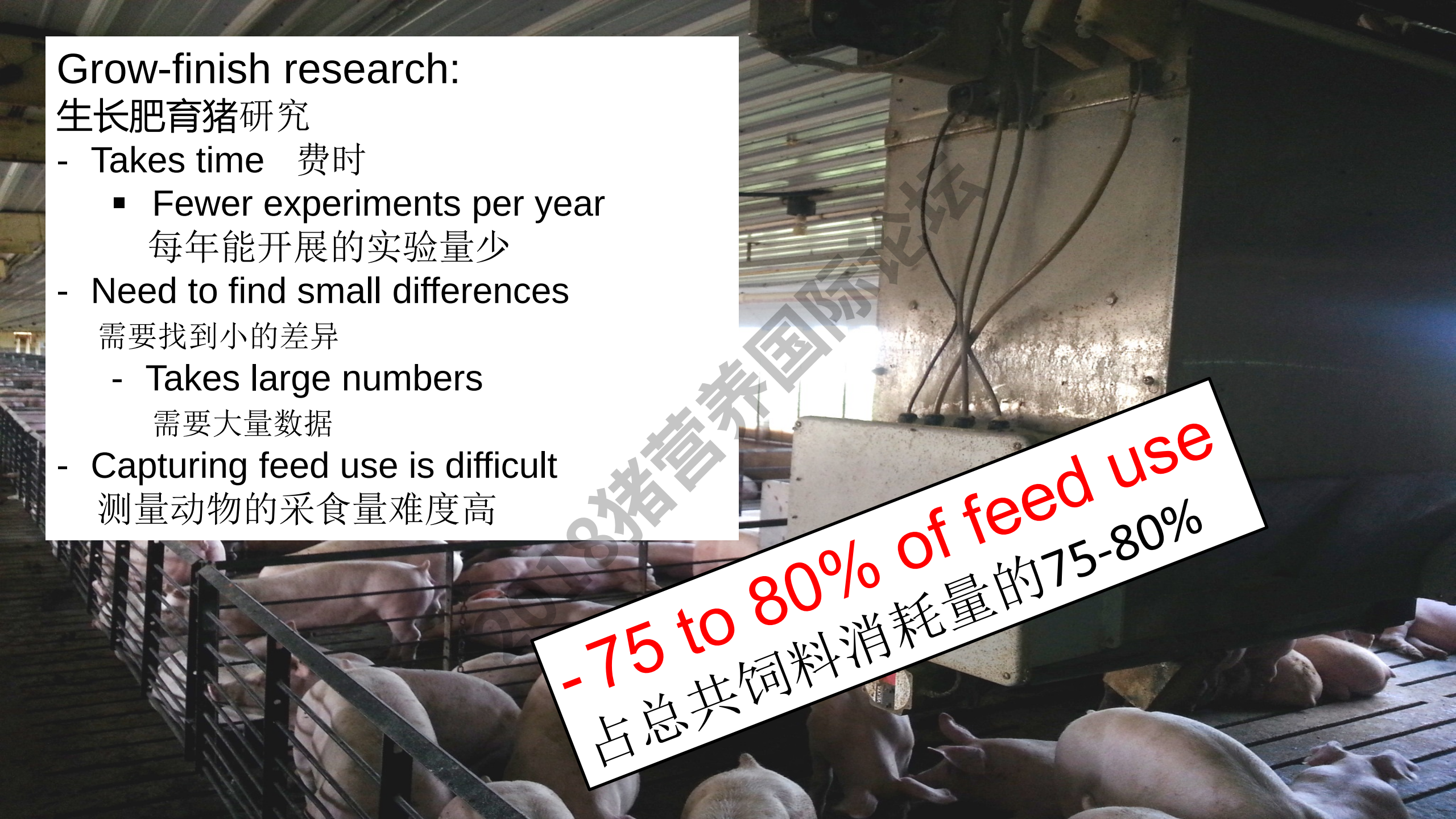
Practical diet considerations to optimize profit in growing-finishing pigs

生长肥育猪效益最大化的实用日粮方案

K-STATE Research and Extension



Grow-finish research:
生长肥育猪研究

- Takes time　费时
  - Fewer experiments per year
    每年能开展的实验量少
- Need to find small differences
  需要找到小的差异
  - Takes large numbers
    需要大量数据
- Capturing feed use is difficult
  测量动物的采食量难度高

~75 to 80% of feed use

占总共饲料消耗量的75-80%

Areas of research and concern for finishing pigs should be approached similarly to how diets are formulated
肥育猪的研究和关注领域应与配制日粮的方式类似

1）Energy density 能量浓度
2）Lysine:calorie ratio
赖氨酸能量比
3）Amino acid:Lys ratios
氨基酸与赖氨酸比
4）STTD P:calorie ratio
标准总肠道可消化磷与能量比
5）Ca:P ratio 钙磷比
6）Vitamins & minerals
维生素和矿物质
7）Feed additives 饲料添加剂

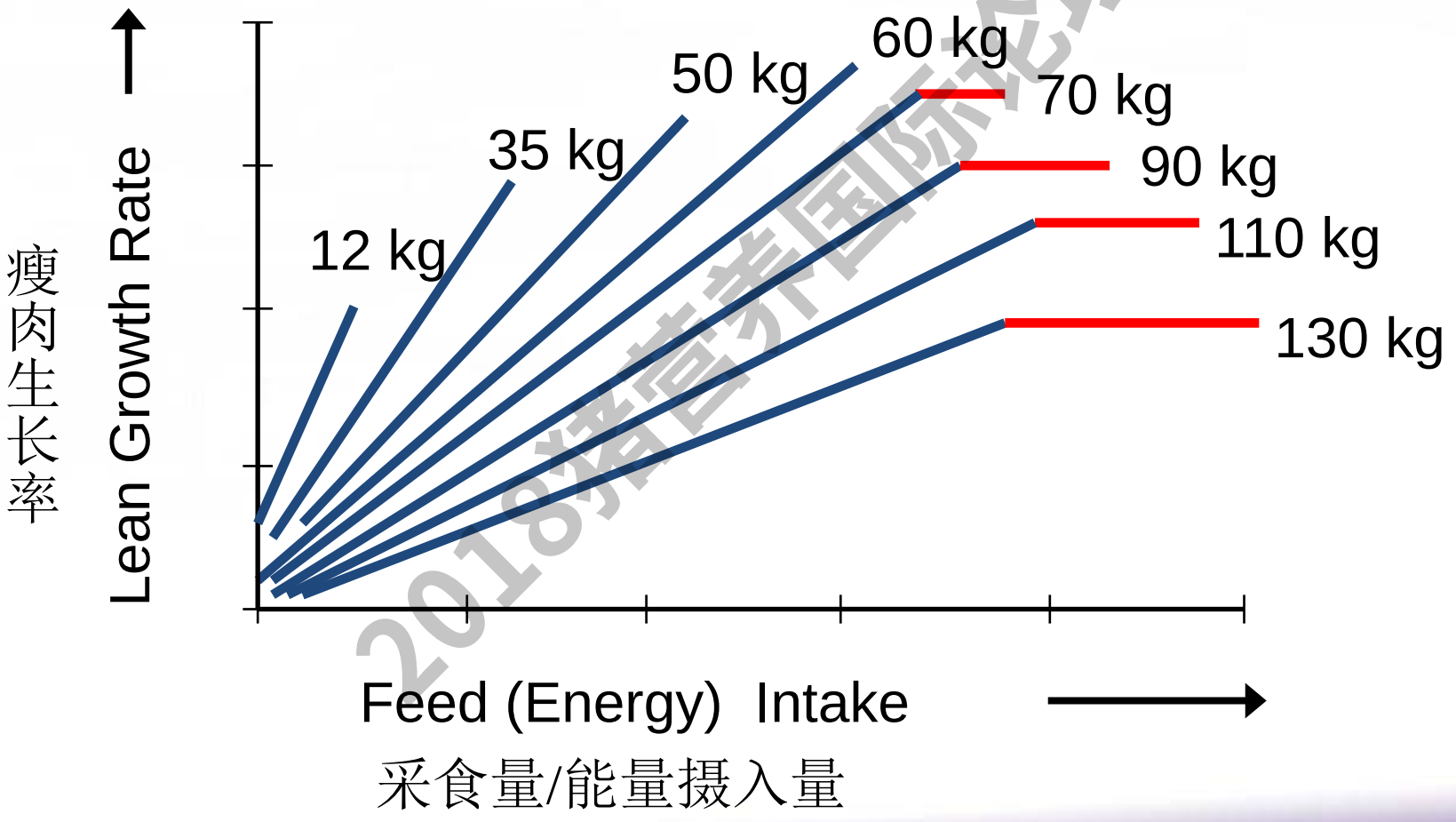
Setting dietary energy level
设定日粮能量水平

- Must know how in incremental change in dietary energy influences: 需要知道日粮能量变化对以下性能的影响：
  - Diet cost 日粮成本
  - Pig performance (ADG, F/G) 猪生长性能（平均日增重，料肉比）
  - Carcass criteria (dressing %, lean %, other) 胴体标准（屠宰率，瘦肉率等）

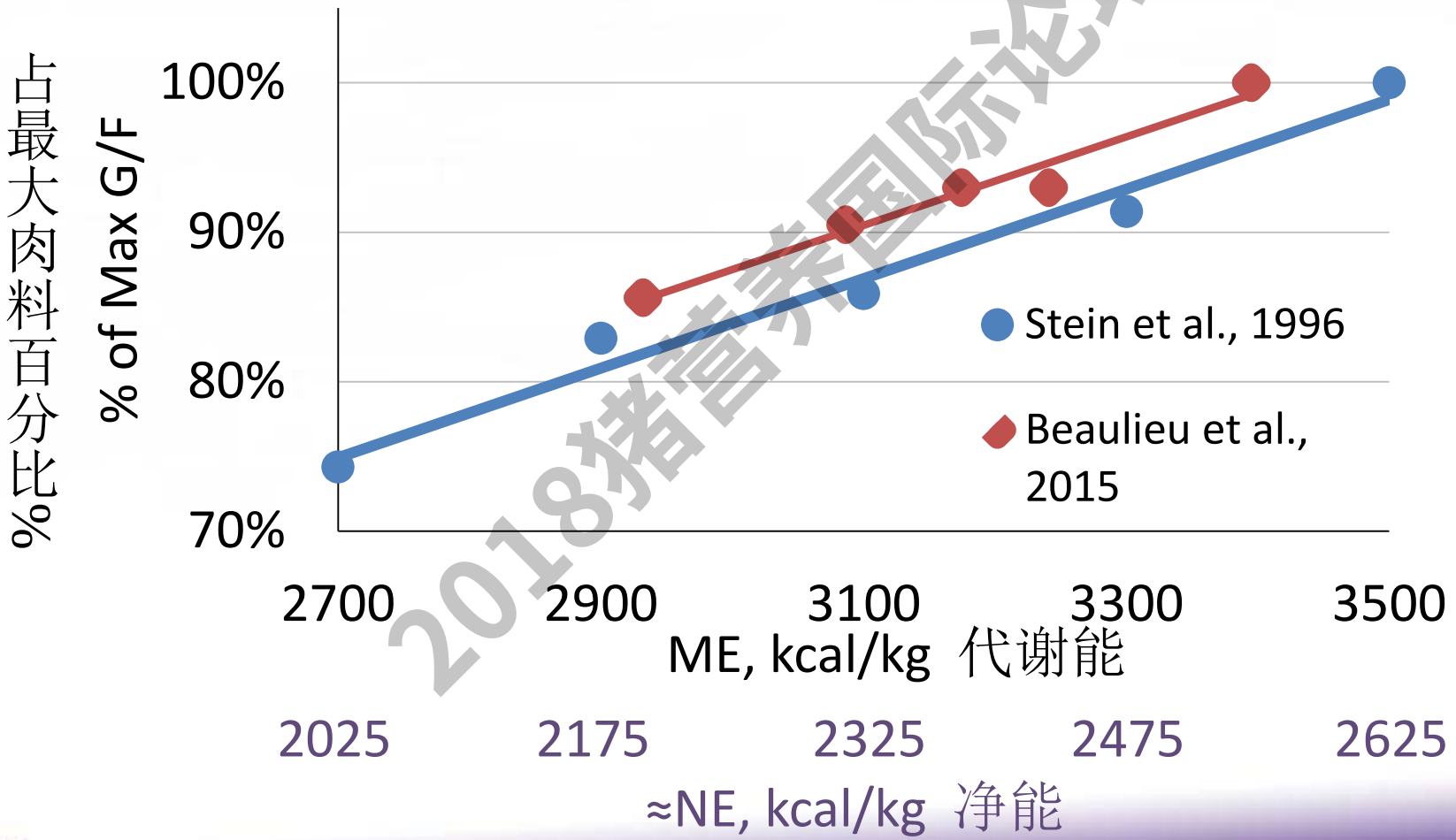
- Market price to determine value of changes in pig performance
调整猪的生长性能应该由市场价格决定

Influence of energy intake on lean growth

能量摄入对瘦肉生长的影响

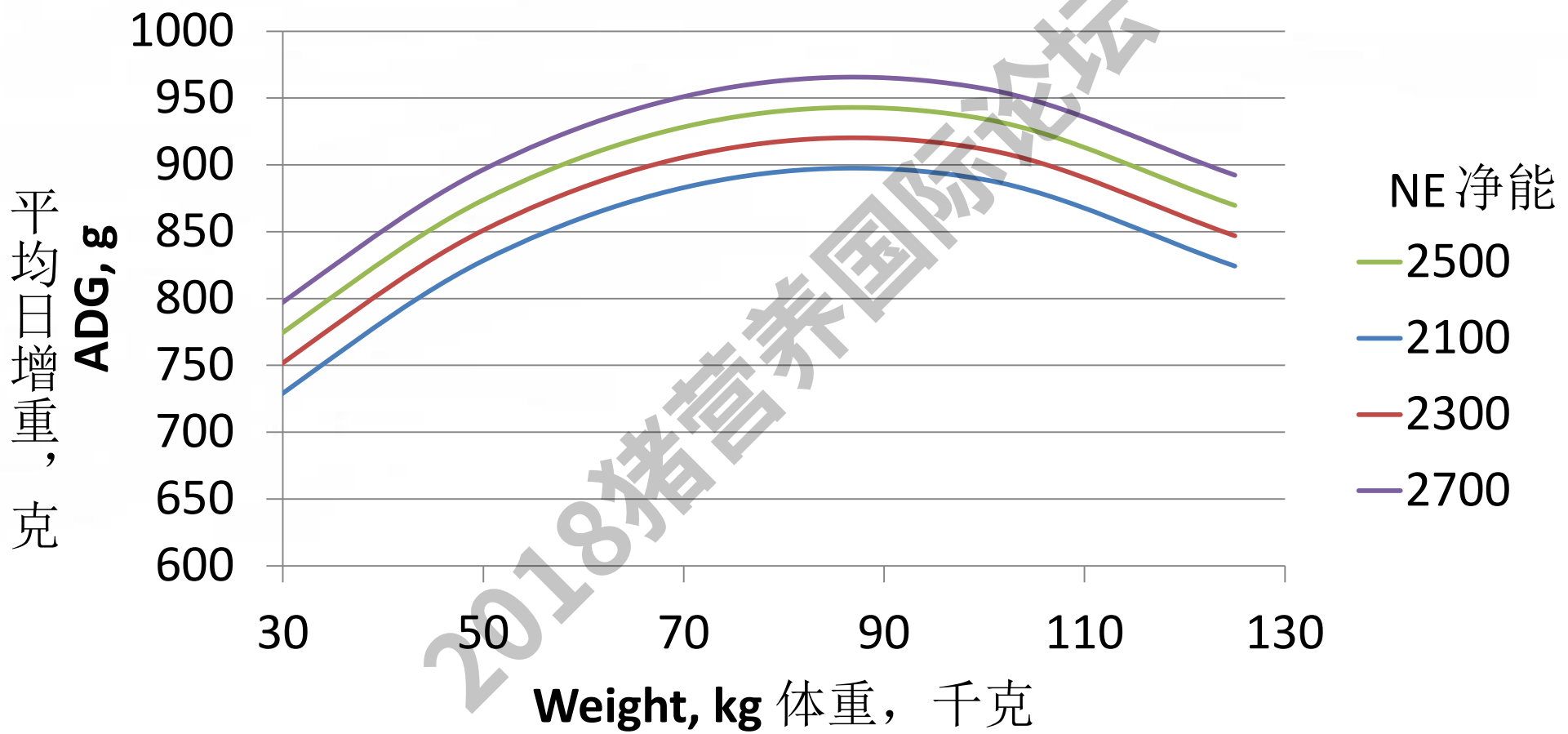


Influence of energy intake on feed efficiency
能量摄入对饲料利用效率的影响



Influence of NE on ADG

净能对平均日增重的影响

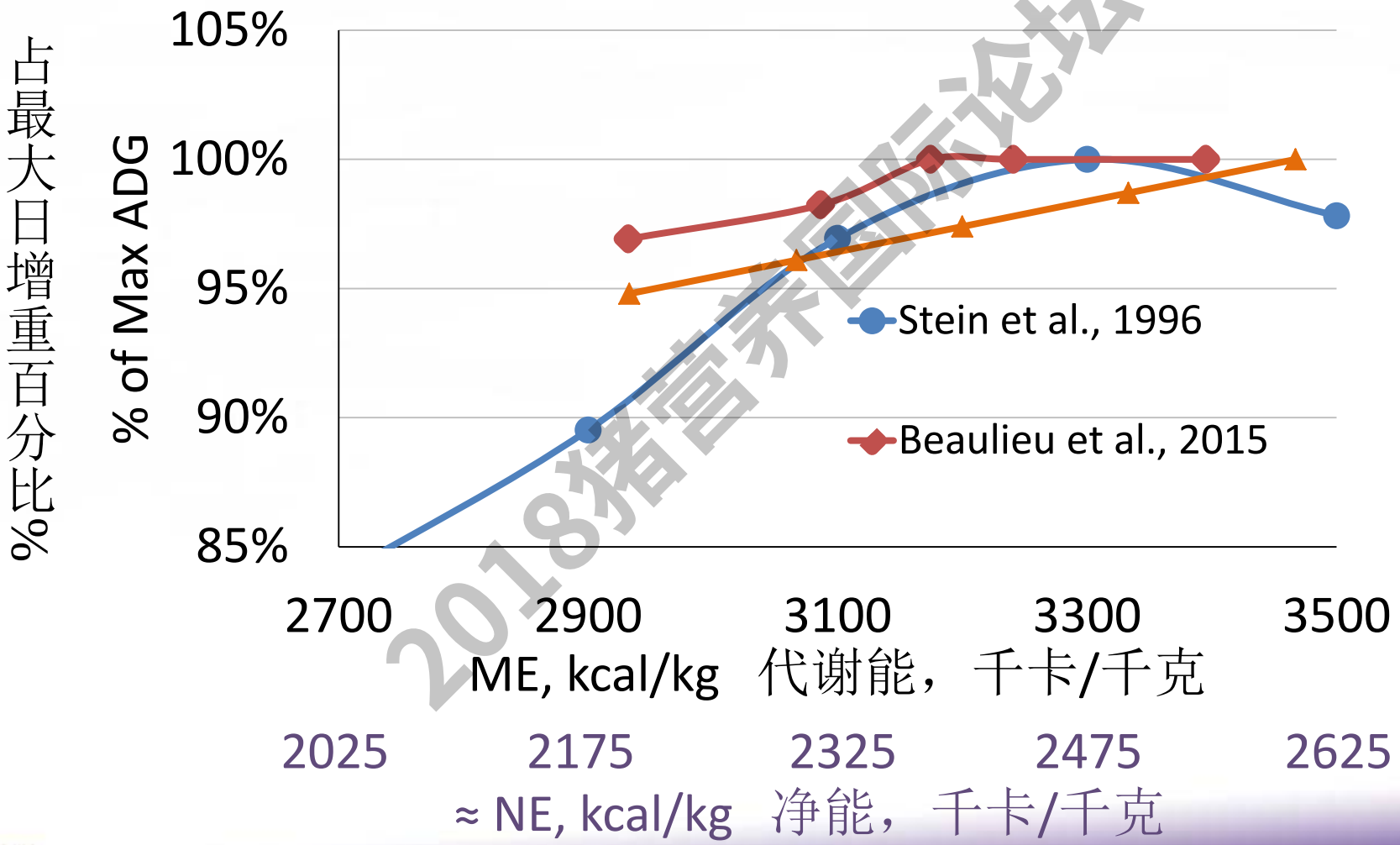


ADG, g = 0.1135×NE (kcal/kg) + 8.8142×Average BW (kg) – 0.05068×[Average BW (kg)]^2+ 275.99

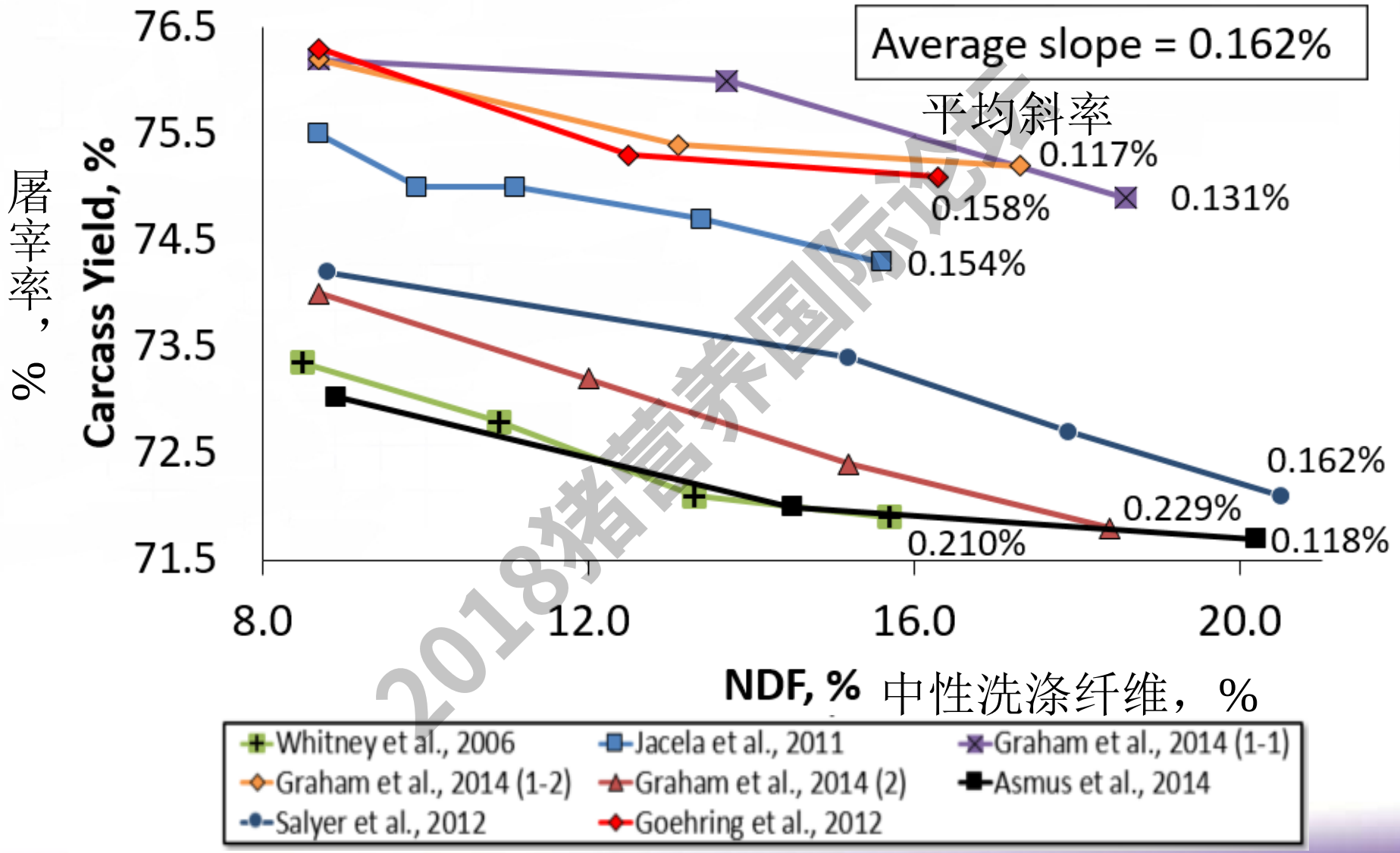
Nitikanchana et al. (2015).

Influence of energy intake on ADG

能量摄入对平均日增重的影响



Impact of increasing NDF on Carcass Yield
中性洗涤纤维增加对屠宰率的影响



Coble et al. (2015)

Carcass yield prediction equation
屠宰率预测方程

Papers used in regression analysis 用于回归分析的论文

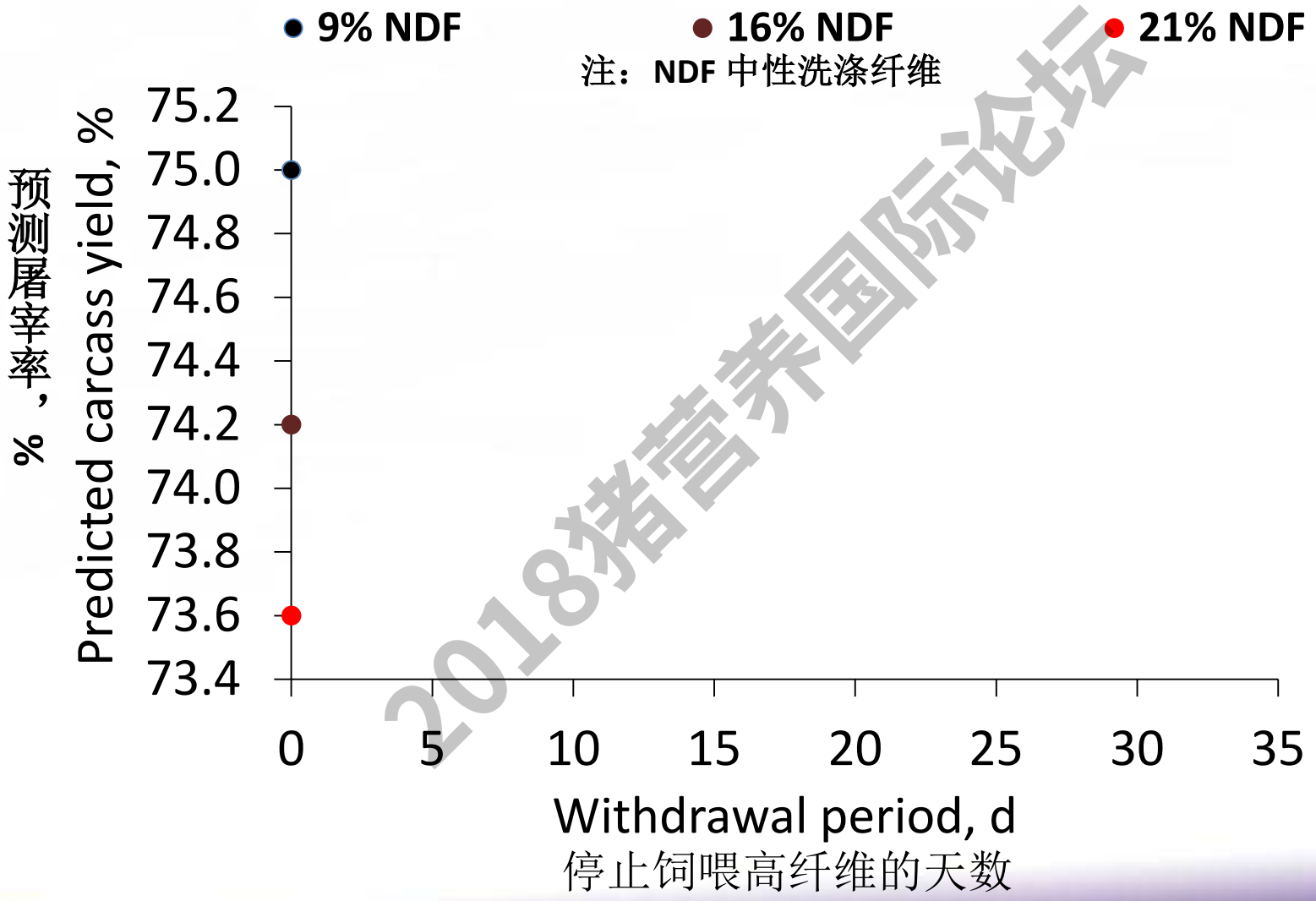
First author, year 第一作者，年份	Source[1] 来源	NDF1[2], % 中性洗涤纤维1，%	NDF2[3], % 中性洗涤纤维2，%	WP[4], d	Initial BW, kg 始重	Final BW, kg 末重	Yield, % 产量，%
Asmus, 2014	J	8.8 - 20.2	8.8 - 20.2	0-47	41.0	122.8	71.6 - 73.2
Coble, 2015 (exp. 1)	T	8.8 - 20.2	8.8 - 20.2	0-20	38.4	126.0	71.2 - 72.7
Coble, 2015 (exp. 2)	T	8.8 - 20.2	8.8 - 20.3	0-24	44.5	132.5	74.3 - 75.4
Gaines, 2007	J	8.7 - 15.3	8.8 - 15.3	0-42	66.1	128.5	75.9 - 77.1
Graham, 2014	J	8.8 - 20.2	8.8 - 20.2	0-24	55.8	126.8	72.8 - 74.2
Jacela, 2009	M	8.5 - 15.0	8.4 - 14.9	0-41	39.0	121.5	75.1 - 75.9
Nemecheck, 2013	J	8.8 - 20.2	8.8 - 20.2	0-17	49.6	129.0	74.7 - 75.1
Xu, 2010	J	8.8 - 15.3	8.8 - 15.3	0-63	30.0	125.0	75.8 - 77.0

[1] Source type: J=Journal, T=Thesis, M=Technical memo. 来源类型：J =期刊，T =论文，M =技术备忘录。
[2] Range of NDF concentration in dietary phase before the final phase. 最终阶段前日粮NDF浓度范围。
[3] Range of NDF concentration in final dietary phase before marketing. 上市前最后日粮阶段NDF浓度范围。
[4] Range of withdrawal period. 休药期范围

$$\text{Yield屠宰率, \%} = 0.03492 \times \text{WP (d)} - 0.05092 \times \text{NDF1 (\%)} - 0.06897 \times \text{NDF2 (\%)} - 0.00289 \times (\text{NDF2 (\%)} \times \text{WP (d)}) + 76.0769$$

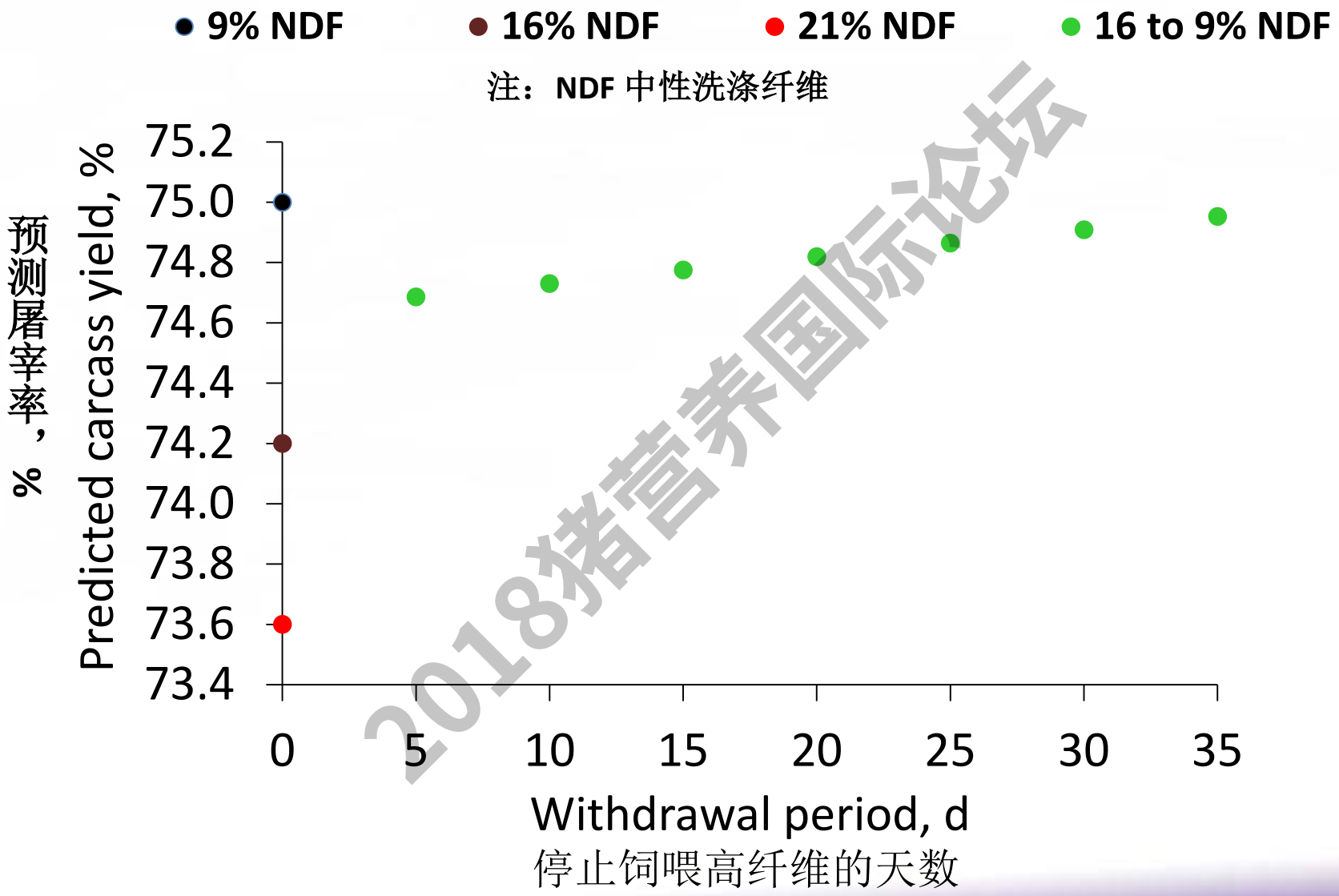
Soto et al. (2017).

Predicted carcass yield 预测屠宰率



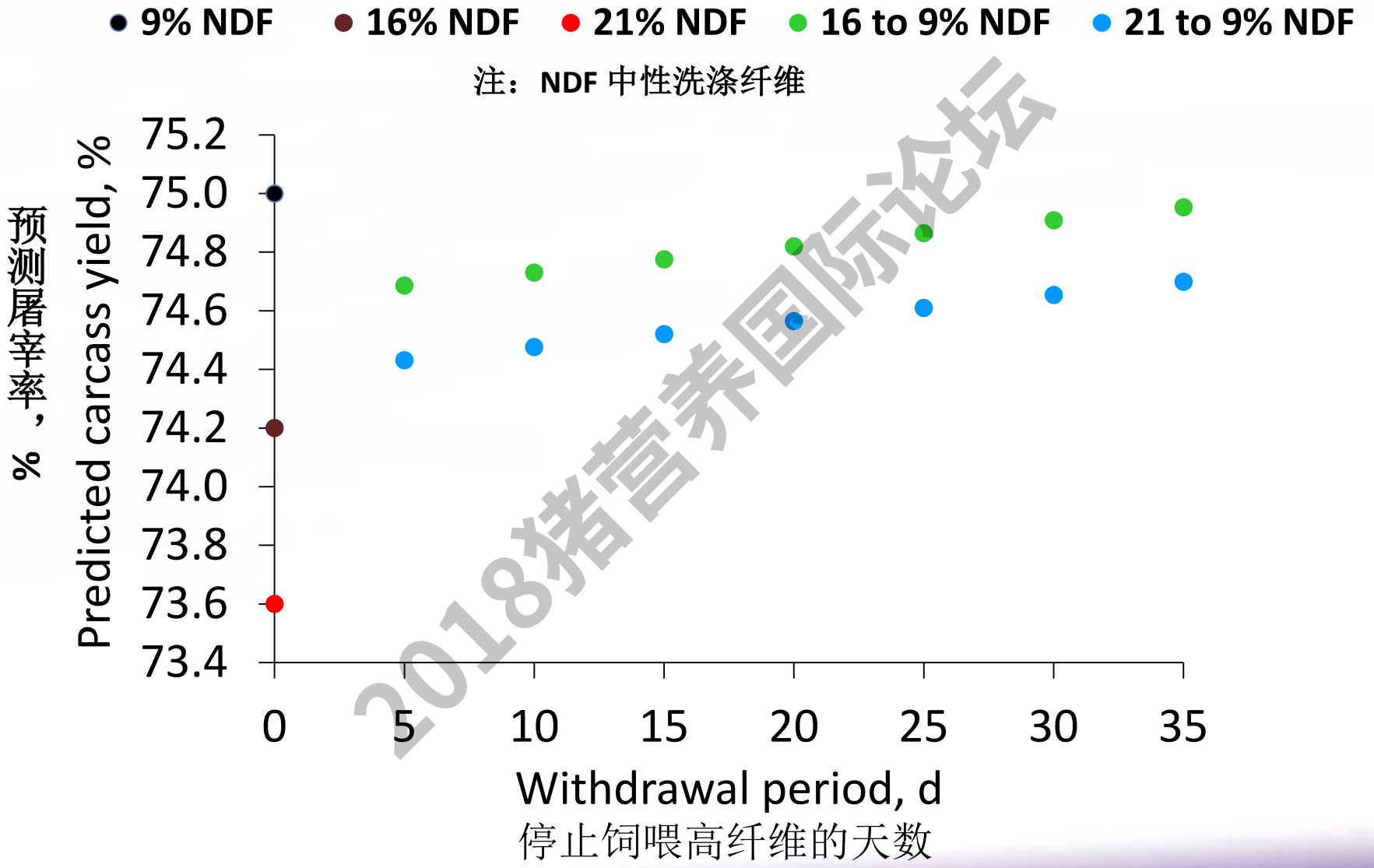
Soto et al. (2017)

Predicted carcass yield 预测屠宰率



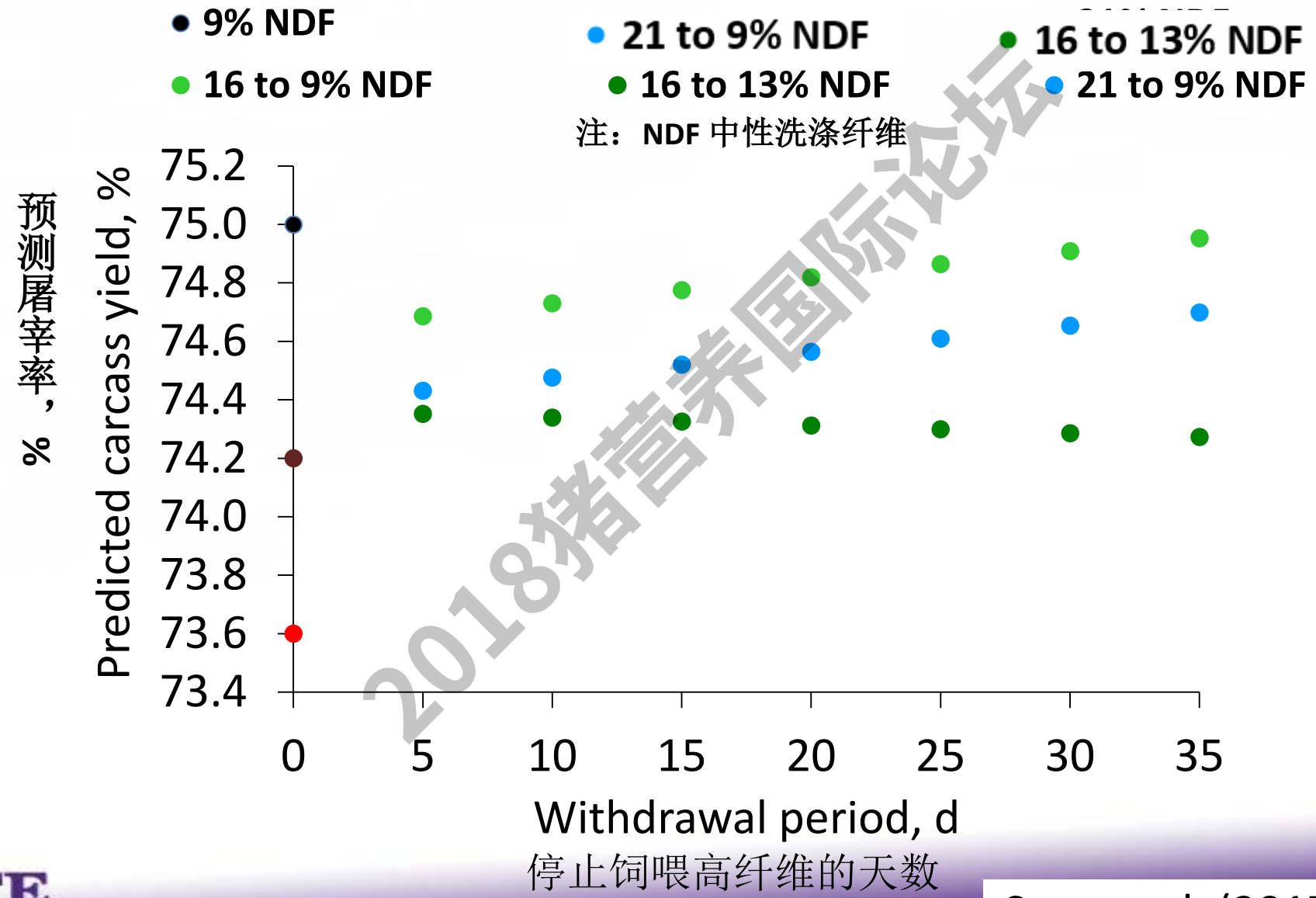
Soto et al. (2017)

Predicted carcass yield 预测屠宰率



Soto et al. (2017)

Predicted carcass yield 预测屠宰率



Soto et al. (2017)

Ingredient selection and energy prediction
原料选择与能量

- Many ingredients can be used. 可选择的原料种类很丰富
  - NPB (2008a,b); NRC (2012); Stein et al (2016)
- Use consistent methodology to set energy values for each ingredient: 使用一致的方法设定每种原料能量值
  - NRC equations, INRA software, CVB, others NRC方程，INRA软件，CVB，其他
  - Calculate energy value relative to a reference ingredient 计算相对于参考原料的能量值(Gonçalves et al., 2016b).

Economic model for optimum dietary energy for growing-finishing pigs

生长肥育猪最佳日粮能量经济模型

Kansas State University | applied swine nutrition

PIC

Section 1. Economics and System performance

1	Live price, $/lb	0.62
2	Carcass price, $/lb	0.85
3	Feeder pig cost (50 lb), $/pig	55.00
4	Facility cost, $/pig/d	0.11
5	Current ADG, lb	2.10
6	Current Feed efficiency	2.90
7	Current carcass yield, %	73.00
8	Other cost[1], $/pig	8.00

[1] Veterinary supplies, field service personnel, trucking

Economic evaluation criteria (Live or Carcass)	Carcass
Marketing basis (Fixed weight or fixed time)	Fixed Time
Growth curve (enter own values or use default)	Default

Section 2. Weight by phase and current dietary energy levels

Select number of dietary phases: 6

Phase	Initial weight, lb	Final weight, lb	Current NE, Kcal/lb	Range NE (Kcal/lb) Min	Max
1	50.0	75.0	1,104	1,083	1,122
2	75.0	125.0	1,122	1,097	1,137
3	125.0	170.0	1,130	1,110	1,153
4	170.0	210.0	1,145	1,119	1,164
5	210.0	250.0	1,150	1,126	1,170
6	250.0	285.0	1,140	1,117	1,159

Back to main menu | Summary of Calculations

Section 3. Dietary specifications

Are your diets adequate on SID Lys? Yes

Dietary Phase	Energy Level	NE, Kcal/lb	Cost, $/Ton	NDF, %
1	Min	1,083	159.71	-----
		1,093	168.08	-----
	Current	1,104	177.77	-----
		1,113	187.83	-----
	Max	1,122	204.55	-----

Model settings
模型设置

Economics & System Performance
经济与系统性能

Nutritional program
营养方案

K-STATE Research and Extension

Knowledge for Life

SID Lysine requirement of finishing pigs

肥育猪对标准回肠可消化赖氨酸的需求量

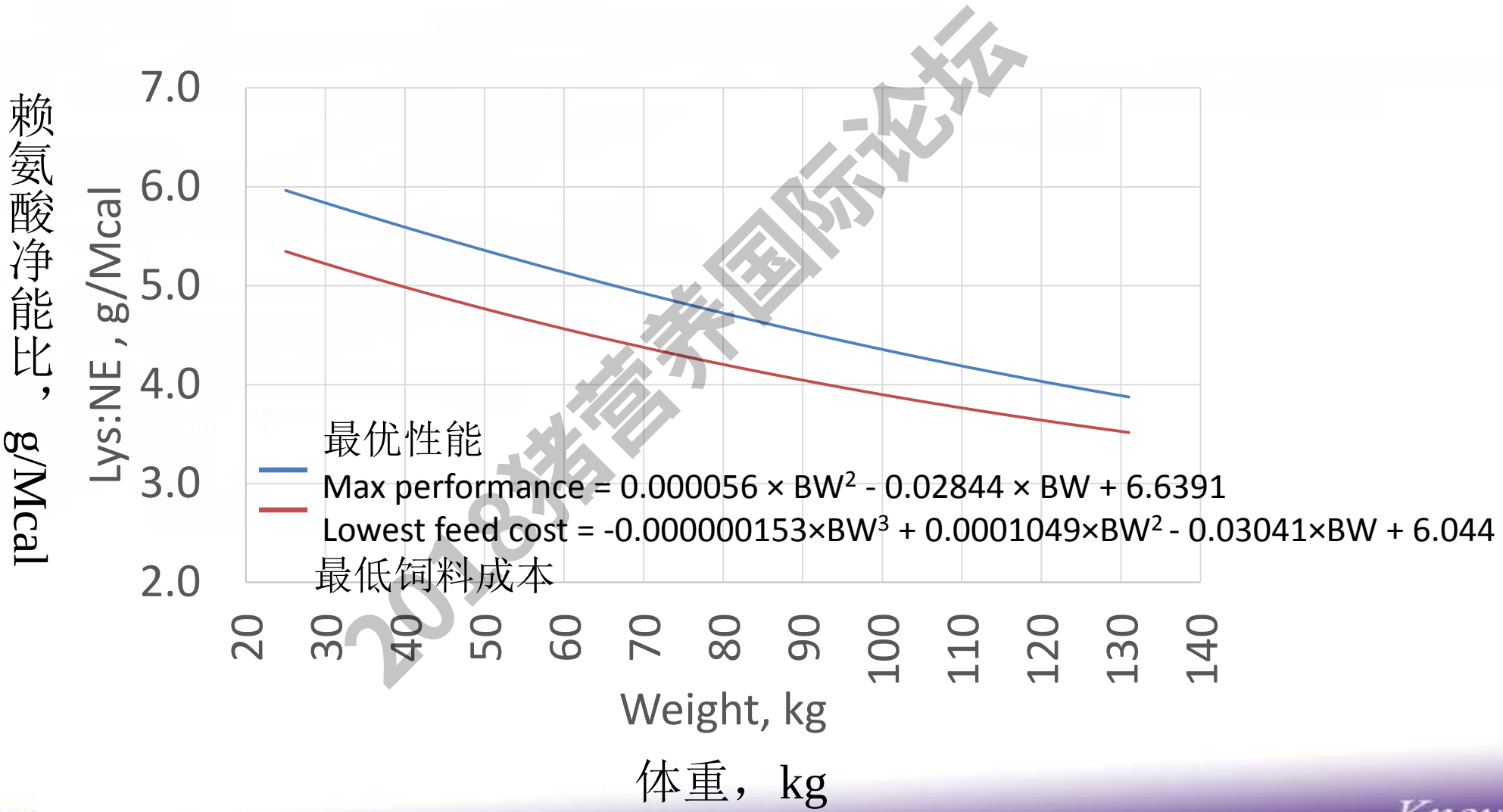
	Exp. 实验量	Weight, kg 体重范围	g/kg gain 每千克增重需要的赖氨酸量
Main et al., 2008	7	35 - 120	20
De La Llata et al., 2001	2	27 - 120	20
Bergstrom et al. 2010	4	37 - 129	20 to 21
Srichana et al., 2004	4	34 - 100	20
Shelton et al., 2009	1	55 - 80	20

- 18 experiments = 20 g/kg gain

18组实验=20 g/kg增重

SID lysine estimates for PIC gilts from 20 to 120 kg

20-120kg PIC母猪的标准回肠可消化赖氨酸需求



Minimum ratios for other amino acids relative to lysine
其他氨基酸与来赖氨酸的最小比例

	Weight range, kg 体重范围，kg			
	25 to 50	50 to 75	75 to 100	100 to 135
Isoleucine[a] 异亮氨酸	52	52	52	52
Leucine 亮氨酸	100	100	100	100
Met & Cys 蛋氨酸&半胱氨酸	56	56	56	58
Threonine 苏氨酸	61	62	63	65
Tryptophan[b] 色氨酸	18 - 21	18 - 21	18 - 21	19 - 21
Valine 缬氨酸	68	68	68	70

[a] Diets with high leucine (ex. > 140% of Lys) require higher isoleucine (ex. 60% of lysine).
高含量亮氨酸日粮（如> 140%）需要更高含量的异亮氨酸（如60%的赖氨酸）。

[b] Optimal tryptophan:lysine ratio depends on value of weight gain.
最适色氨酸与赖氨酸比例由日增重的经济价值决定

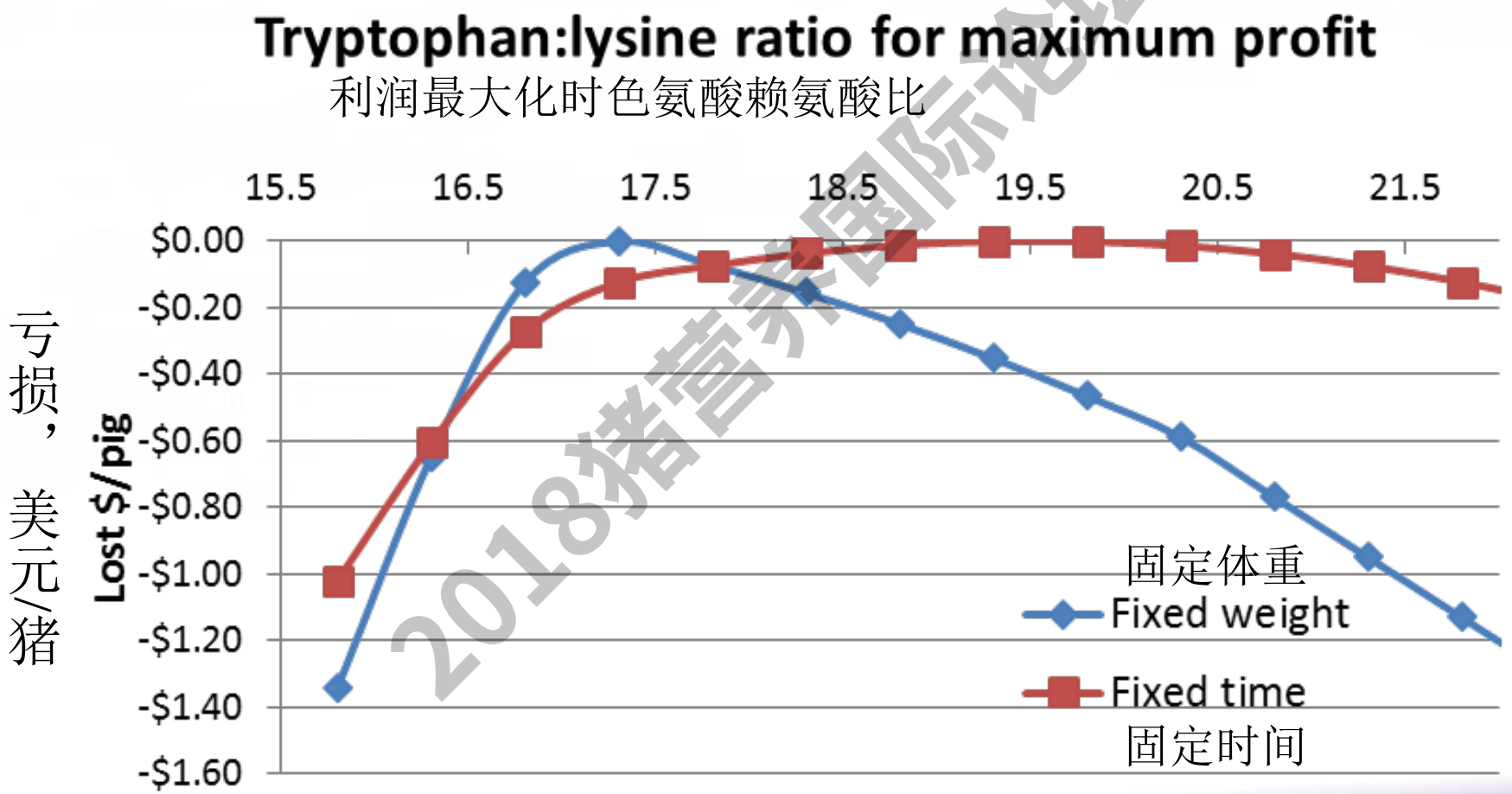
SID tryptophan:lysine ratio at different target performance levels of finishing pigs

育肥猪在不同目标生长性能水平下标准回肠可消化色氨酸与赖氨酸比

	Percent of maximum performance, % 占最大生产性能百分比 %					
Item项目	95%	96%	97%	98%	99%	100%
ADG 平均日增重	17.6%	18.3%	18.9%	19.8%	20.8%	23.5%
F/G 料肉比	14.9%	15.3%	15.7%	16.1%	16.5%	16.9%

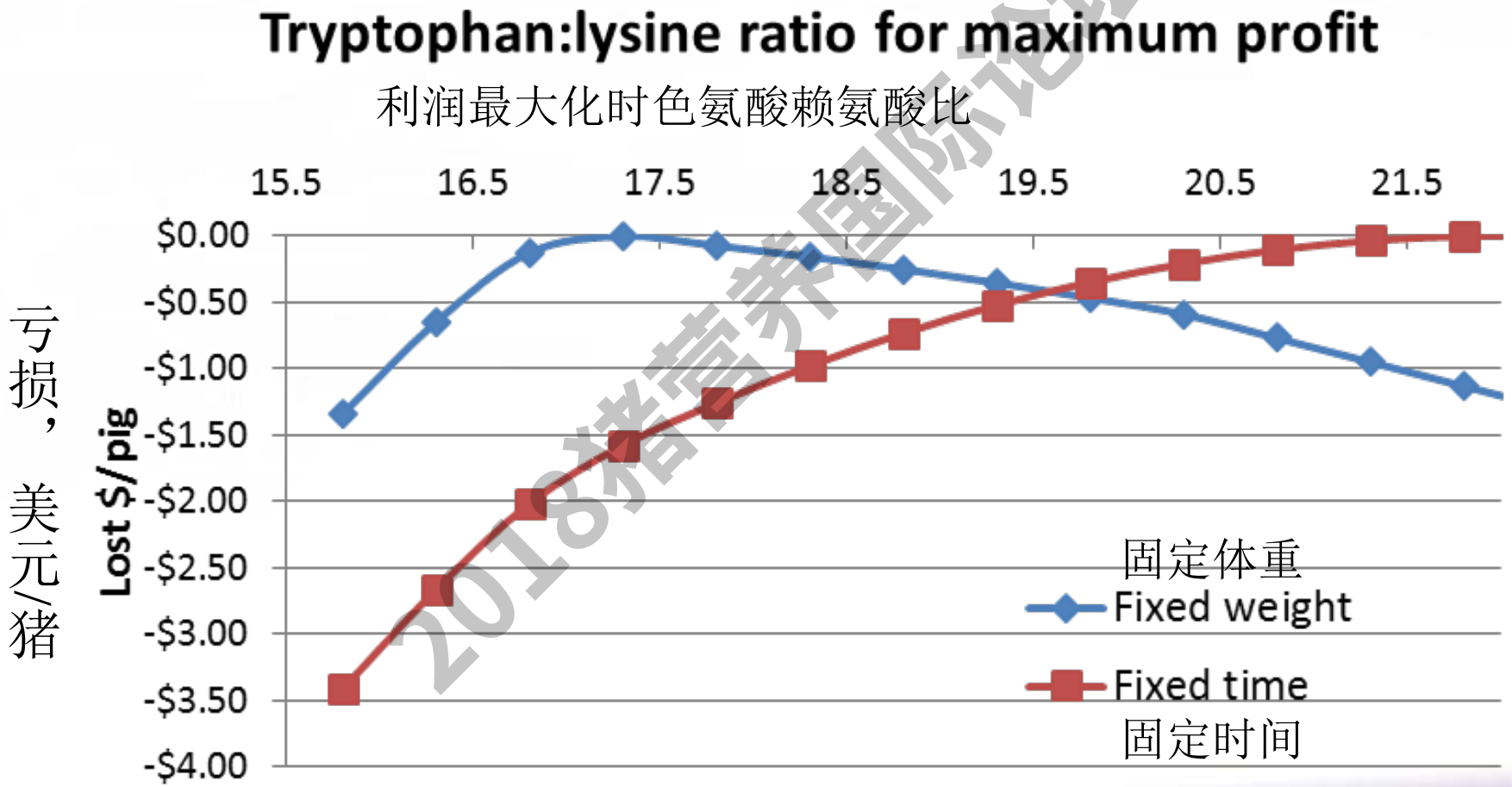
adapted from Goncalves et al., 2015

Optimal Trp:Lys ratio during low profit (below breakeven)
低利润时最适色氨酸赖氨酸比（低于盈亏平衡）



Optimal Trp:Lys ratio during high profit

高利润时最适色氨酸赖氨酸比



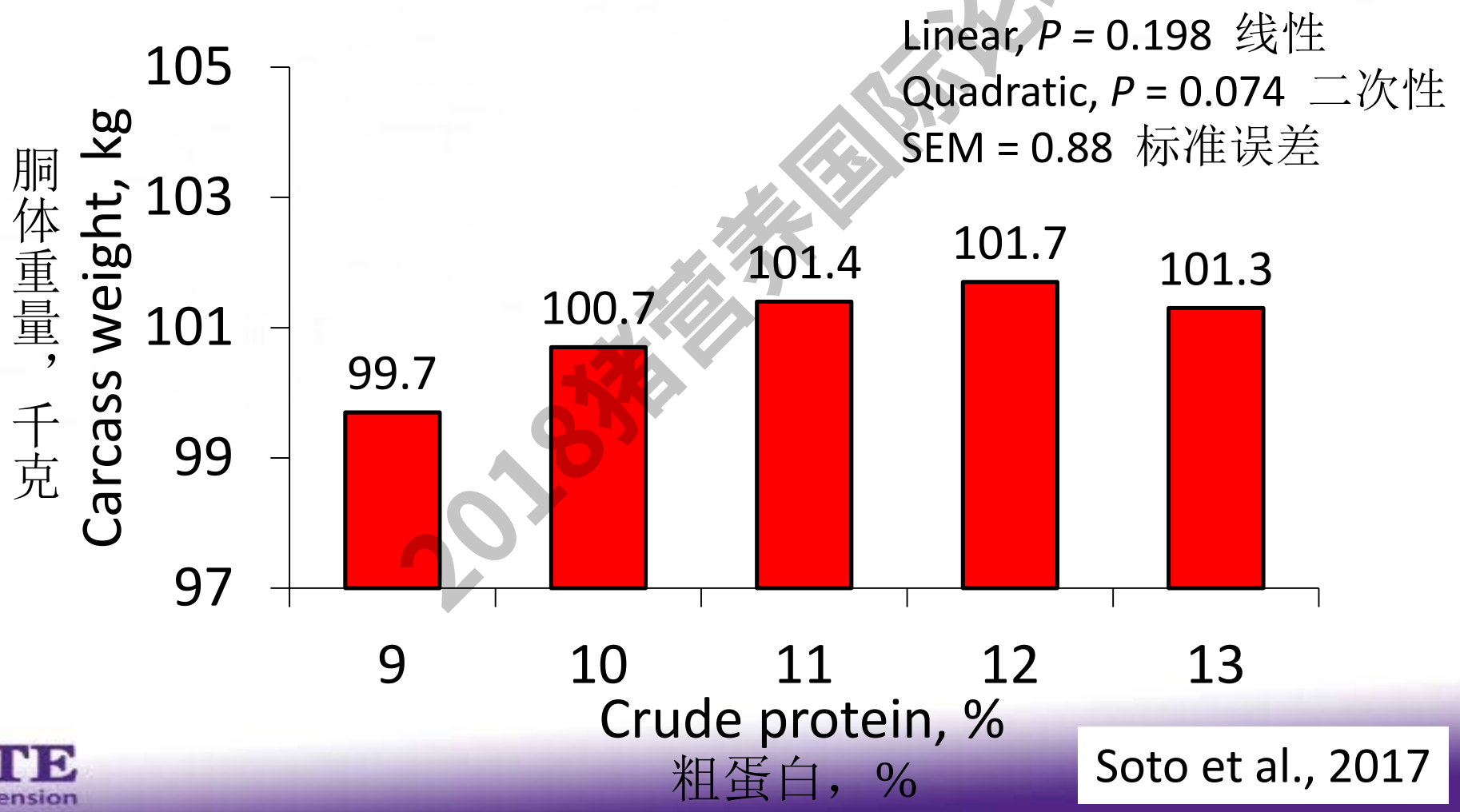
K-STATE Research and Extension

Model at www.KSUswine.org

Knowledge for Life

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

110~135 kg育肥猪中最适粗蛋白含量的测定



Soto et al., 2017

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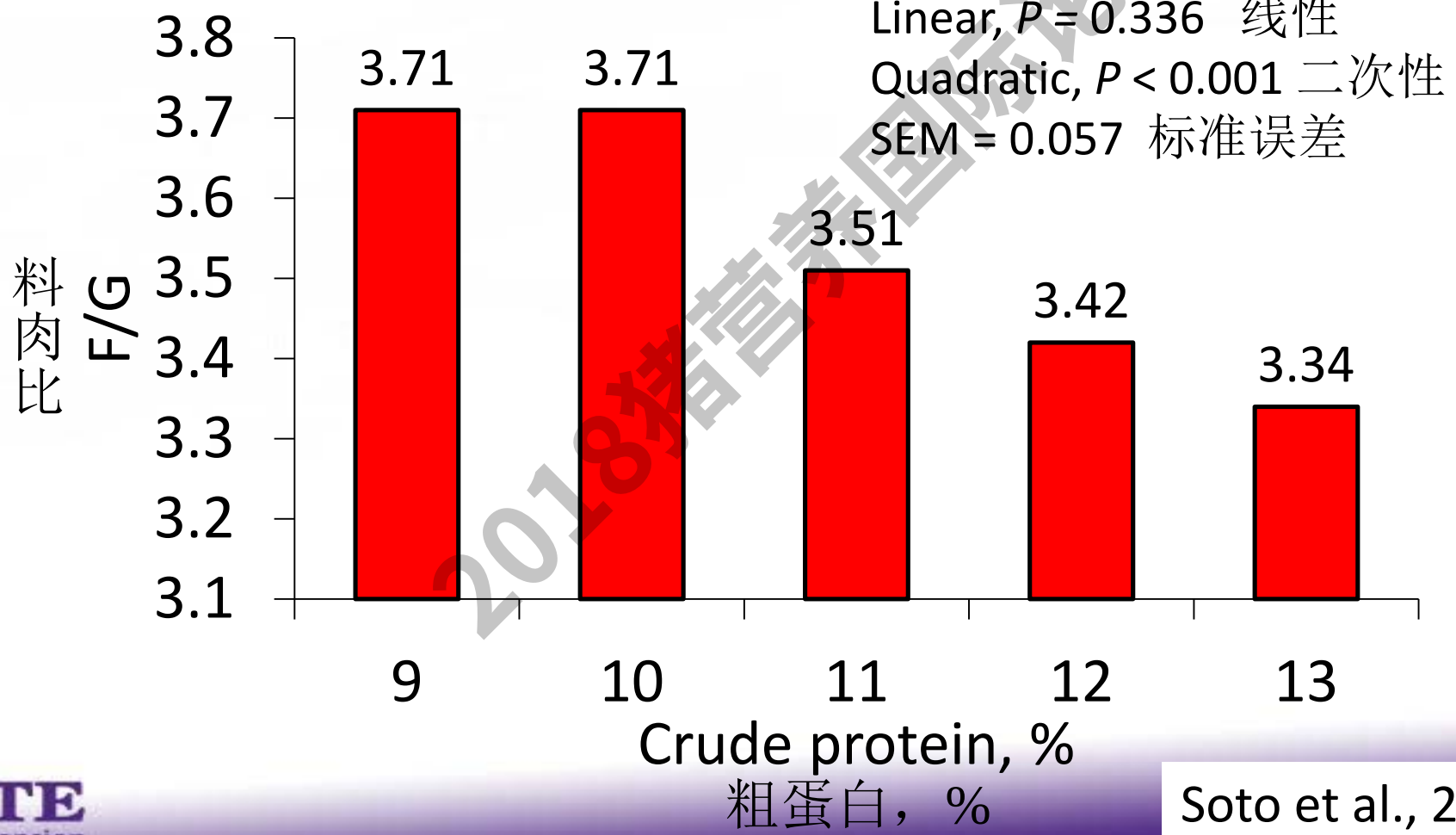
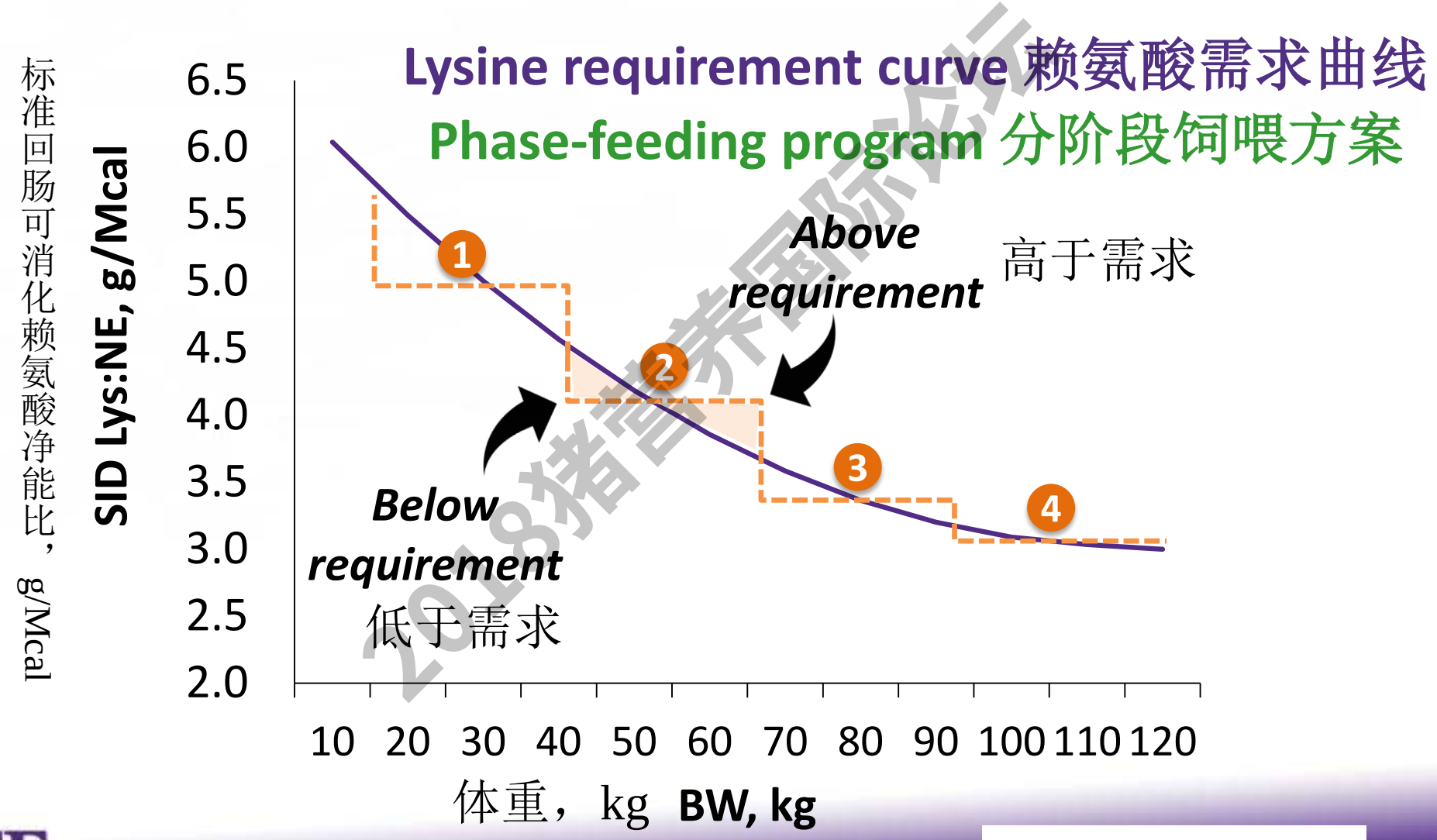


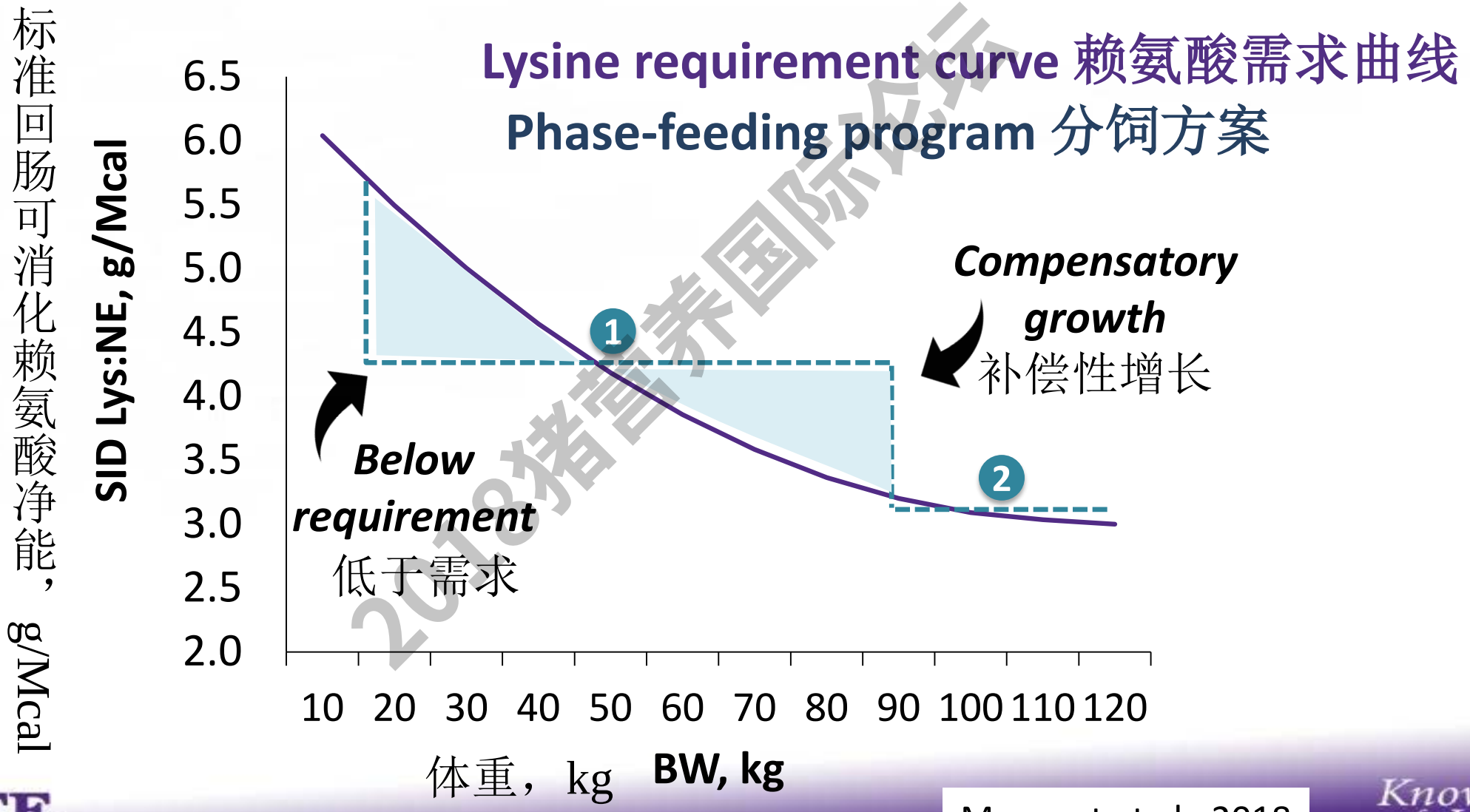
Soto et al., 2017

Phase-feeding 分阶段饲喂



Menegat et al., 2018

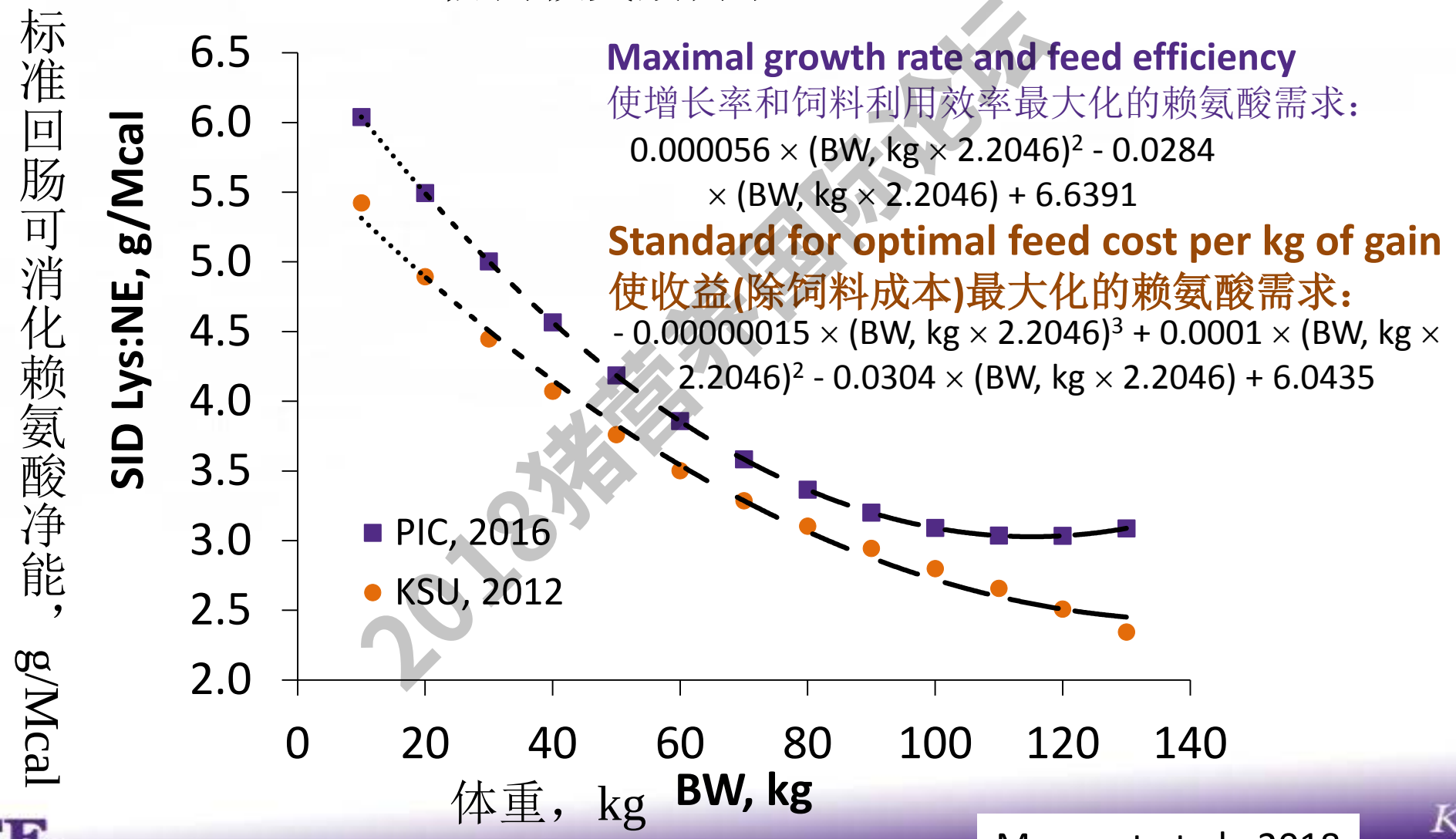
Phase-feeding 分阶段饲喂



Menegat et al., 2018

Estimated Lysine Requirements

估测赖氨酸需求量



Maximal growth rate and feed efficiency

使增长率和饲料利用效率最大化的赖氨酸需求：

$0.000056 \times (BW, kg \times 2.2046)^2 - 0.0284 \times (BW, kg \times 2.2046) + 6.6391$

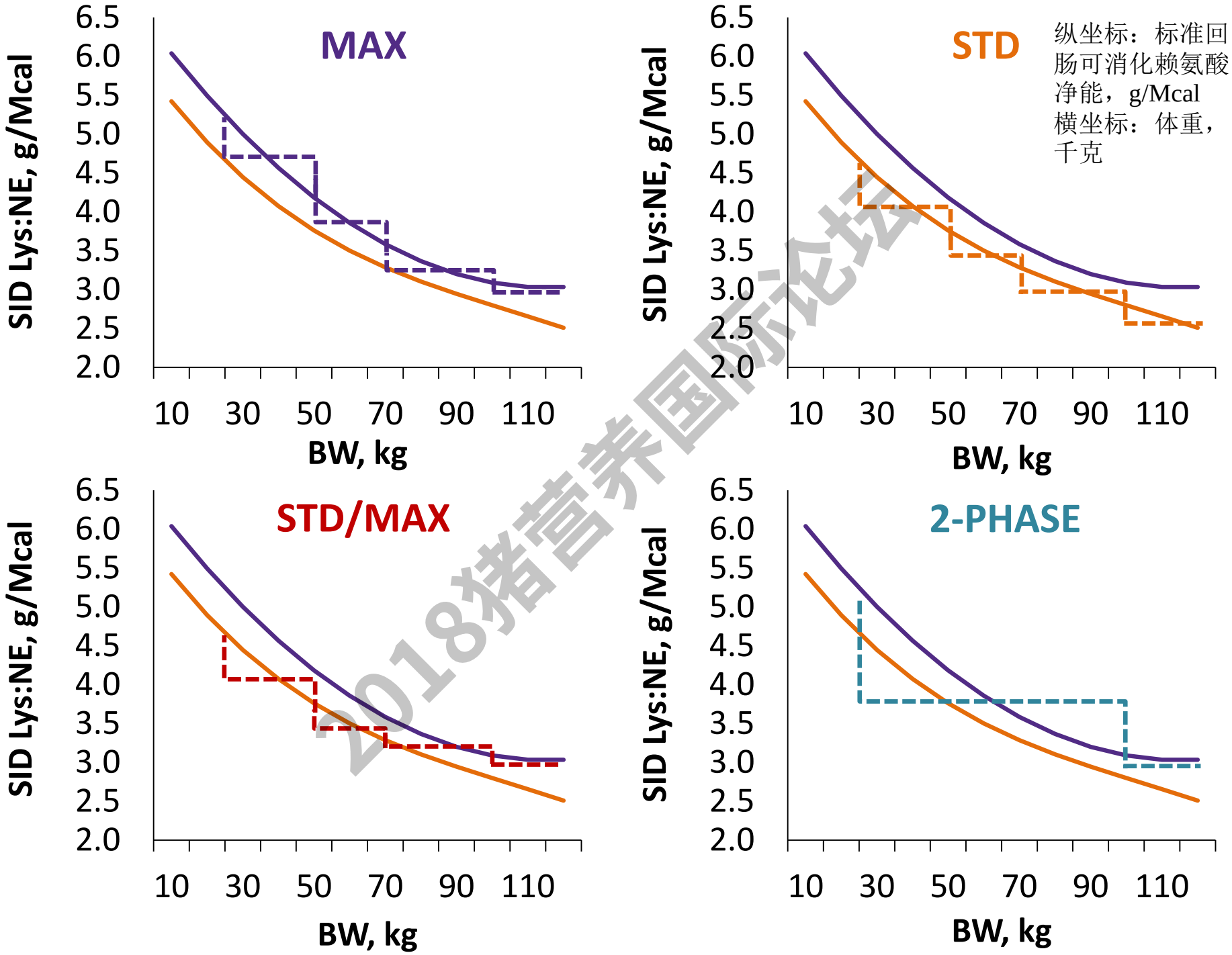
Standard for optimal feed cost per kg of gain

使收益(除饲料成本)最大化的赖氨酸需求：

$-0.00000015 \times (BW, kg \times 2.2046)^3 + 0.0001 \times (BW, kg \times 2.2046)^2 - 0.0304 \times (BW, kg \times 2.2046) + 6.0435$

Menegat et al., 2018

Exp. 1 例1



Exp. 1 例1

Average daily gain by phase

分阶段平均日增重

[abc] $P < 0.05$ within phase

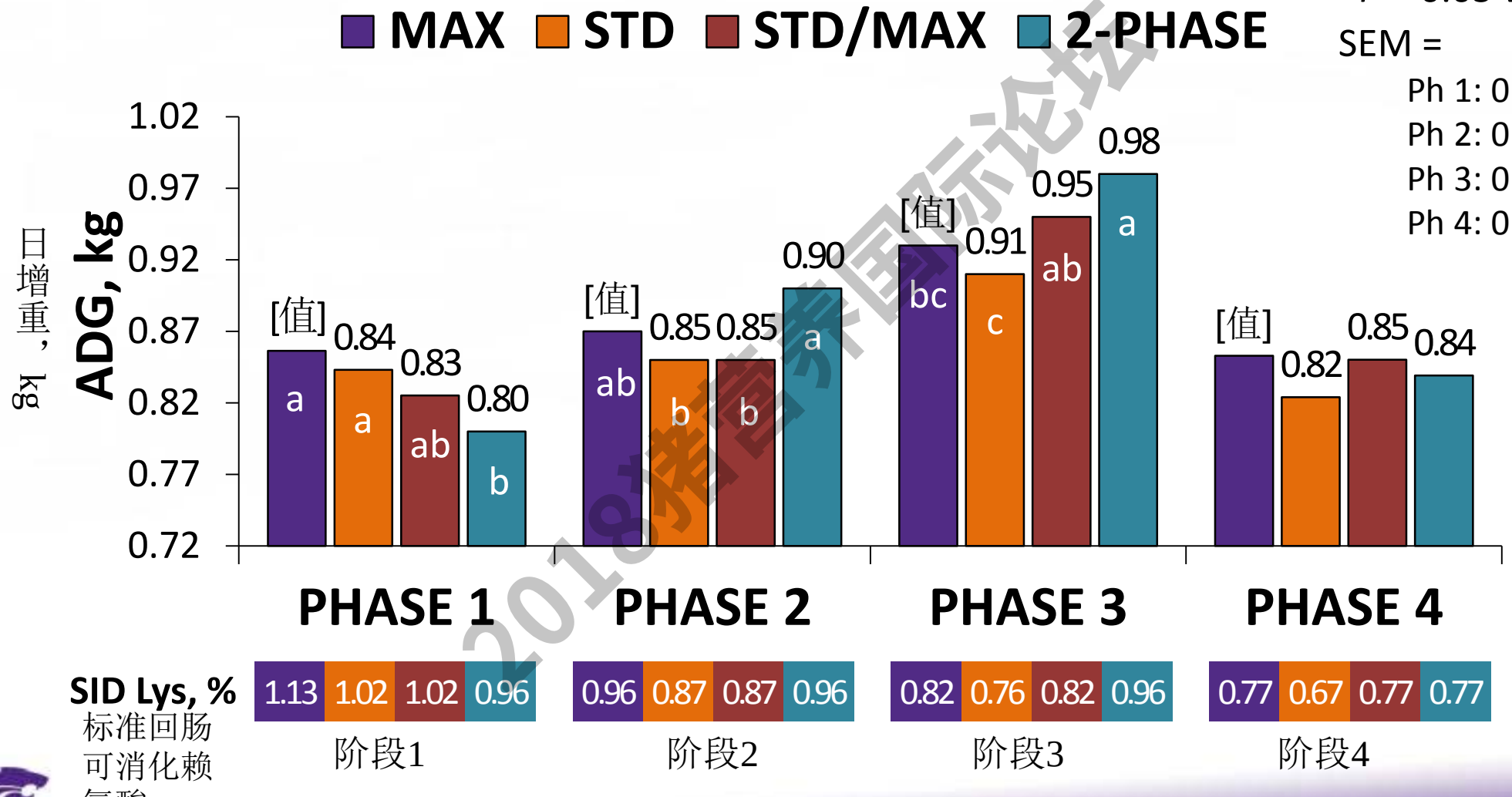
SEM =

Ph 1: 0.011

Ph 2: 0.011

Ph 3: 0.010

Ph 4: 0.015



Menegat et al., 2018

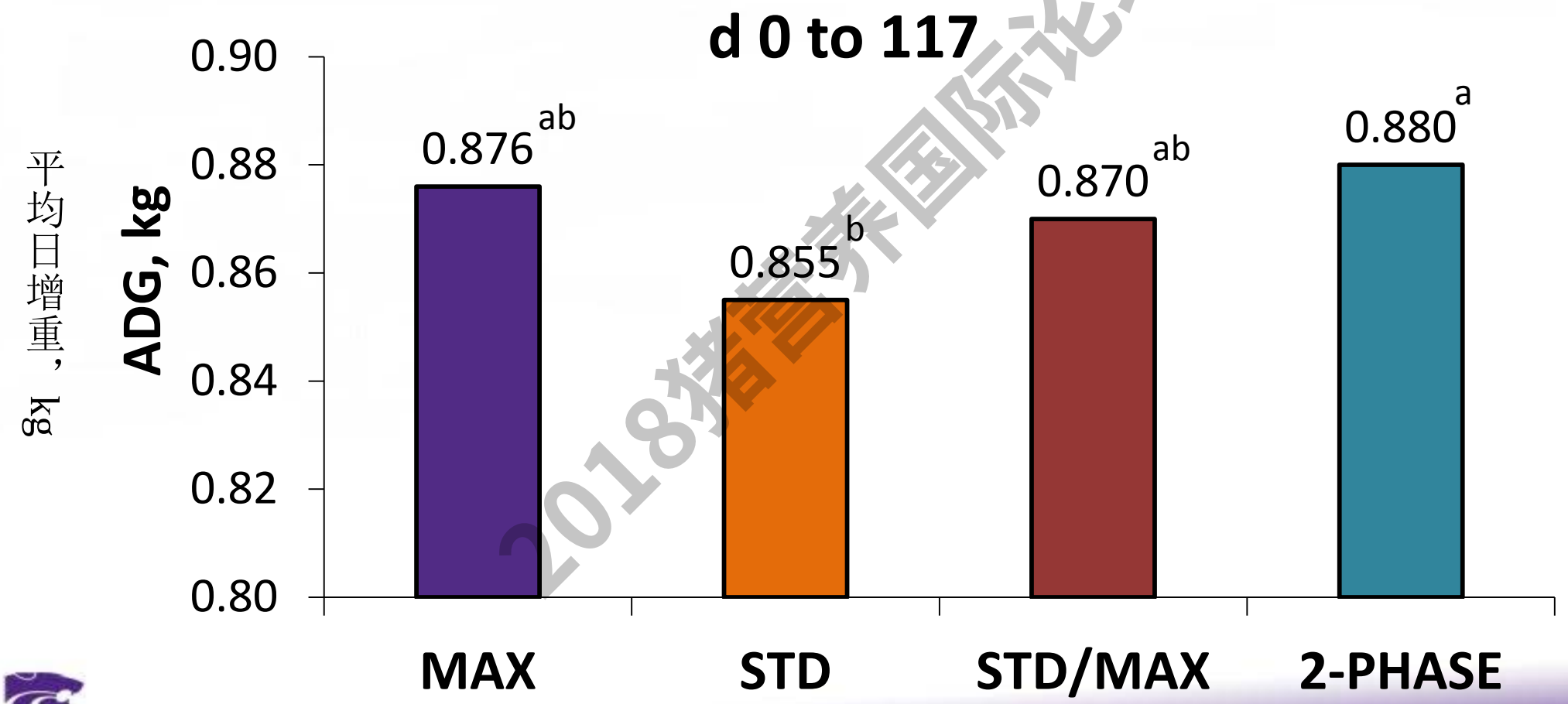
Exp. 1 例1

Effect of phase feeding program on overall average daily gain

阶段饲喂方案对总体平均日增重的影响

SEM = 0.006

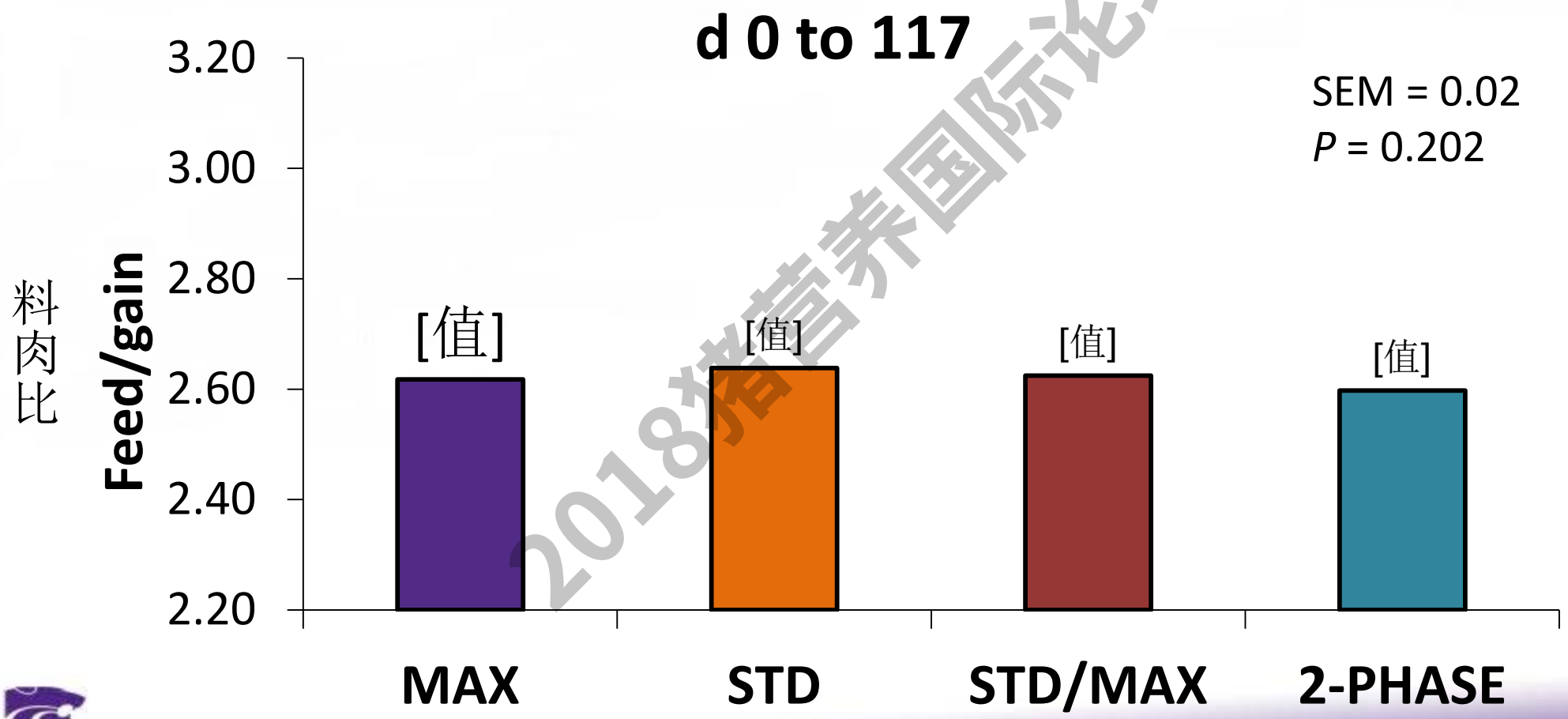
$^{ab}P = 0.048$



Menegat et al., 2018

Effect of phase feeding program on overall feed efficiency

阶段饲喂方案对总体饲养效率的影响



Menegat et al., 2018

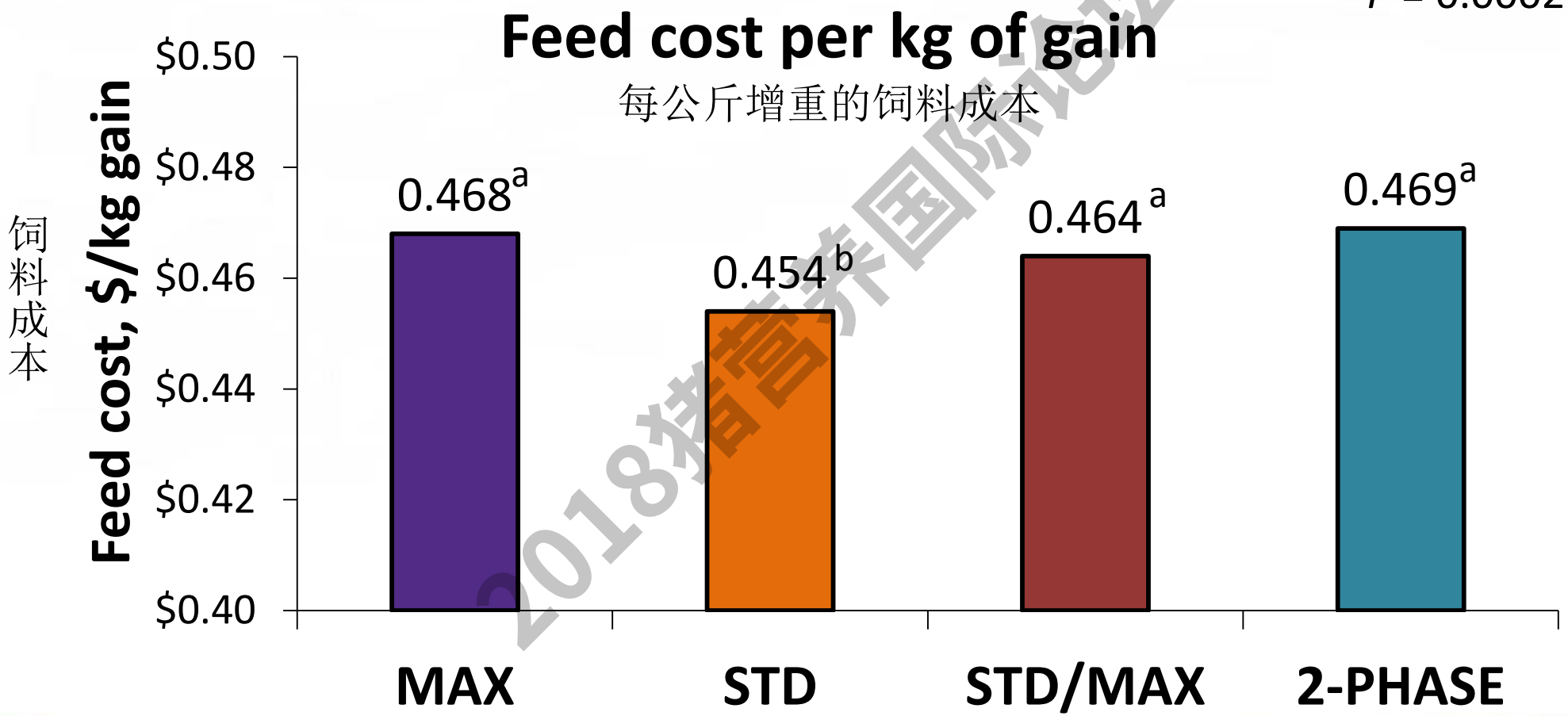
Exp. 1 例1

Effect of phase feeding program on economics

阶段饲喂方案对经济学的影响

SEM = 0.003

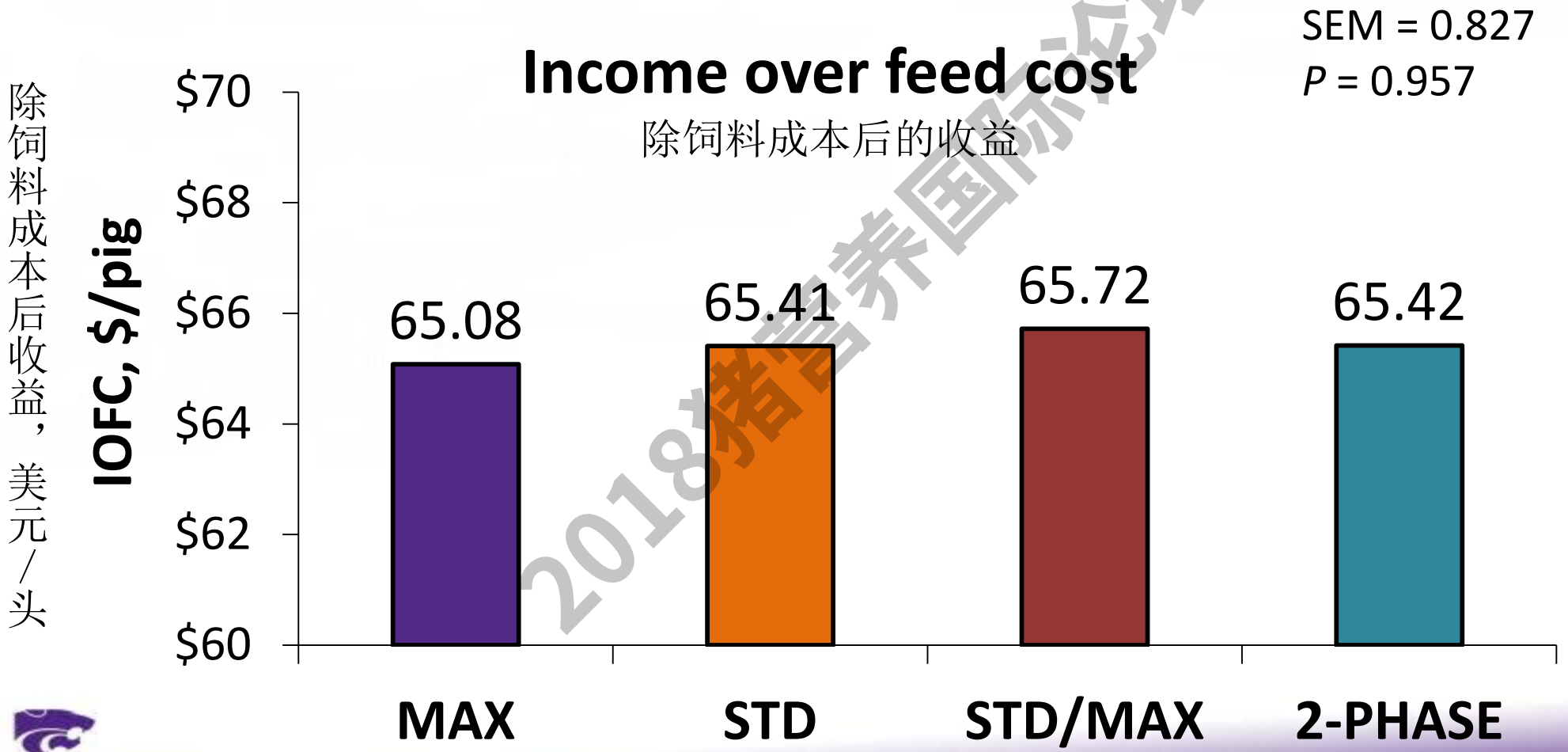
[ab] $P = 0.0002$



Menegat et al., 2018

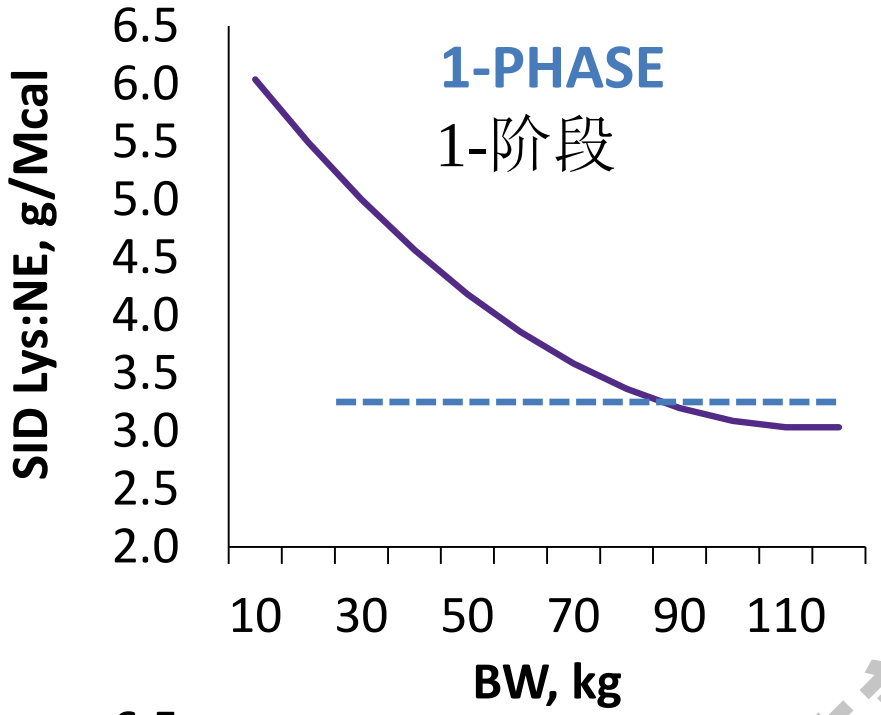
Effect of phase feeding program on economics

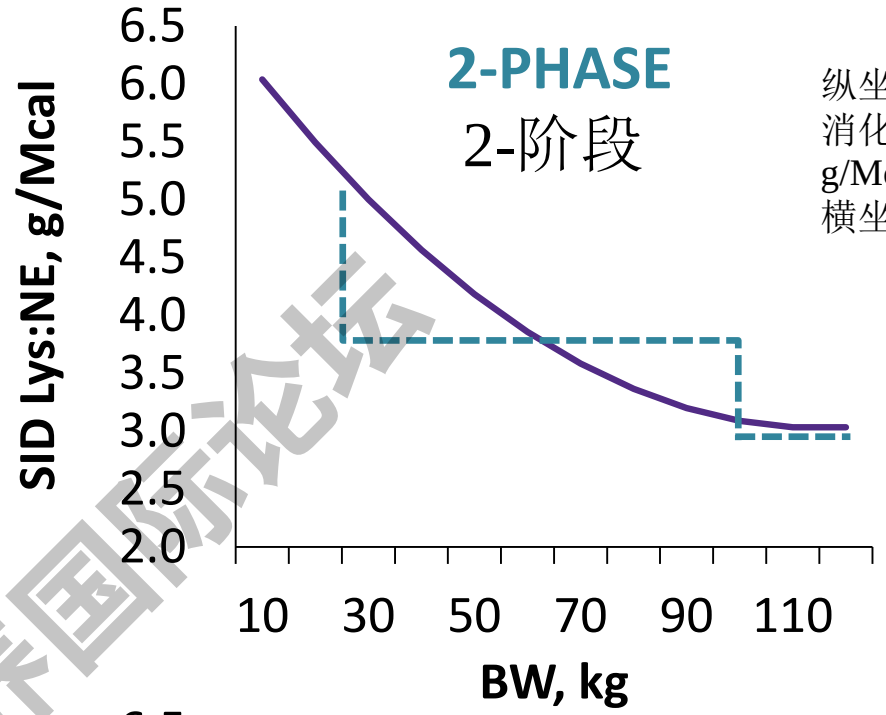
阶段饲喂方案对利润的影响



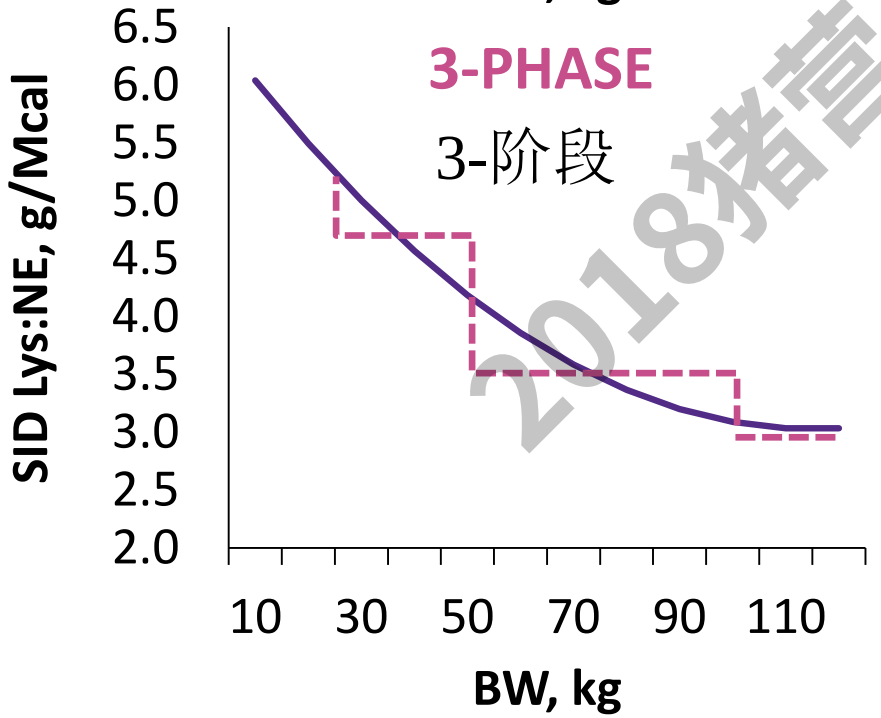
Menegat et al., 2018

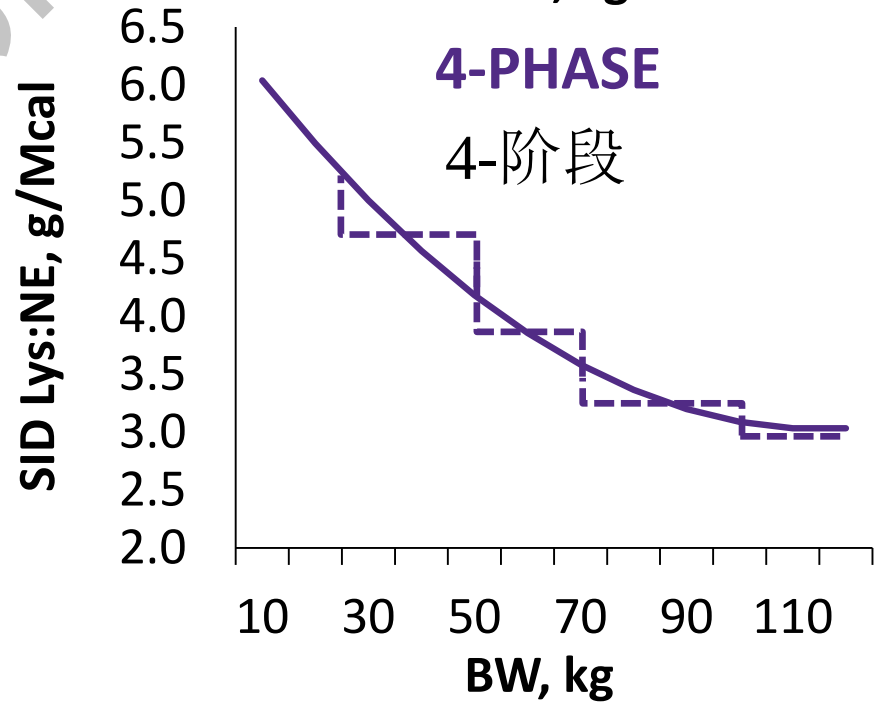
Exp. 2 例2





纵坐标：标准回肠可消化赖氨酸净能比，g/Mcal
横坐标：体重，千克





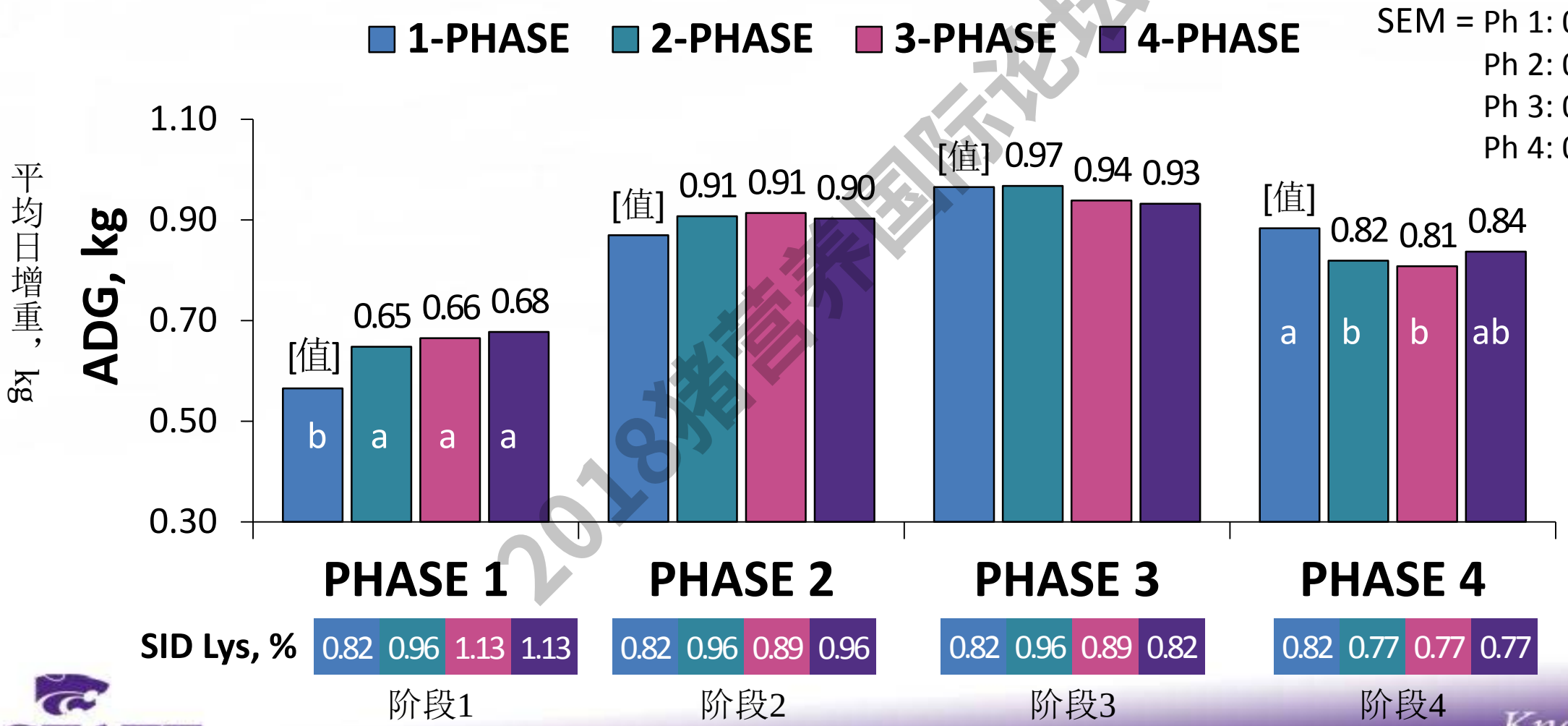
Exp. 2 例2

Average daily gain by phase

分阶段平均日增重

[ab] $P < 0.05$ within phase

SEM = Ph 1: 0.016
Ph 2: 0.014
Ph 3: 0.012
Ph 4: 0.022

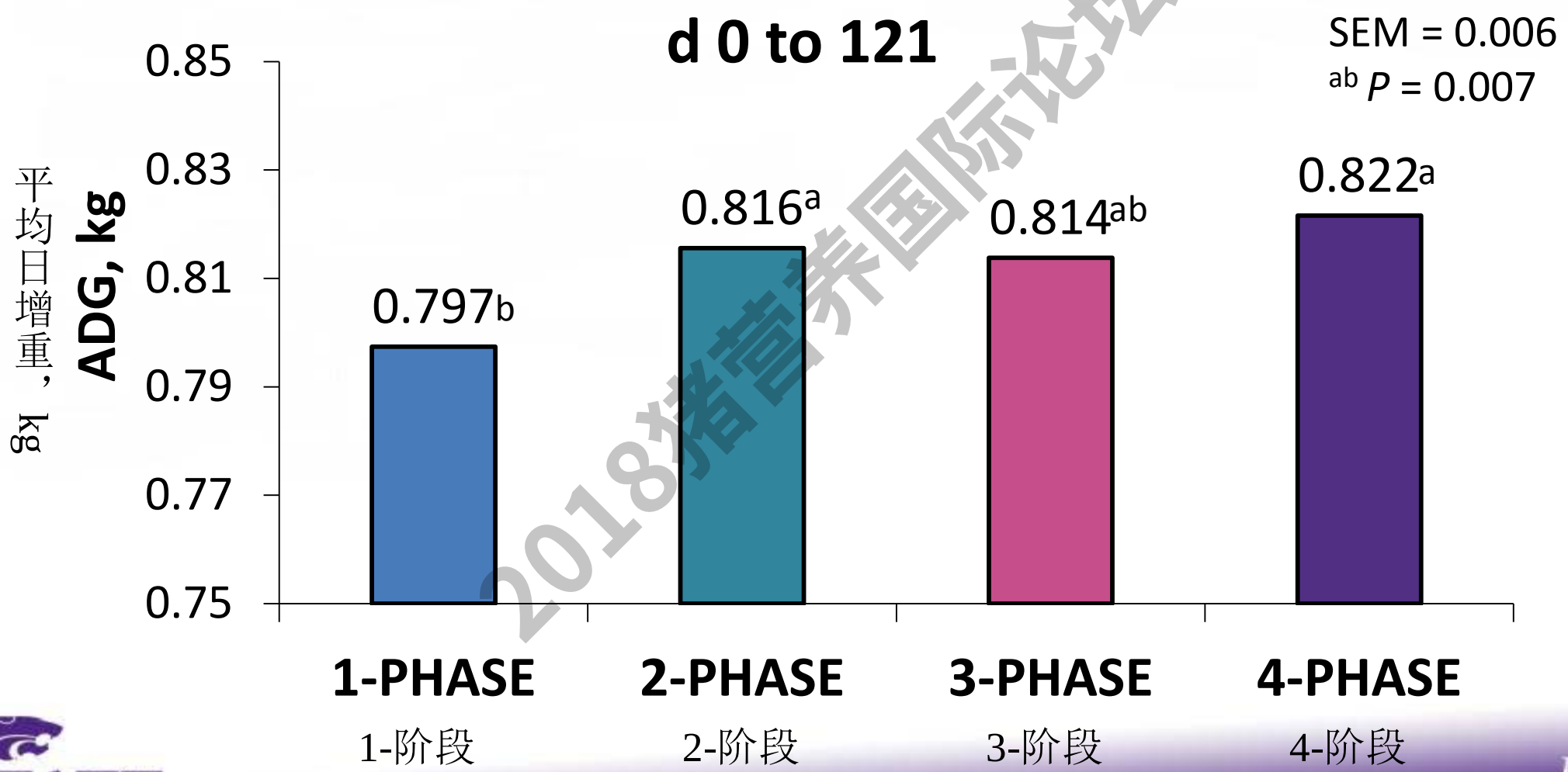


Menegat et al., 2018

Exp. 2 例2

Effect of phase feeding program on overall average daily gain

分阶段饲喂方案对总体平均日增重的影响

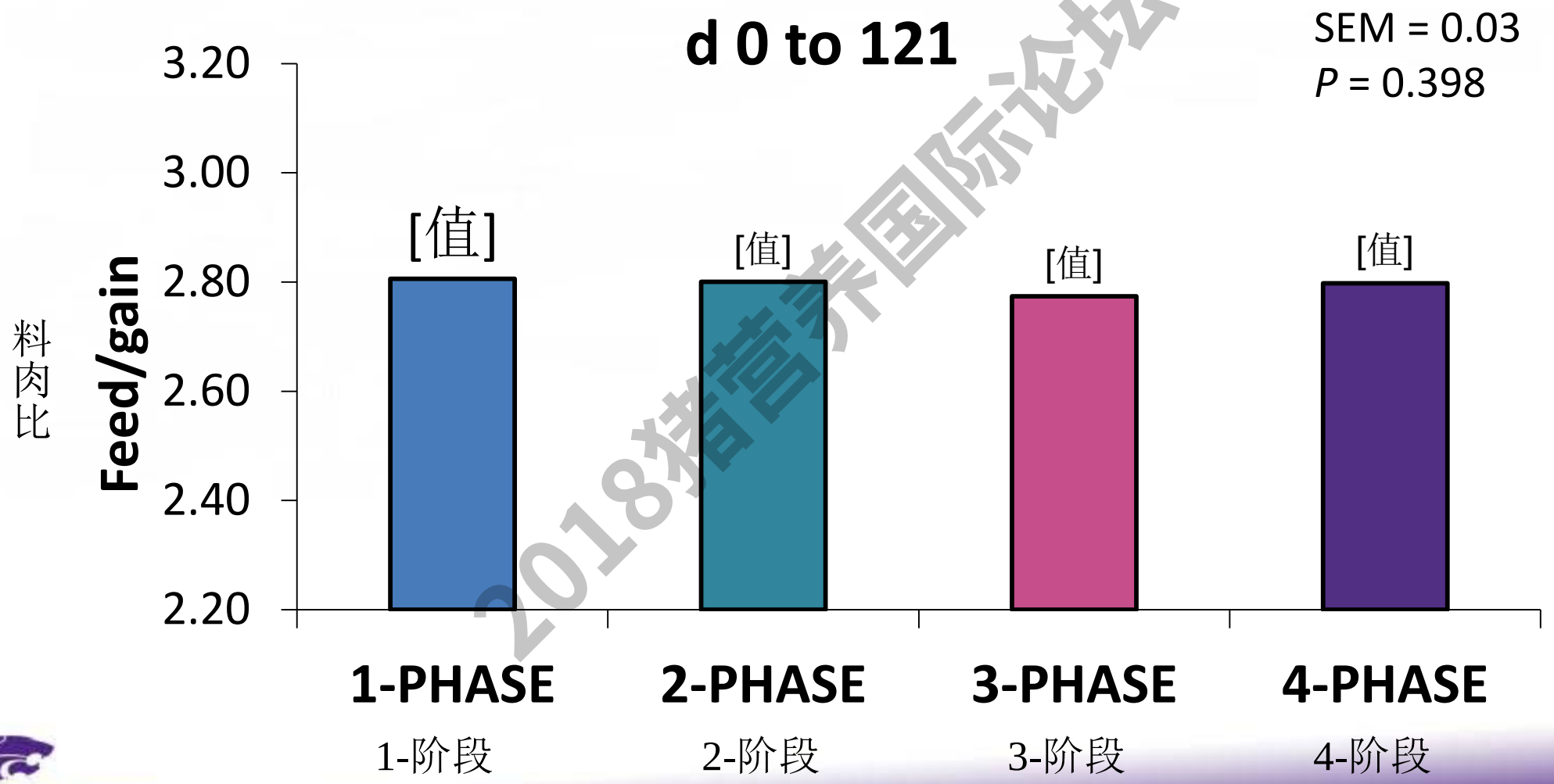


Menegat et al., 2018

Exp. 2 例2

Effect of phase feeding program on overall feed efficiency

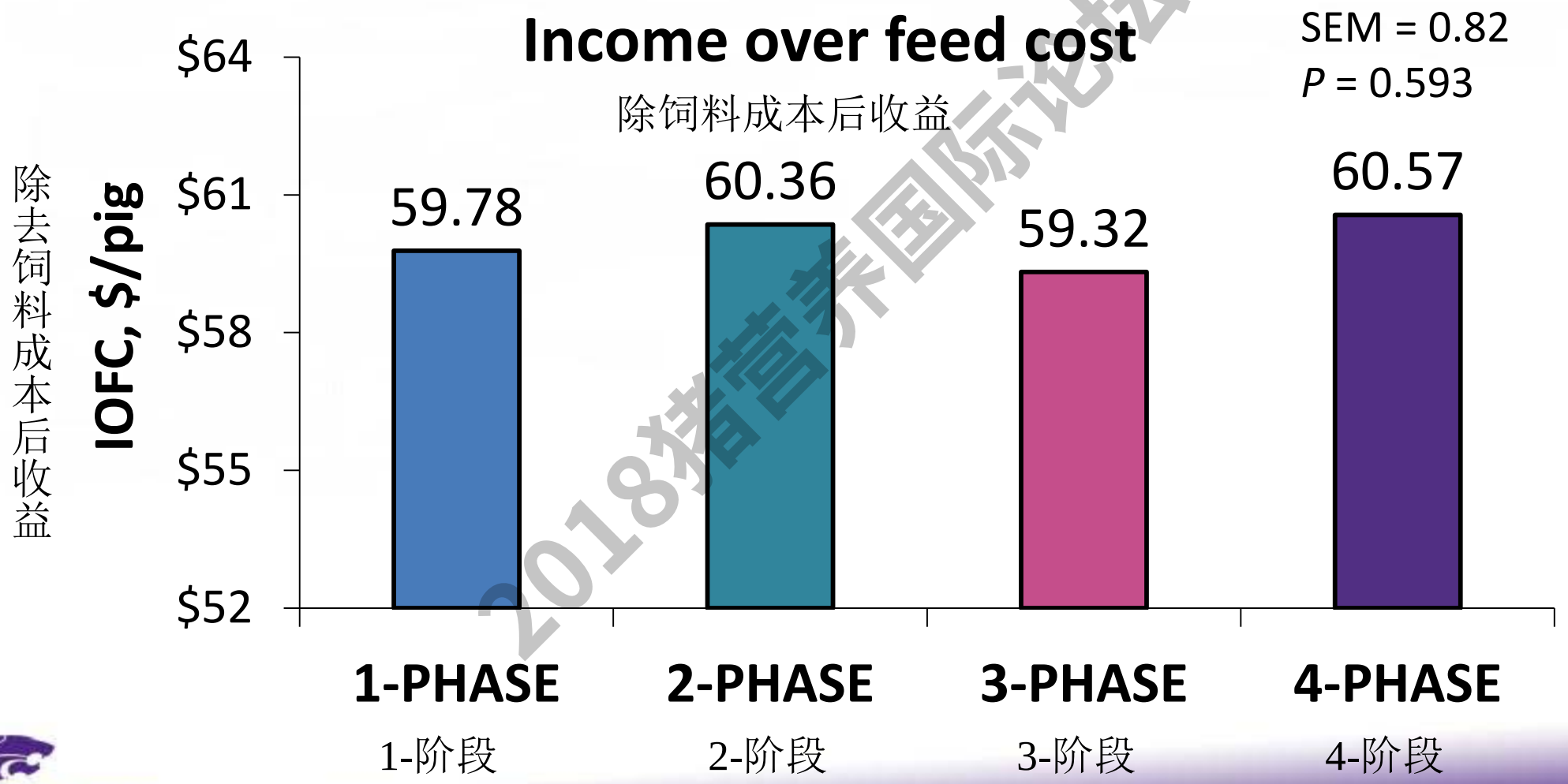
分阶段饲喂方案对饲料效率的影响



Menegat et al., 2018

Effect of phase feeding program on economics

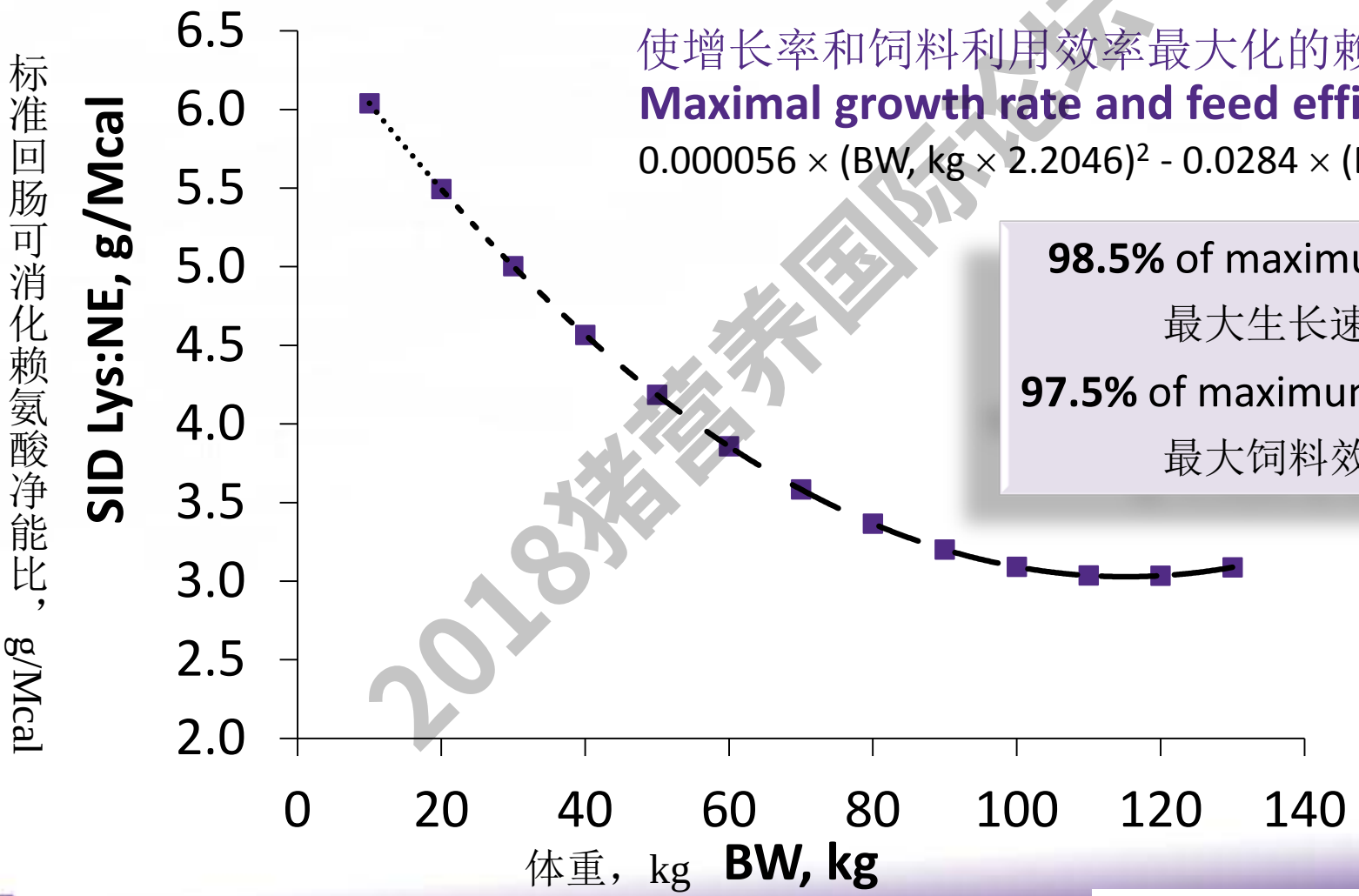
分阶段饲喂方案对利润的影响



Menegat et al., 2018

Estimated Lysine Requirements

估计赖氨酸需要量



使增长率和饲料利用效率最大化的赖氨酸需求：

Maximal growth rate and feed efficiency

$0.000056 \times (BW, kg \times 2.2046)^2 - 0.0284 \times (BW, kg \times 2.2046) + 6.6391$

98.5% of maximum growth rate

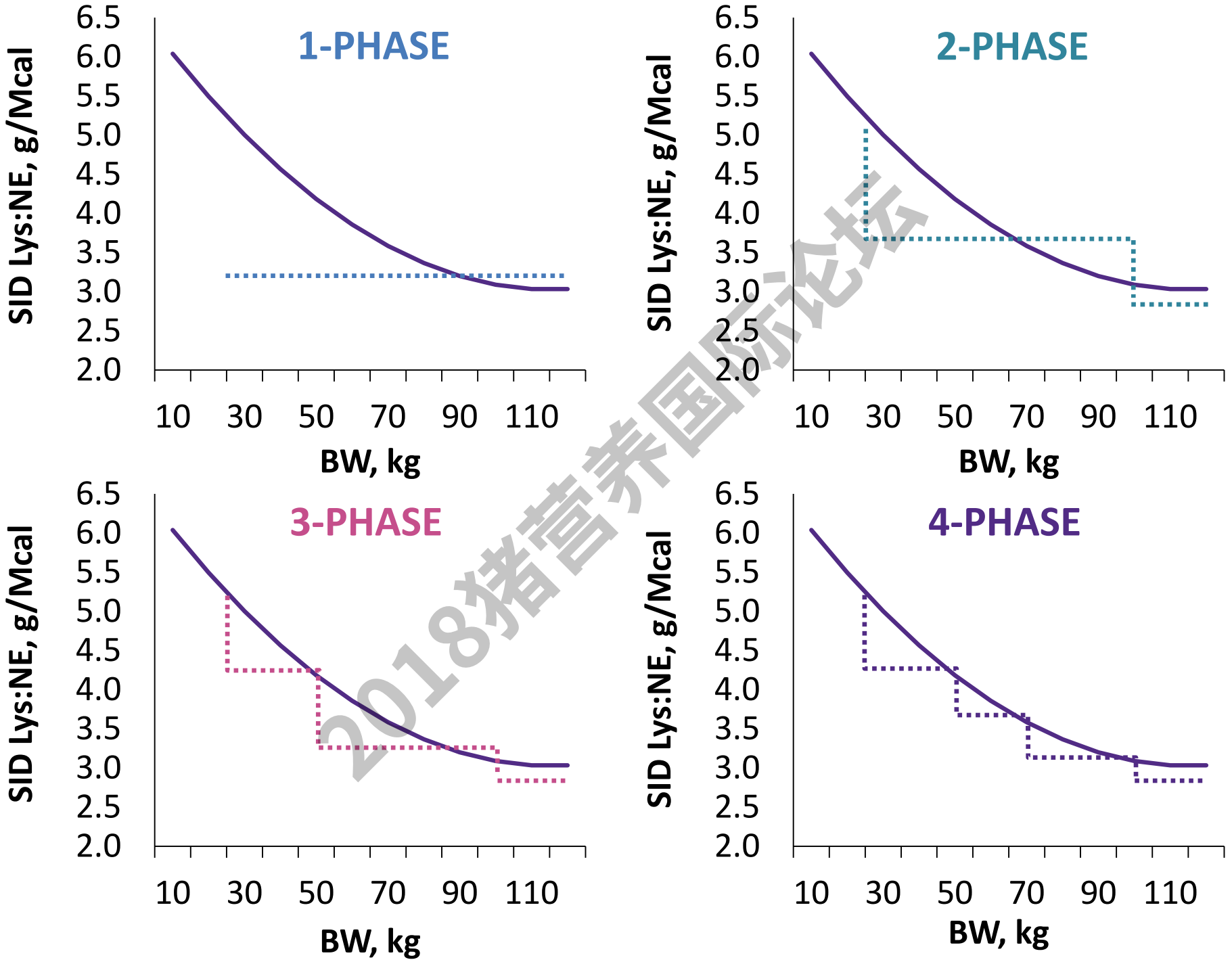
最大生长速度98.5%

97.5% of maximum feed efficiency

最大饲料效率97.5%

Menegat et al., 2018

Exp. 3 例3

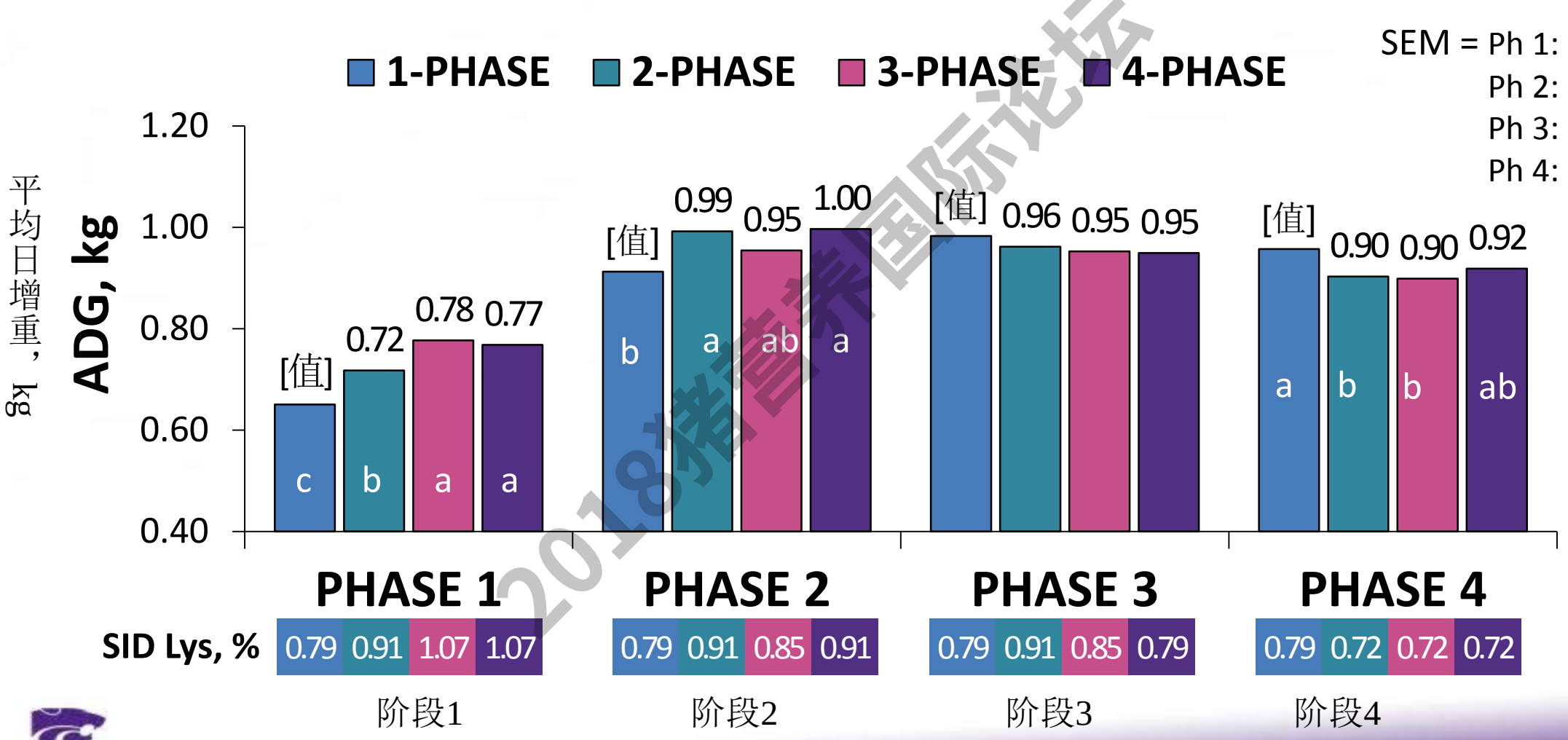


Average daily gain by phase

分阶段平均日增重

[abc] $P < 0.05$ within phase

SEM = Ph 1: 0.011
Ph 2: 0.013
Ph 3: 0.015
Ph 4: 0.011

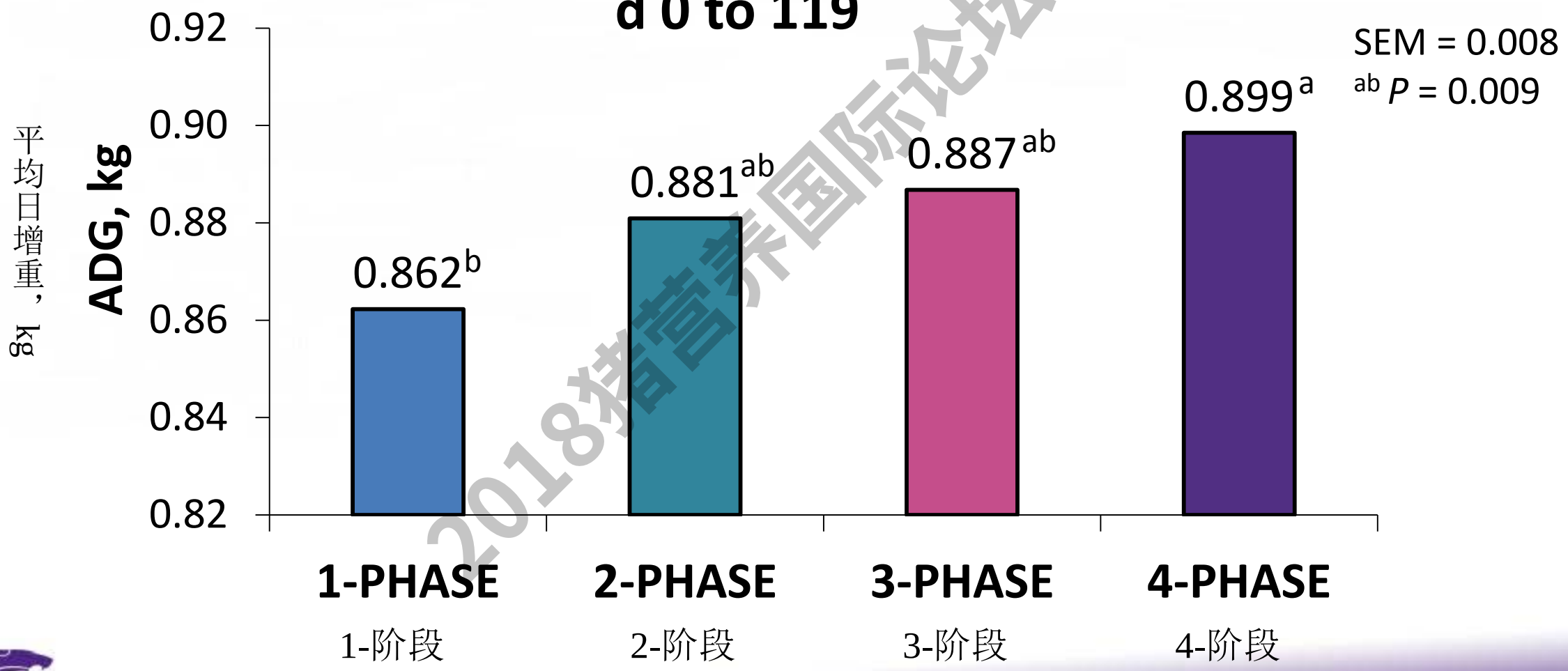


Menegat et al., 2018

Exp. 3 例3

Effect of phase feeding program on overall average daily gain

分阶段饲喂方案对整体平均日增重的影响

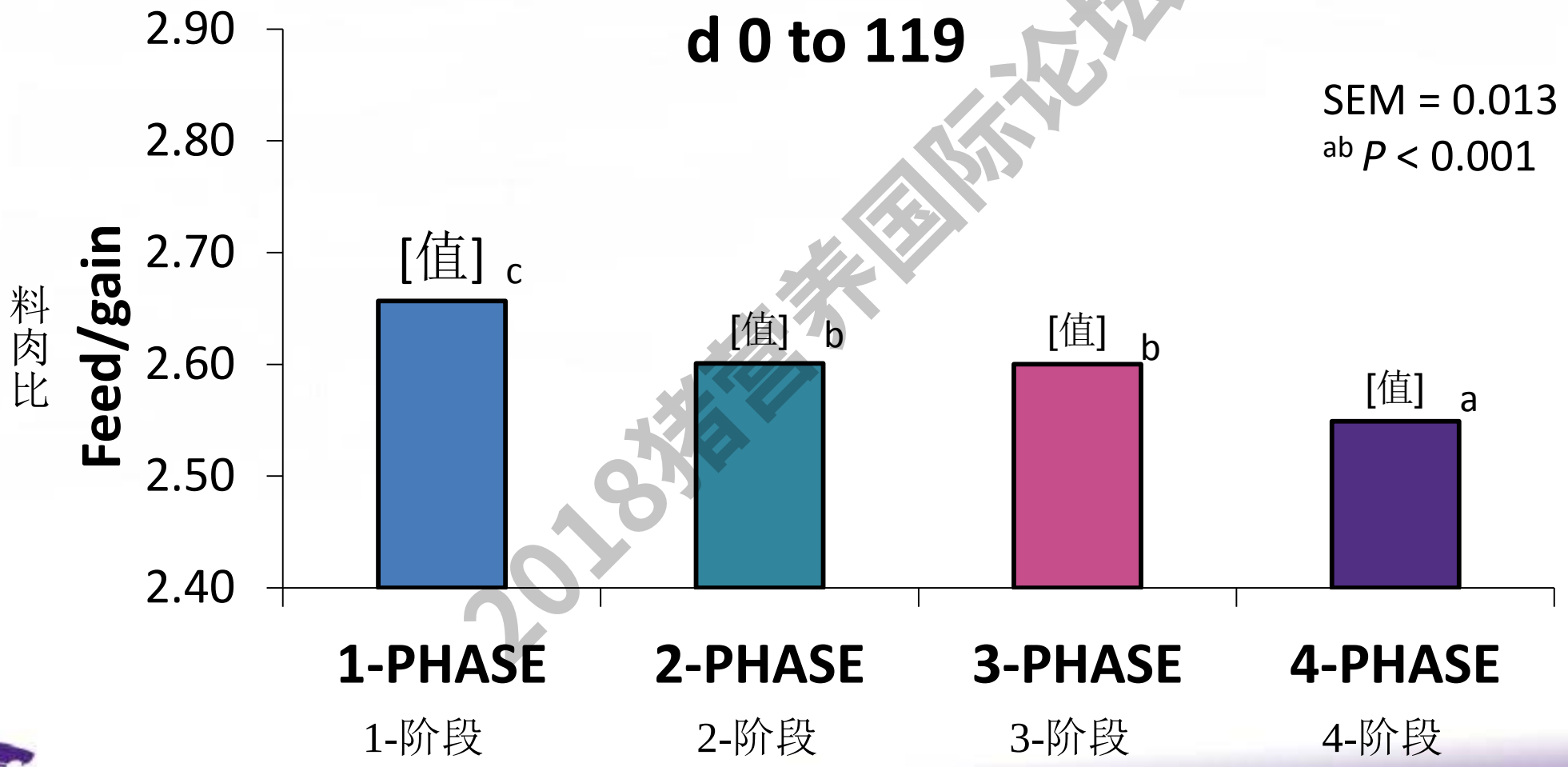


Menegat et al., 2018

Exp. 3 例3

Effect of phase feeding program on overall feed efficiency

分阶段饲喂方案对整体饲料效率的影响

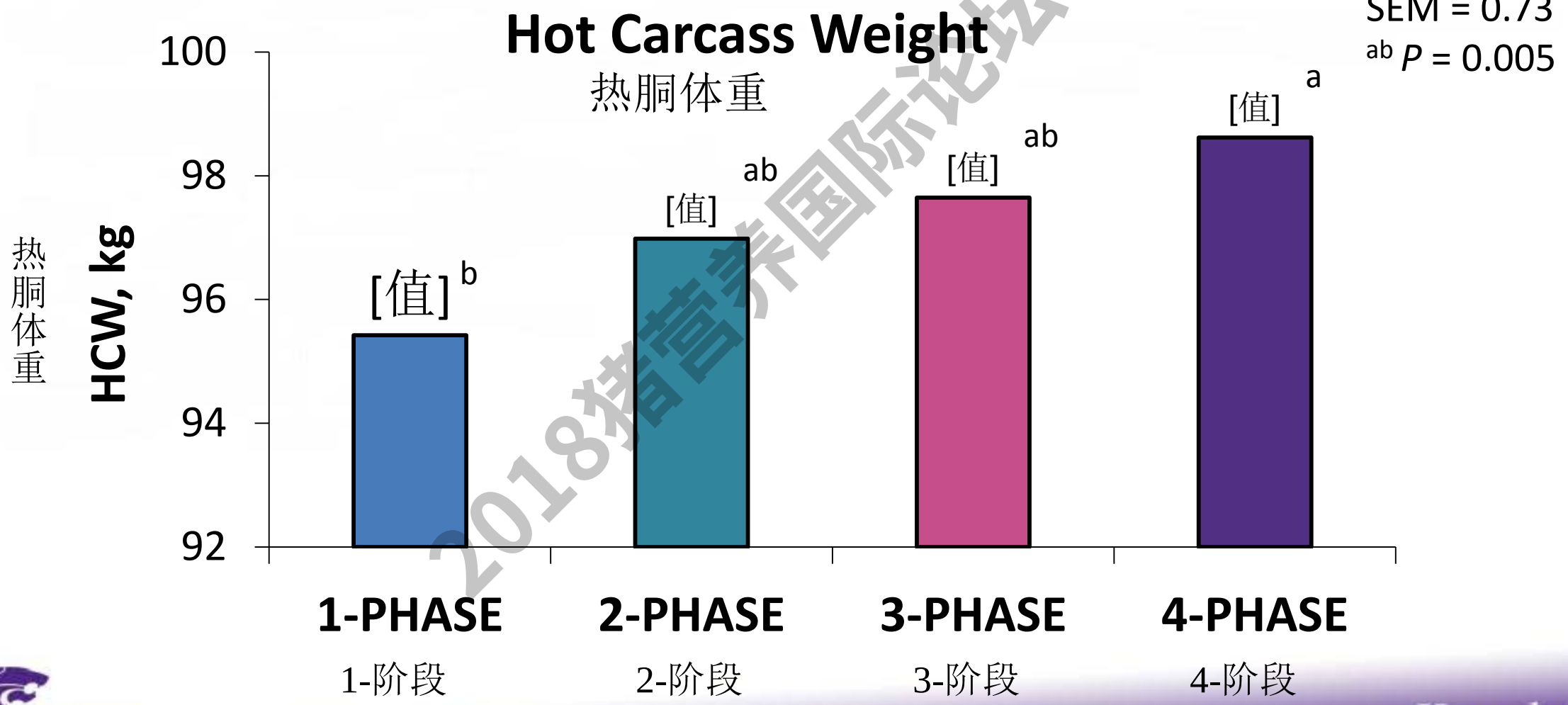


Menegat et al., 2018

Exp. 3 例3

Effect of phase feeding program on carcass characteristics

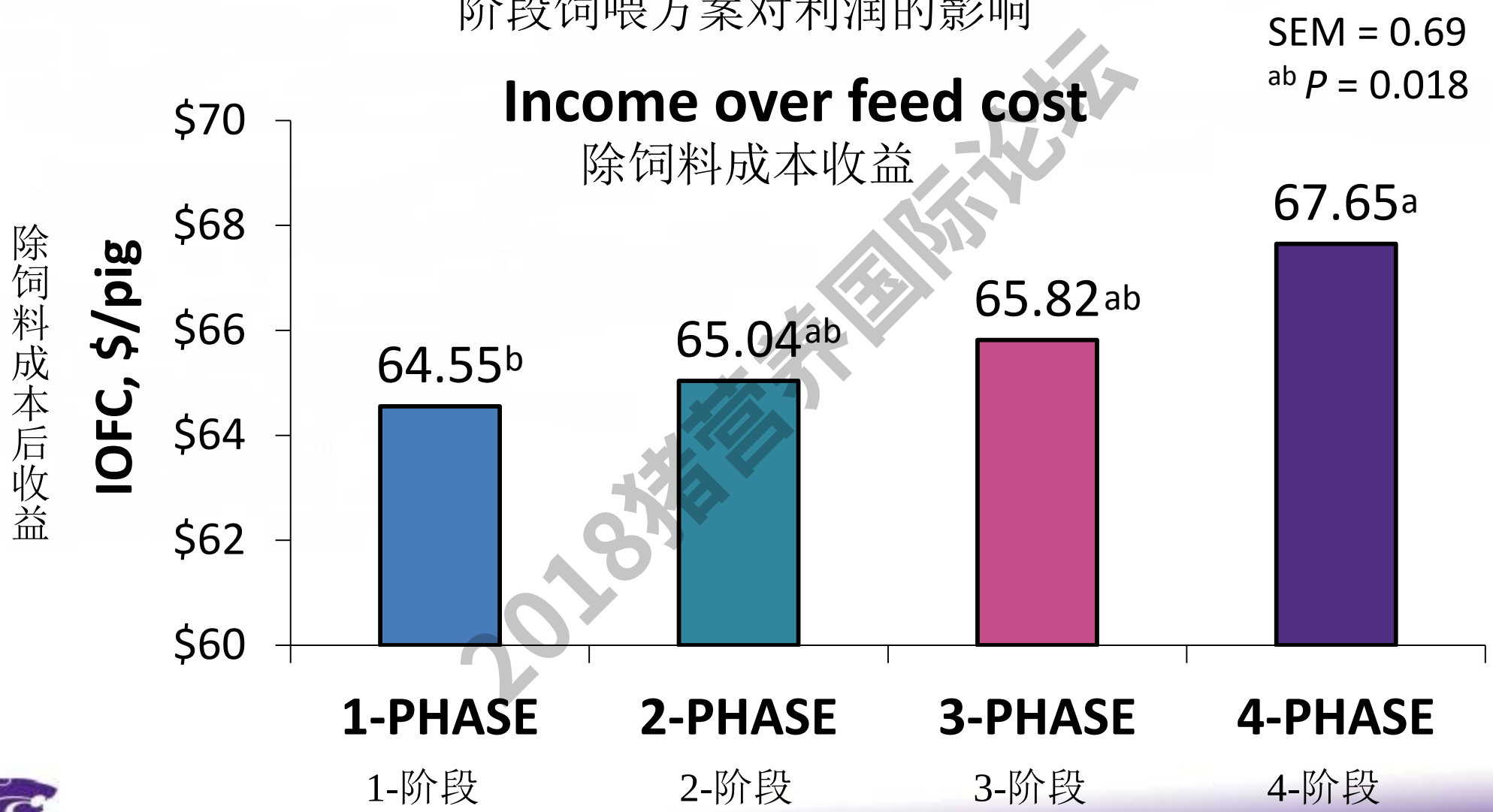
阶段饲喂方案对胴体特性的影响



Menegat et al., 2018

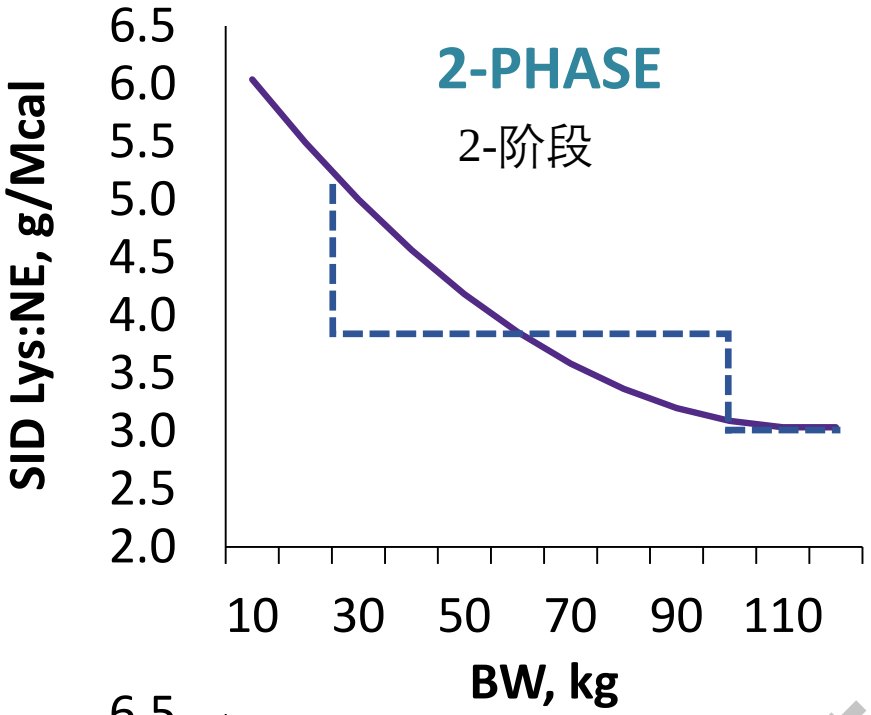
Effect of phase feeding program on economics

阶段饲喂方案对利润的影响



Menegat et al., 2018

纵坐标：标准回肠可消化赖氨酸净能比，g/Mcal
横坐标：体重，千克



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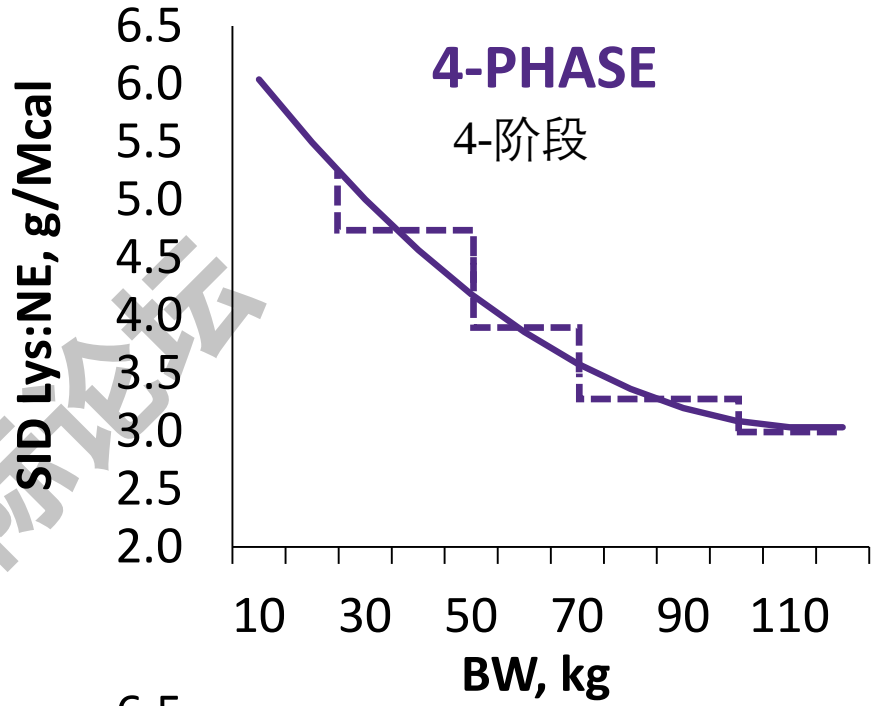

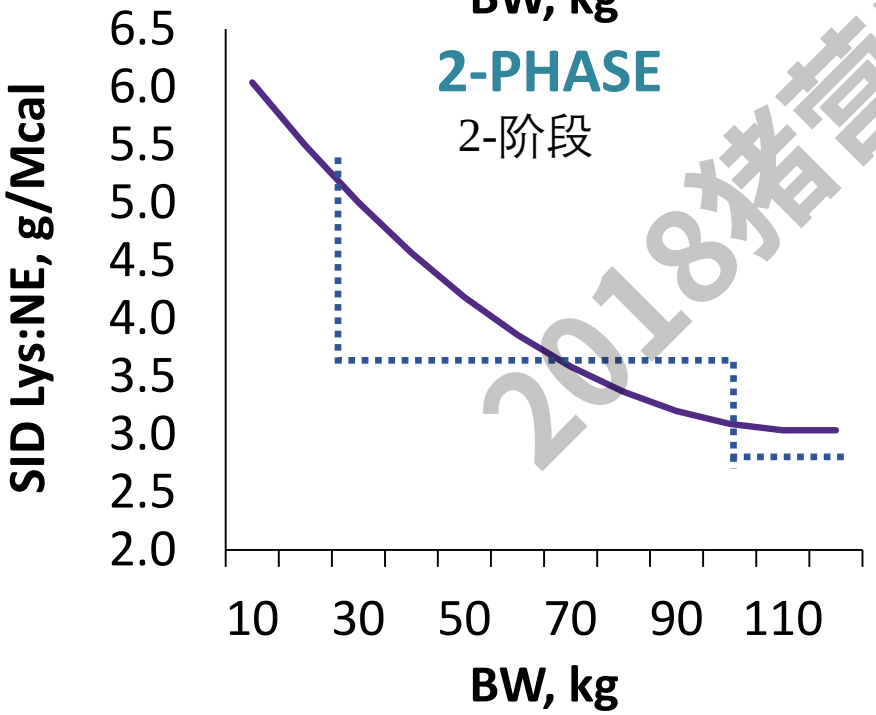

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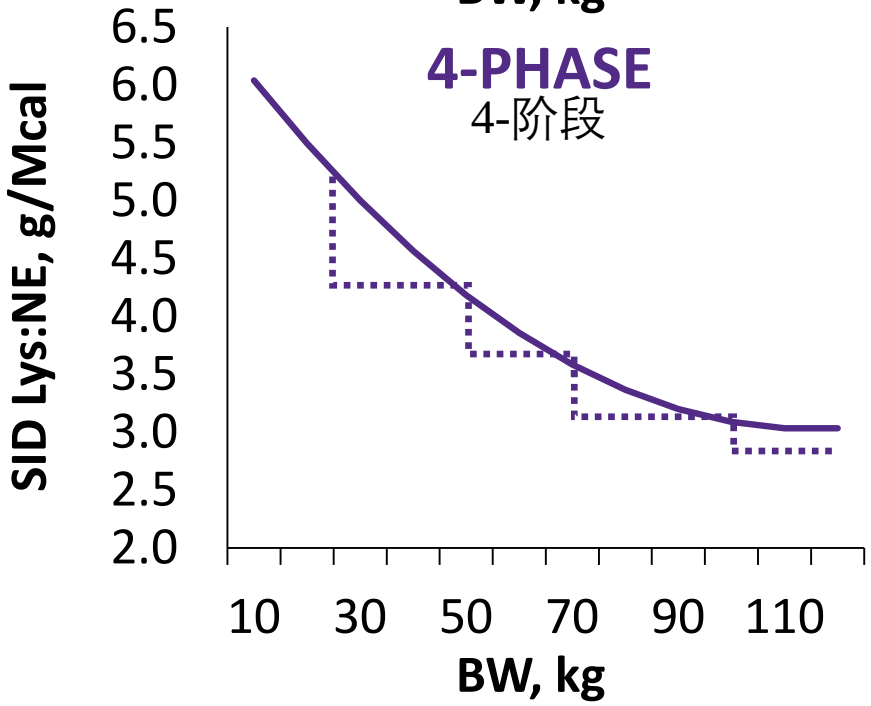
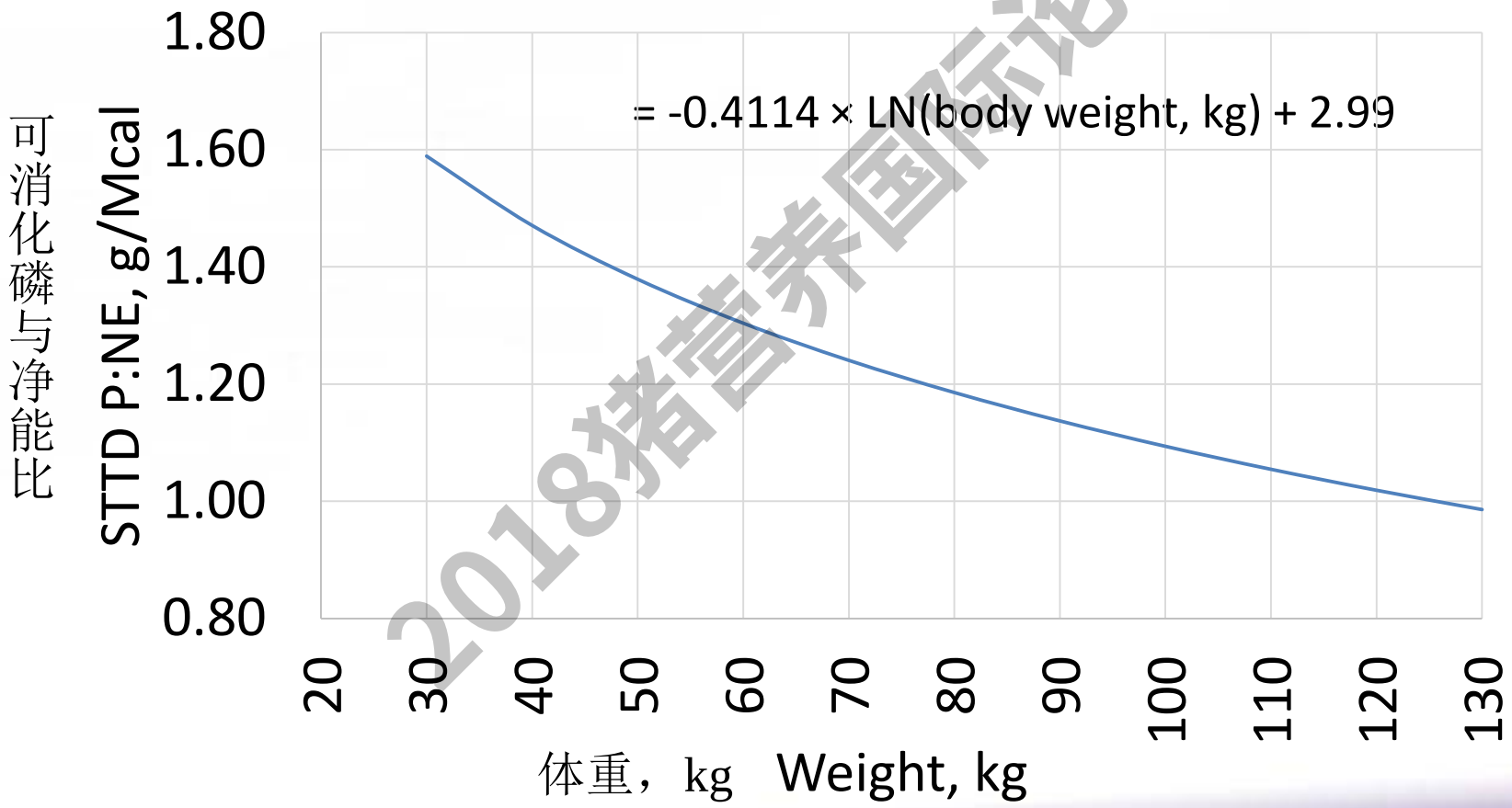


STTD P requirement of finishing gilts for maximum growth and feed efficiency (Includes use of high phytase levels)

使最大生长和饲料效率最大化所需的STTD P（包括使用高浓度的植酸酶水平）



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Vier et al., 2017

Calcium:phosphorus ratios 钙磷比

- STTD Ca: STTD P 标准全肠道可消化钙磷比
- Total Ca: STTD P 总钙与标准全肠道可消化磷比
- Analyzed Ca:STTD P 分析钙与标准全肠道可消化磷比
- Total Ca:Total P 总钙与总磷比
- Analyzed Ca : Analyzed P 分析钙与分析磷比
  - 1:1 to 1.3:1

Other minerals and vitamins 其他矿物元素和维生素

- Vitamins and minerals 维生素和矿物元素
  - Recommended levels vary considerably (Flohr et al., 2015)
    各种推荐水平之间有很大差异
  - Lower margins of safety for increased profitability do not lower performance (Del Tuffo et al., 2018)
    有时通过降低安全边际来提升利润不会损害生产性能
    - www.KSUswine.org for current recommendations 我们目前推荐量
  - Copper added at growth promoting levels, especially in early finishing
    添加铜促进生长，特别是在肥育期早期

Practical diet considerations to optimize profit in growing-finishing pigs

生长肥育猪效益最大化的实用日粮方案

- Grow-finish feed ≈ 80% of feed use! 生长肥育饲料占饲料总使用量的80%
- Determining the most economical energy level 确定最经济的能量水平
  - Influence of dietary fiber and fat on dressing percentage and fat quality.
    膳食纤维和脂肪对屠宰率和脂肪质量的影响
  - A consistent method to estimate net energy or productive energy for individual ingredients.
    采用一致的方法来估算单一原料的能量值
- Lysine:calorie ratio and number of diet phases 不同日粮阶段的赖氨酸能量比
  - Amino acid ratios to lysine 其他氨基酸与赖氨酸比
- Phosphorus:calorie ratio and Ca:P ratio 磷与能量比和钙磷比
- Vitamins, trace minerals, and salt 维生素、微量元素和盐
- Feed additives 饲料添加剂
  - Thoroughly evaluate before using 使用前经过充分评估

Kansas State University | applied swine nutrition

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Knowledge for Life

Feeding programs and use of additives in growing-finishing pigs

生长育肥猪饲喂方案及添加剂的应用

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swine nutritionist

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