



An update on the Feed-a-Gene research and innovation project

关于饲料-基因研究和创新项目的最新进展报告

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Efficiency = gain-over-feed? 效率=增重/饲料?

The efficiency of these
musicians is zero
这些音乐家的效率为零



They do not want to grow;
they eat so that they can play music
他们不想增重;
他们吃饭是为了可以玩音乐

The efficiency of these
giant pandas is also zero ...
这些大熊猫的效率也是零.....



... and they are poor musicians
as well
.....他们也是糟糕的音乐家



The issue of feed efficiency and competition for resources is not new 饲料效率和资源争端的问题一直存在

The Efficiency of the Animal Compared with the Steam Engine.
It is of interest in studying the efficiency of the animal as a converter of energy in work and food production to compare it with a mechanical energy converter such as the steam engine. We have recently been confronted with the phenomenon of the burning of corn for fuel in place of the usual use as a food for animals or man. The economy of this substitute conversion might help solve the question of the ethics of such a substitution. Van de Velde¹⁰ has presented some figures to show that

动物的生产效率 vs. 蒸汽机效率

将动物作为能量转化为工作和食品的转化器进行研究，并将其与机械能转化器如蒸汽机相比是非常有趣的事情。通常来说玉米是动物或人类的食物之一，但是最近我们可以看到将玉米转化为燃料使用的现象。经济性分析可能有助于解决这两种转化方式之间互相替代的伦理问题。Van de Velde提供了一些数据来表明这一点。



Variation among individuals is natural, essential, and very well controlled
个体之间的差异是自然的、必要的，并且控制得非常好





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个体之间的差异是自然的、必要的，并且控制得非常好



~~He does not know his energy~~

~~1.0 requirement~~
Or does he?

或者他真的知道吗??

能量摄入 = 1.000 x 能量消耗

Energy intake =
1.000 x Energy
requirement

她知道她的能量需求

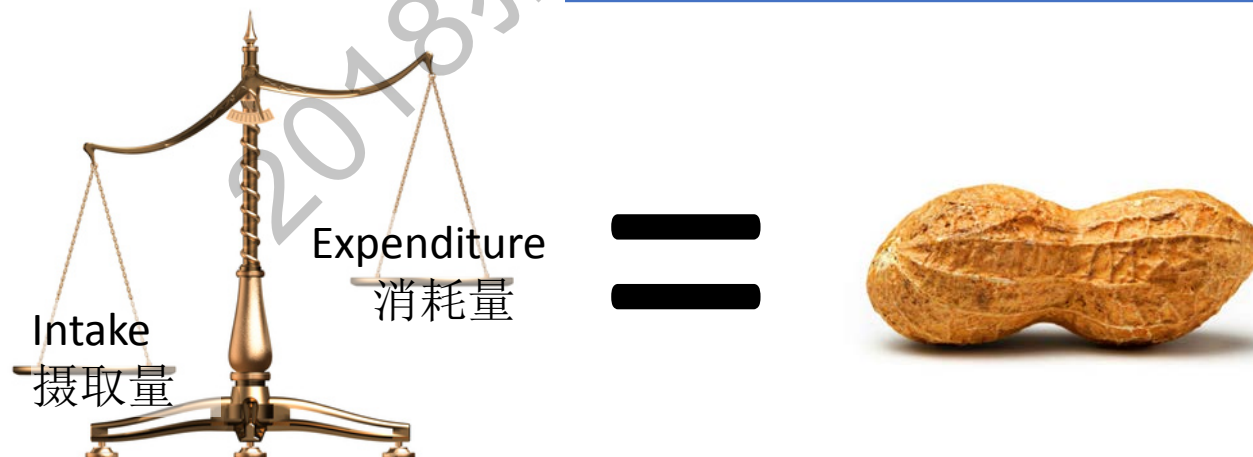
能量摄入 = 1.000 x 能量消耗





Variation among individuals is natural, essential, and very well controlled
 个体之间的差异是自然的、必要的，并且控制得非常好

Item	项目	Energy	能量
Maintenance energy requirement	维持能量需要	2580 kcal/d	2580 千卡/天
0.5% imbalance	0.5%不平衡	13 kcal/d	13 千卡/天
Deposited as lipid	沉积为脂质	1.3 g/d	1.3 克/天
Per year	每年	481 g/yr	481 克/年
Between 20 and 60 years of age	从20至60岁后	19 kg of lipid	19千克脂质



EU funded
Research
project
欧盟资助的
研究项目

2015
2020

€10 M
Budget
1000万欧
元预算

Feed-a-Gene



Adapting the **feed**, the **animal** and
the **feeding techniques** to improve
the efficiency and sustainability of
monogastric livestock production
systems(www.feed-a-gene.eu)

调整饲料、动物和饲养技术，以提高单胃
动物生产系统的效率和可持续性
(www.feed-a-gene.eu)

23

Partners
EU + China
合作伙伴
欧盟+中国

15

Industry
工业

8

Academic
学者



Feed 饲料

Academic partners 学术伙伴
Feed ingredient producer 饲料原料
生产商
Enzyme producer 酶生产商
Feed processing equipment
manufacturer 饲料加工设备制造商



Traits, models, and feeding techniques 性状、模型和饲养技术

Academic partners 学术伙伴
Precision farming equipment
manufacturers
精准养殖设备制造商



Gene 基因

Academic partners 学术伙伴
Pig breeder 猪育种公司
Poultry breeder 家禽育种公司

Interbranch organizations 交叉组织
Extension services 推广服务



The Feed-a-Gene consortium

饲料-基因联盟

研究机构

1. 法国农科院
2. 瓦赫宁根大学和研究所
3. 纽卡斯尔大学
4. 莱里达大学
5. 国际互换贸易协会
6. 卡波斯瓦尔大学
7. 奥胡斯大学
8. 中国农业大学

行业

9. 托佩克种猪
10. 科布斯
11. 哈姆雷特蛋白
12. 布勒公司
13. 杜邦公司
14. Exafan
15. Claitec
16. 国际镍业公司
17. 格兰猪

Research

1. INRA
2. WUR
3. UNew
4. UdL
5. IRTA
6. KU
7. AU
8. CAU

Industry

9. Topigs
10. Cobbs
11. Hamlet Protein
12. Bühler
13. Dupont
14. Exafan
15. Claitec
16. INCO
17. Gran Suino

Extension

18. ACTA
19. IFIP
20. ITAVI
21. Terres Inovia
22. AFZ

Management

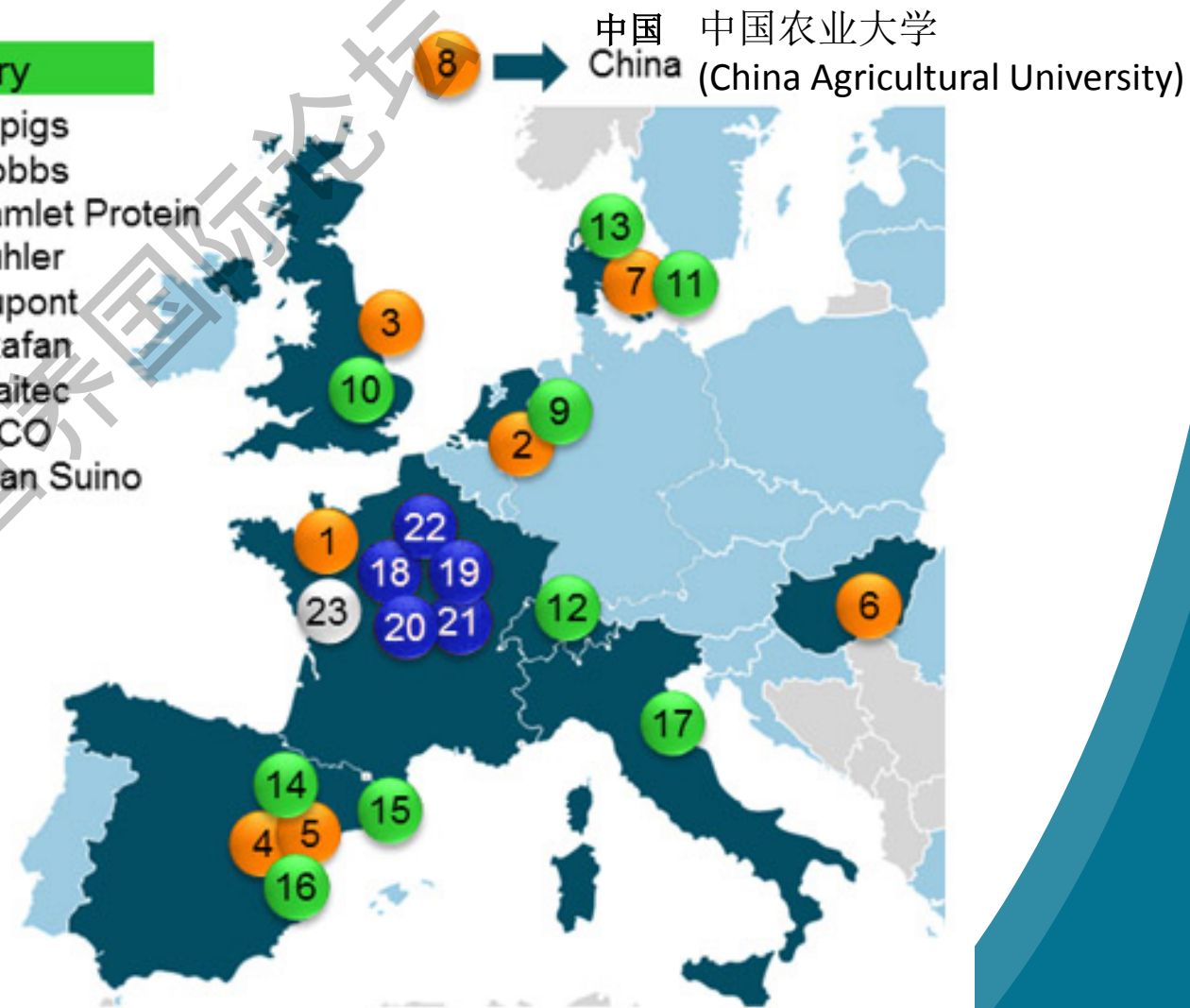
23. IT

扩展

18. 反假冒贸易协议
19. 国际集邮联合会
20. ITAVI
21. 泰雷斯伊诺维亚电信有限公司
22. 法国动物生产协会

管理

23. IT





Objectives of the Feed-a-Gene project 饲料-基因项目的目标



Feed 饲料:

- ▶ Develop new local feed resources that are not/less in competition with food
开发新的当地饲料资源，尽量不与食品竞争
- ▶ Improve the nutritional value of feed resources 提高饲料资源的营养价值



Gene 基因:

- ▶ Use of novel traits indicative for feed efficiency and robustness that can be used as selection criteria
使用表示饲料效率的新性状，这些性状足够强健可用作选育标准
- ▶ “Do better with feeds that may be worse” “用同样或更差的饲料做到更好”



Traits, models, and feeding techniques 性状、模型和饲养技术:

- ▶ Appreciate variation among animals 接受动物之间的差异
- ▶ Develop precision feeding techniques 开发精确饲养技术
- ▶ Evaluate the overall sustainability 评估整体可持续性



It is all about variation 一切都与变异有关

Observe variation in feeds, animals, and the environment

观察 饲料，动物和环境的变异



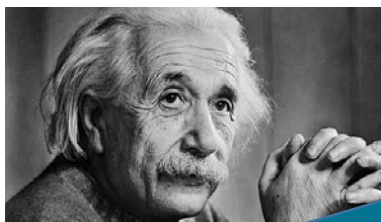
Predict using data-driven models and quantify interactions and variation

预测 使用数据模型量化互作和变异



Understand the underlying mechanisms of variation

了解变异的潜在机制



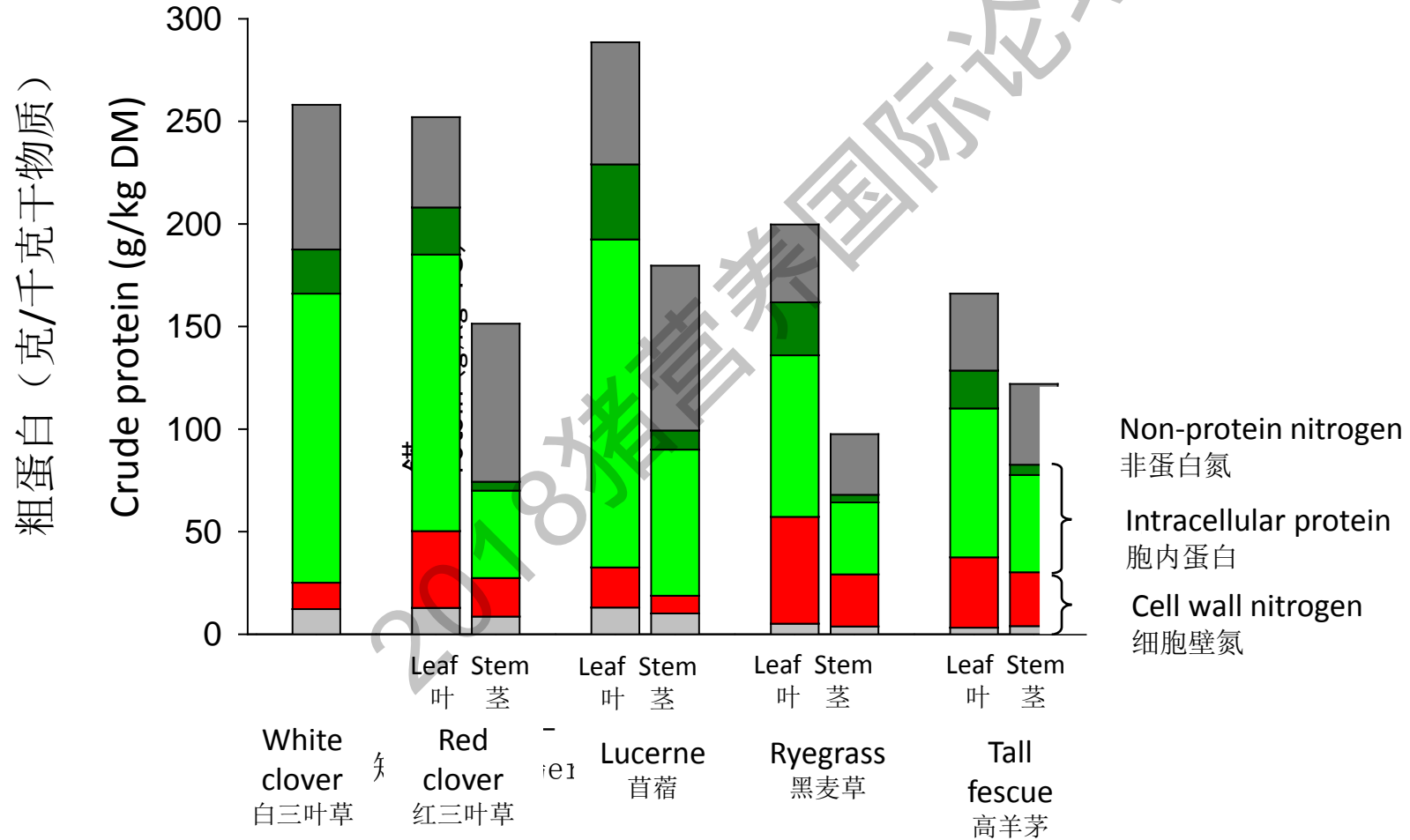
Control through livestock management (e.g., feeding, breeding)

通过牲畜管理（例如饲养、育种）进行控制



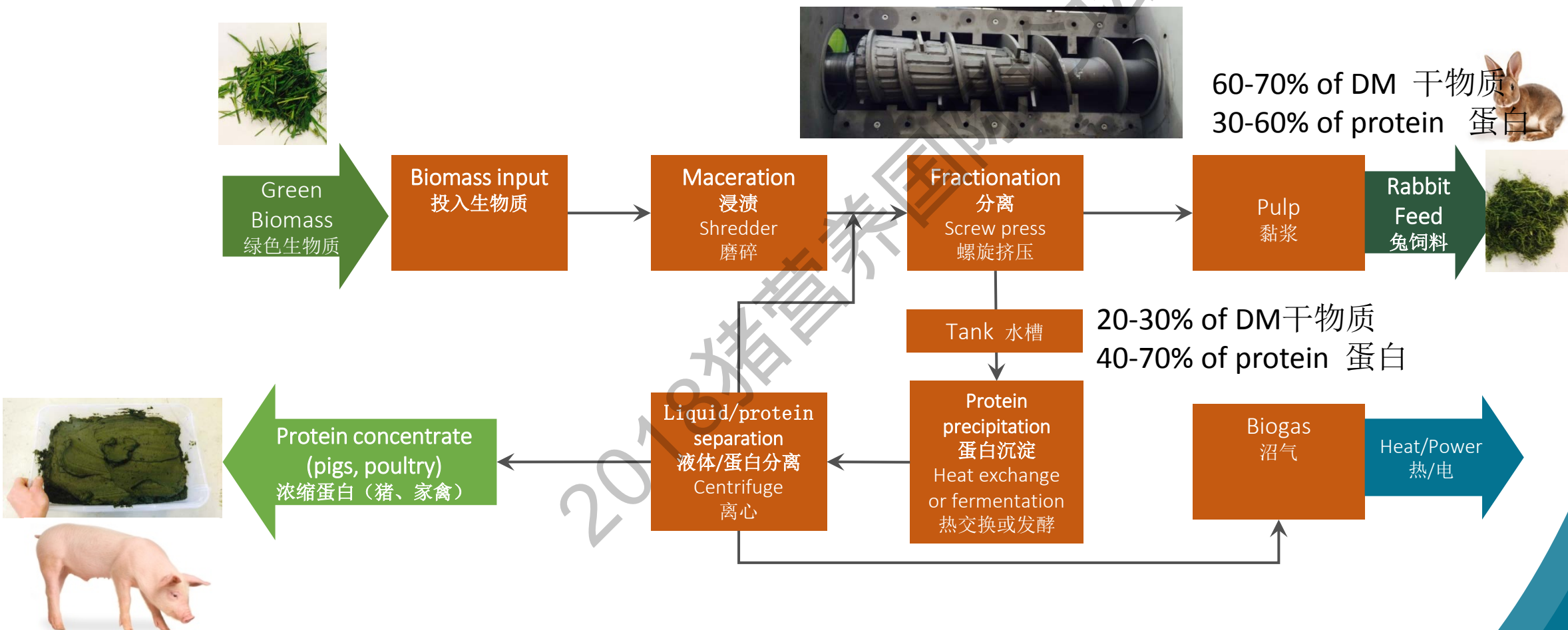


Protein production from green biomass 绿色生物生产蛋白质





Protein production from green biomass 绿色生物生产蛋白质





Protein production from green biomass 绿色生物生产蛋白质

Lab scale 实验室规模



Pilot scale 中试规模



Semi production scale 半生产规模





Upgrading rapeseed meal by feed processing technologies 通过饲料加工技术提升菜籽粕品质

Mixing 混合



Crushing 粉碎



Sifting 过筛



Paddle mixer
桨式混合机



Loading to crusher
装载到粉碎机



Crusher (roller mill)
粉碎机 (滚碎机)



Fractionation:
Plansifter
分离: 平面筛



Fiber-rich fraction
富含纤维的部分



Protein-rich fraction
富含蛋白的部分



New animal traits for innovative feeding and breeding strategies

新的动物饲养和育种创新策略的性状

behavior and welfare

行为和福利



image analysis 图像分析
serotonin, cortisol
血清素、皮质醇

individual feed intake

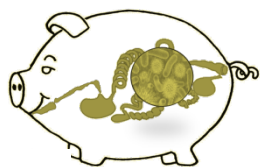
个体采食量



feed intake patterns 采食方式
feeding behavior 采食行为

digestive efficiency

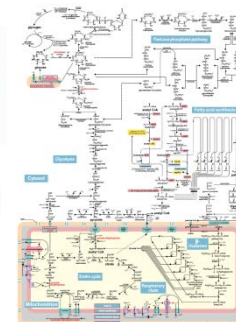
消化率



digestibility markers 消化率指示剂
gut health 肠道健康
Microbiota 微生物群

metabolic efficiency

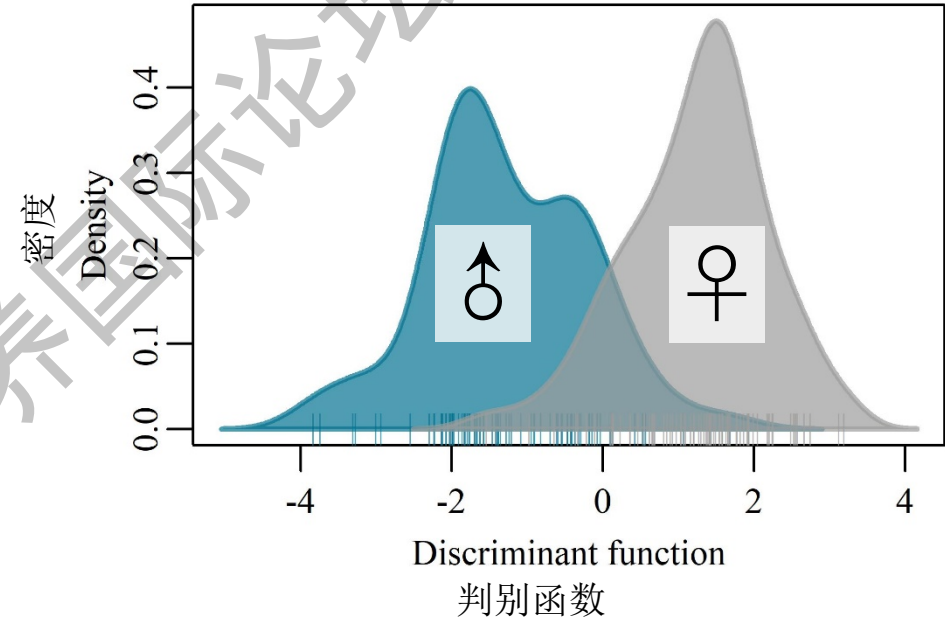
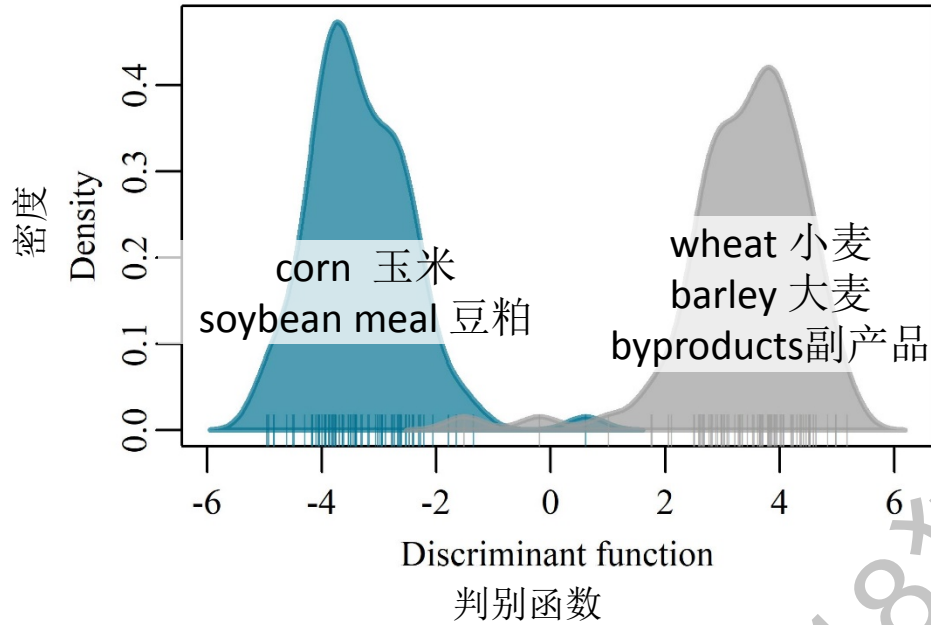
代谢率



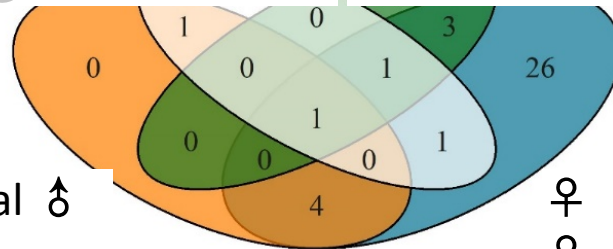
Transcriptomics 转录组学
Proteomics 蛋白质组学
Metabolomics 代谢组学



Microbiota as a trait to differentiate 微生物群作为区分的性状



wheat/barley/byproducts ♂ ♀ wheat/barley/byproducts
 小麦/大麦/副产品 ♂ ♀ 小麦/大麦/副产品



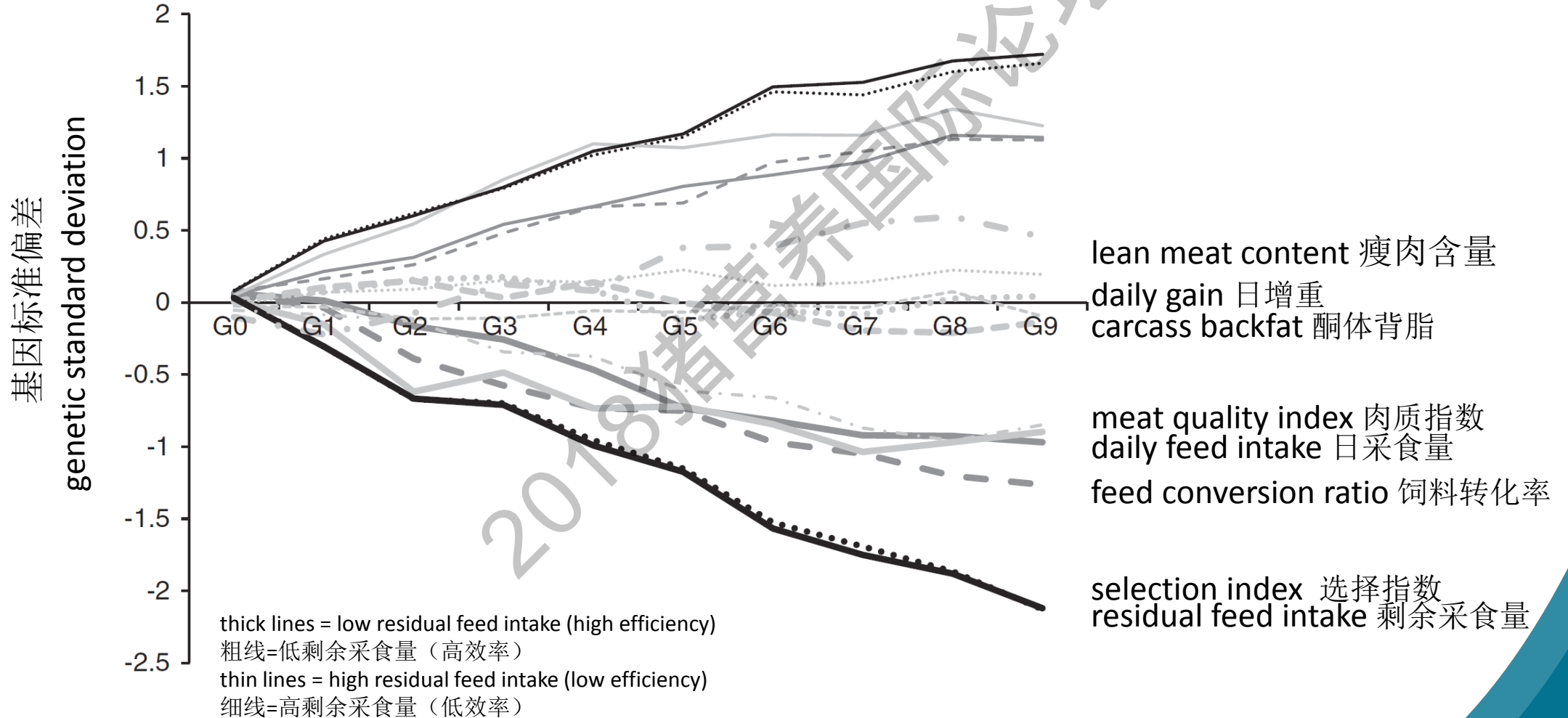
corn/soybean meal ♂
 玉米/豆粕 ♂

♀ corn/soybean meal
 ♀ 玉米/豆粕



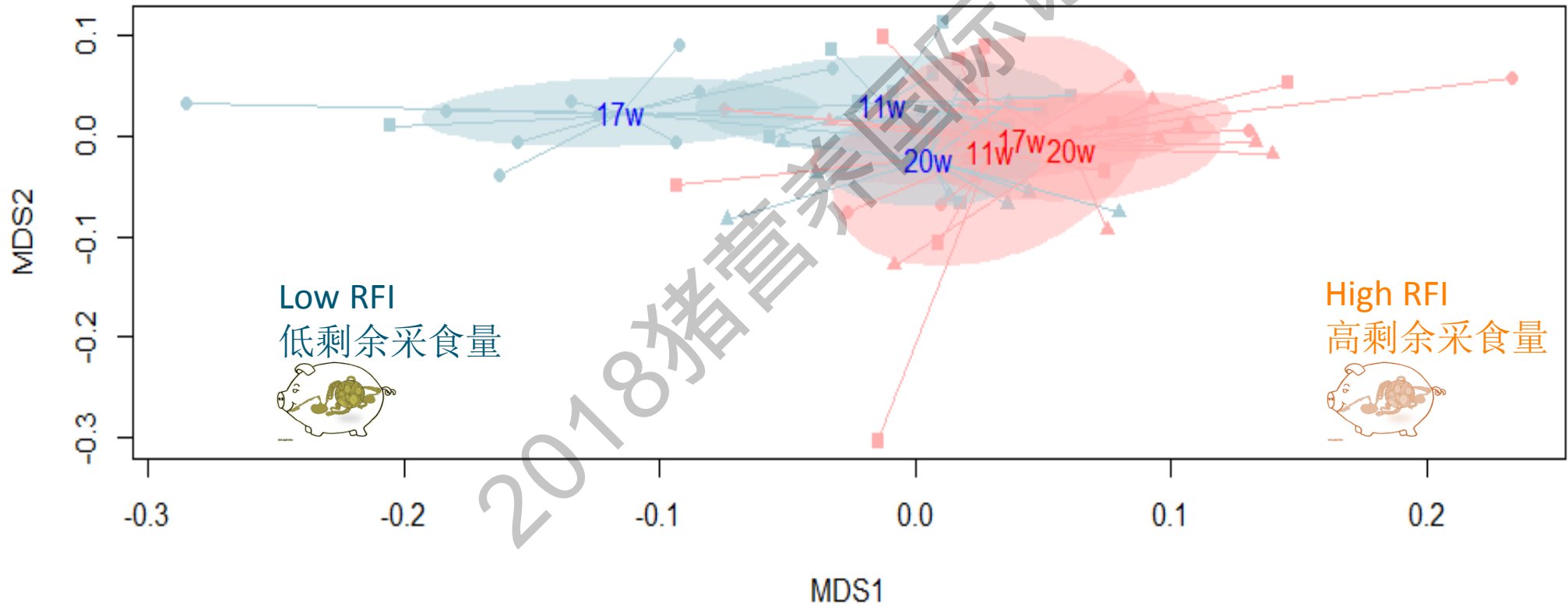
Residual feed intake can be used to study feed efficiency

剩余采食量可用于研究饲料效率



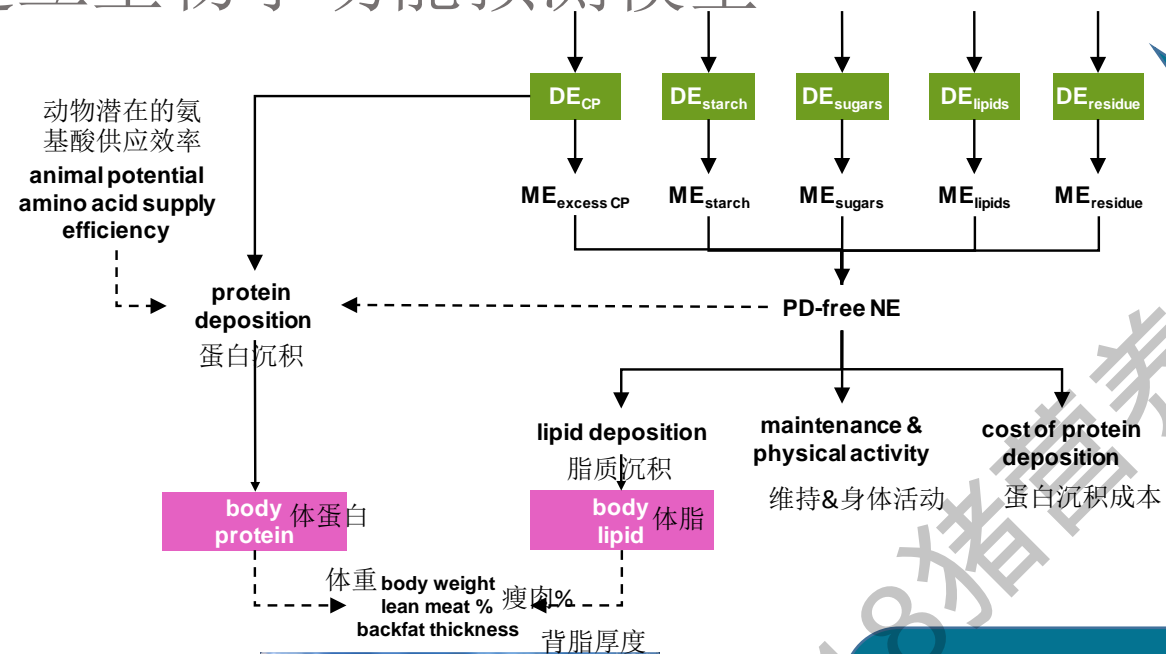
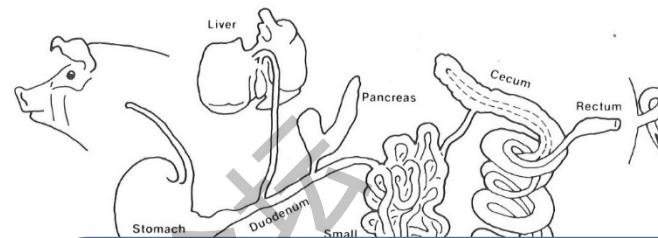


Microbiota as a trait to differentiate 微生物群作为区分的标准





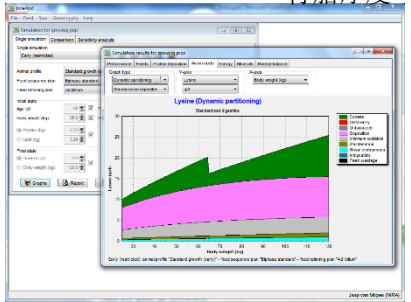
Modeling biological functions 建立生物学功能预测模型



Nutritional growth models such as InraPorc use digestible nutrients as model inputs ... 营养生长模型如InraPorc使用可消化营养素作为模型输入...

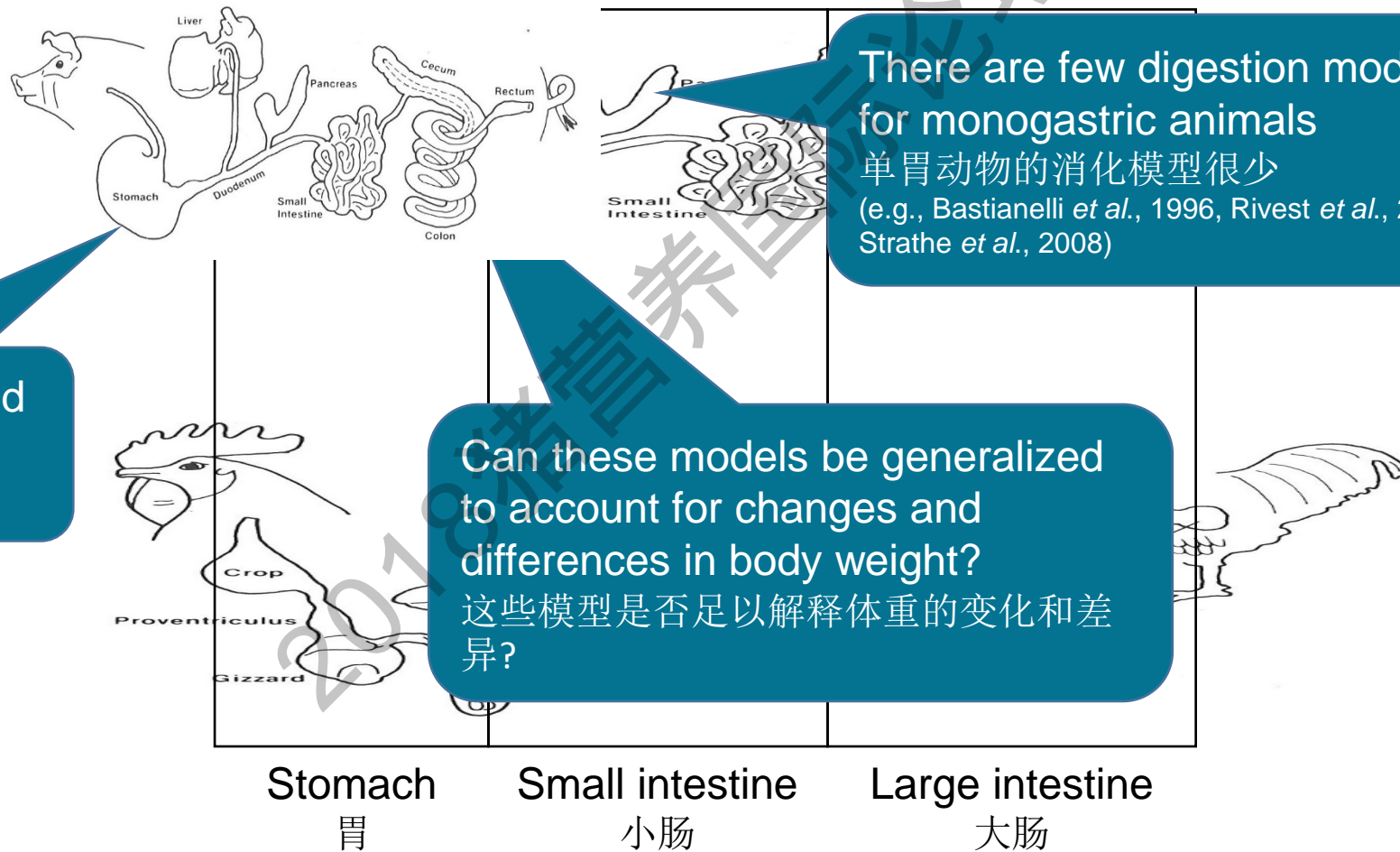


... to predict performance traits of a single animal in a "standard" environment ...在“标准”环境中预测单个动物的生长表现





Modeling digestion in pigs and poultry 建立猪和家禽的消化过程模型



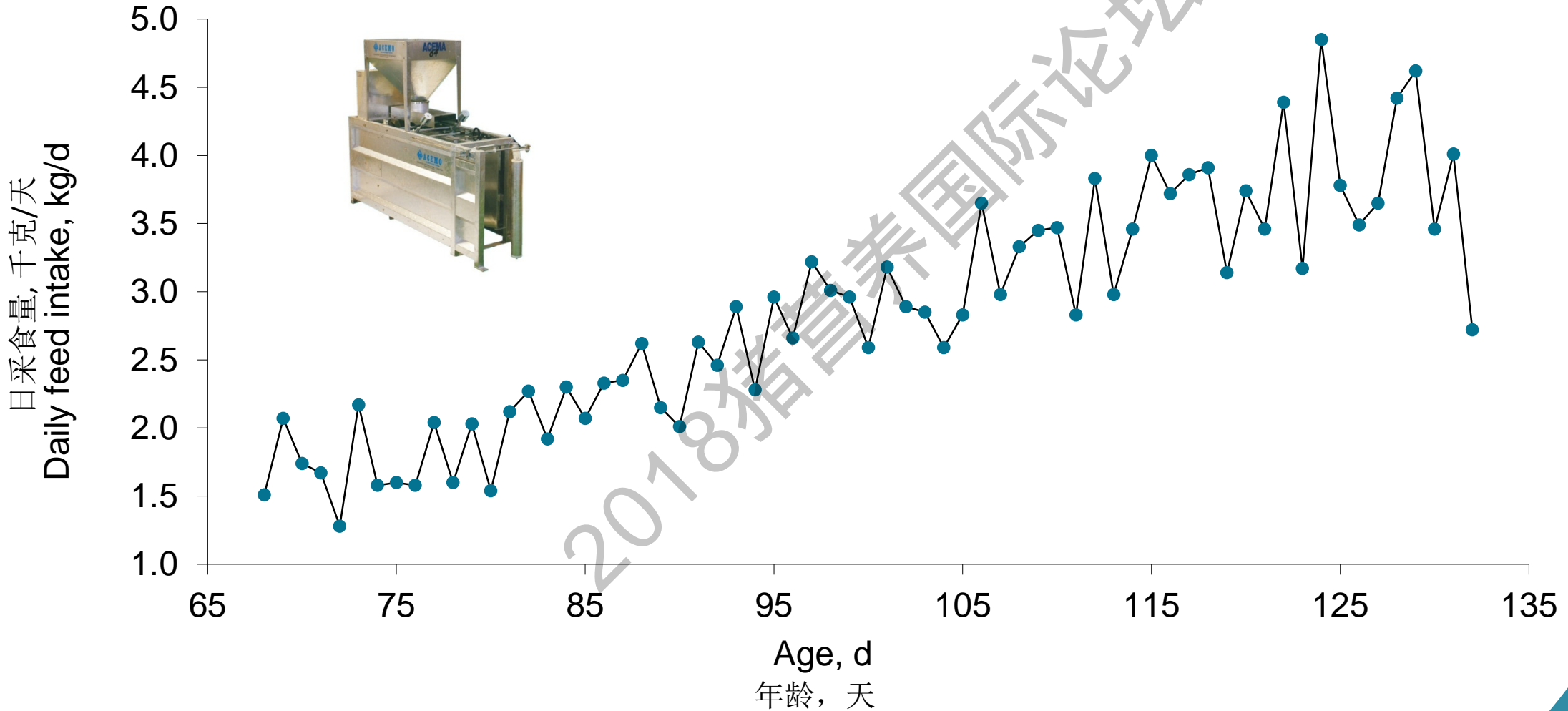
There are few digestion models for monogastric animals
 单胃动物的消化模型很少
 (e.g., Bastianelli *et al.*, 1996, Rivest *et al.*, 2000, Strathe *et al.*, 2008)

Can they be generalized across species?
 它们能推广至其它物种吗?

Can these models be generalized to account for changes and differences in body weight?
 这些模型是否足以解释体重的变化和差异?

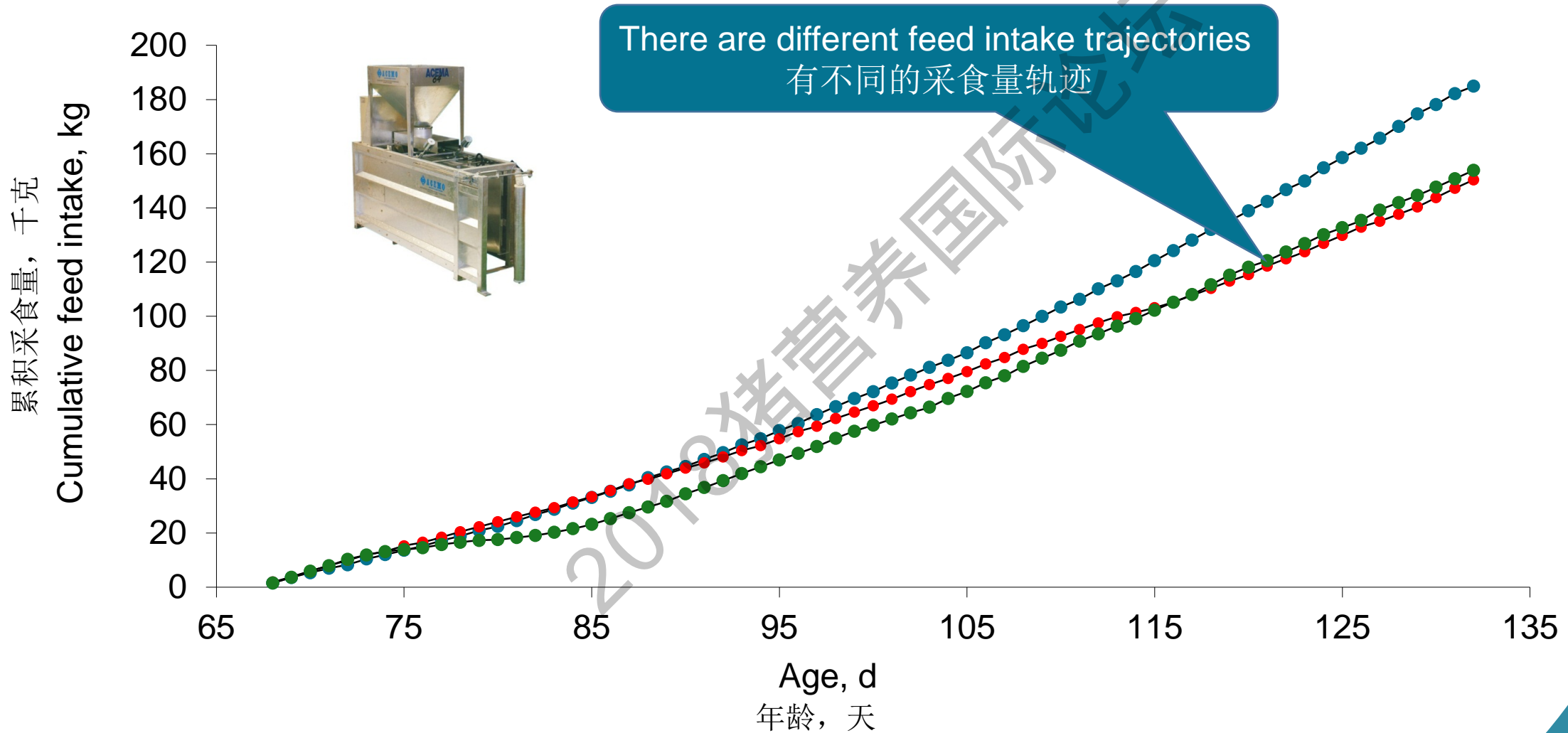


Feed intake patterns can be variable 采食量变异性比较大



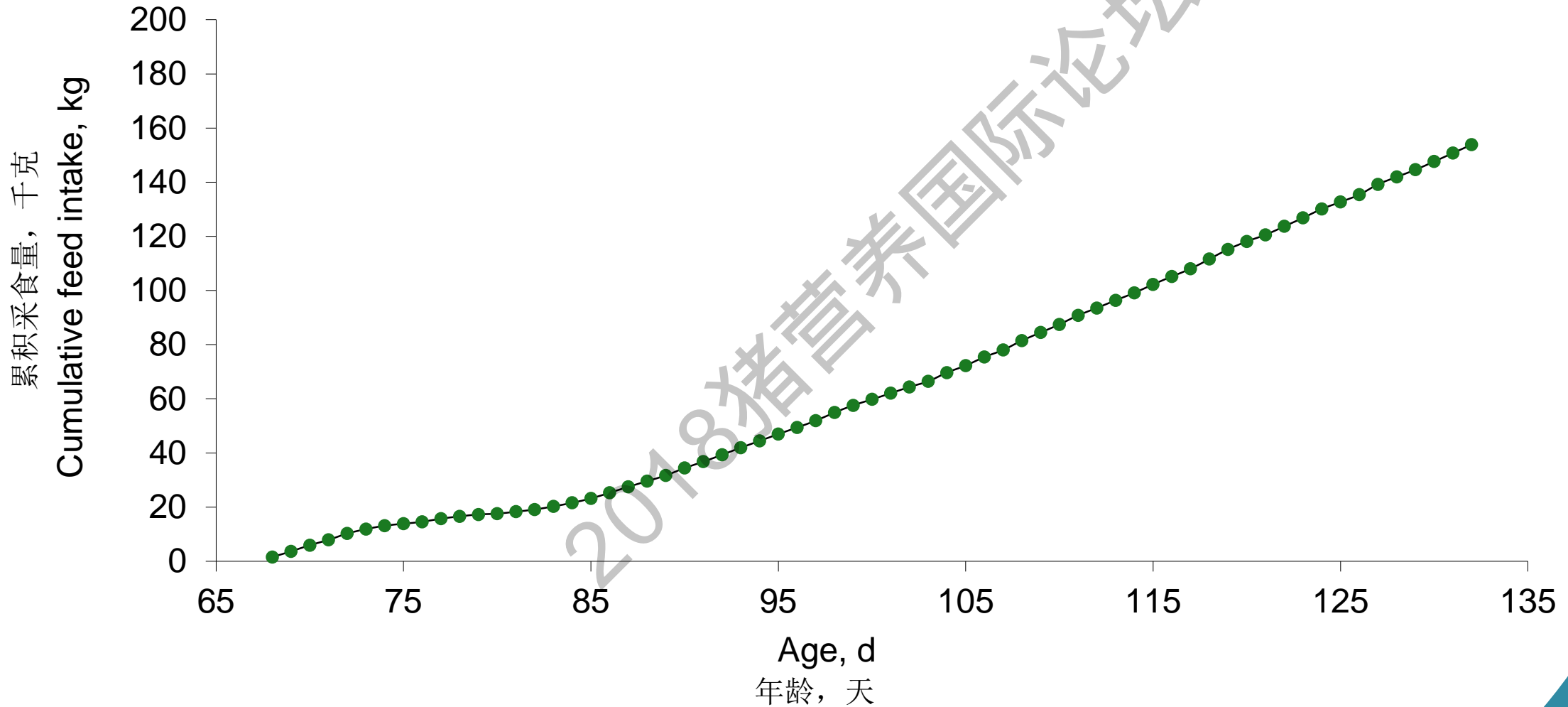


Feed intake patterns can be variable 采食量变异性比较大



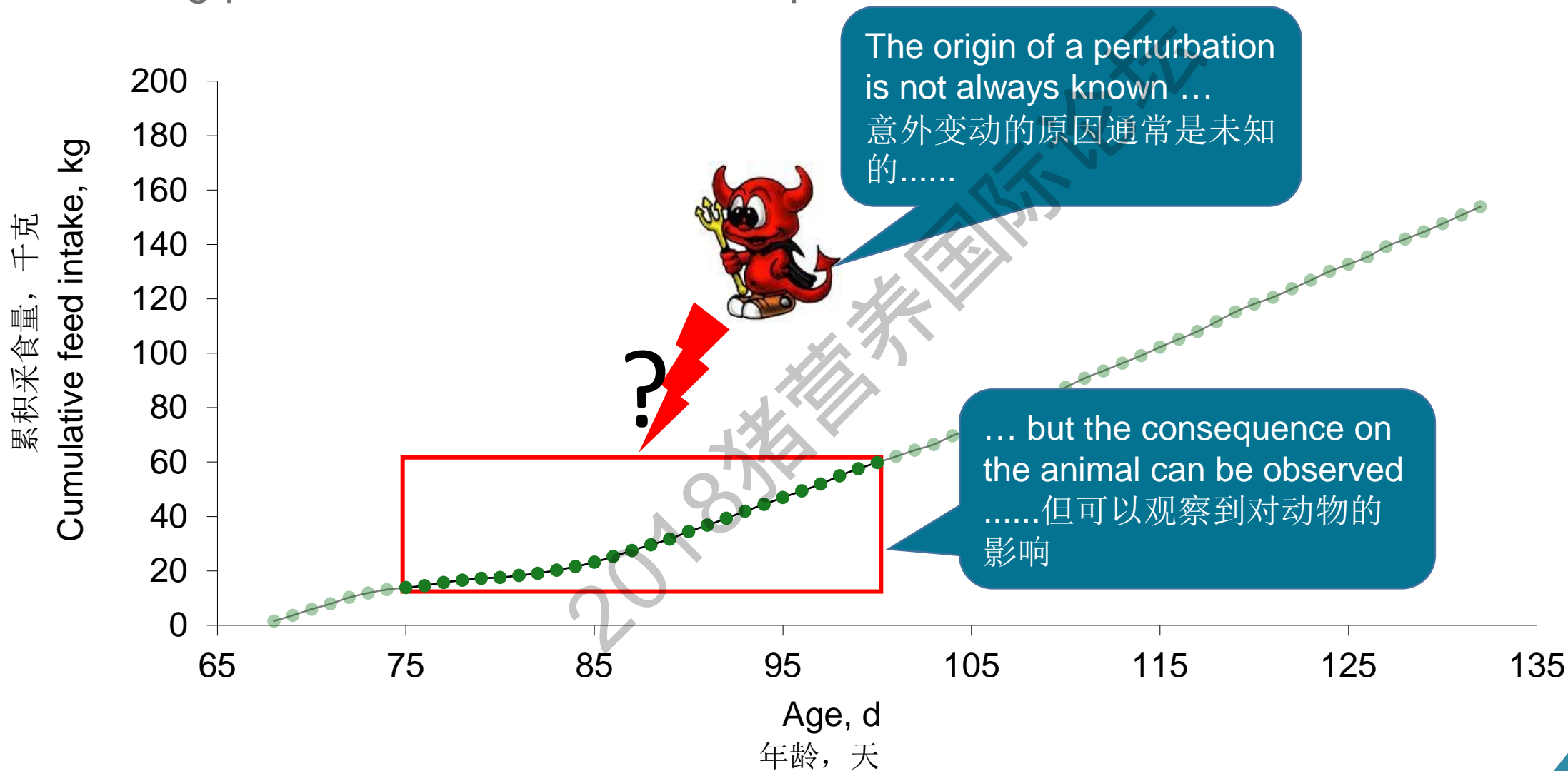


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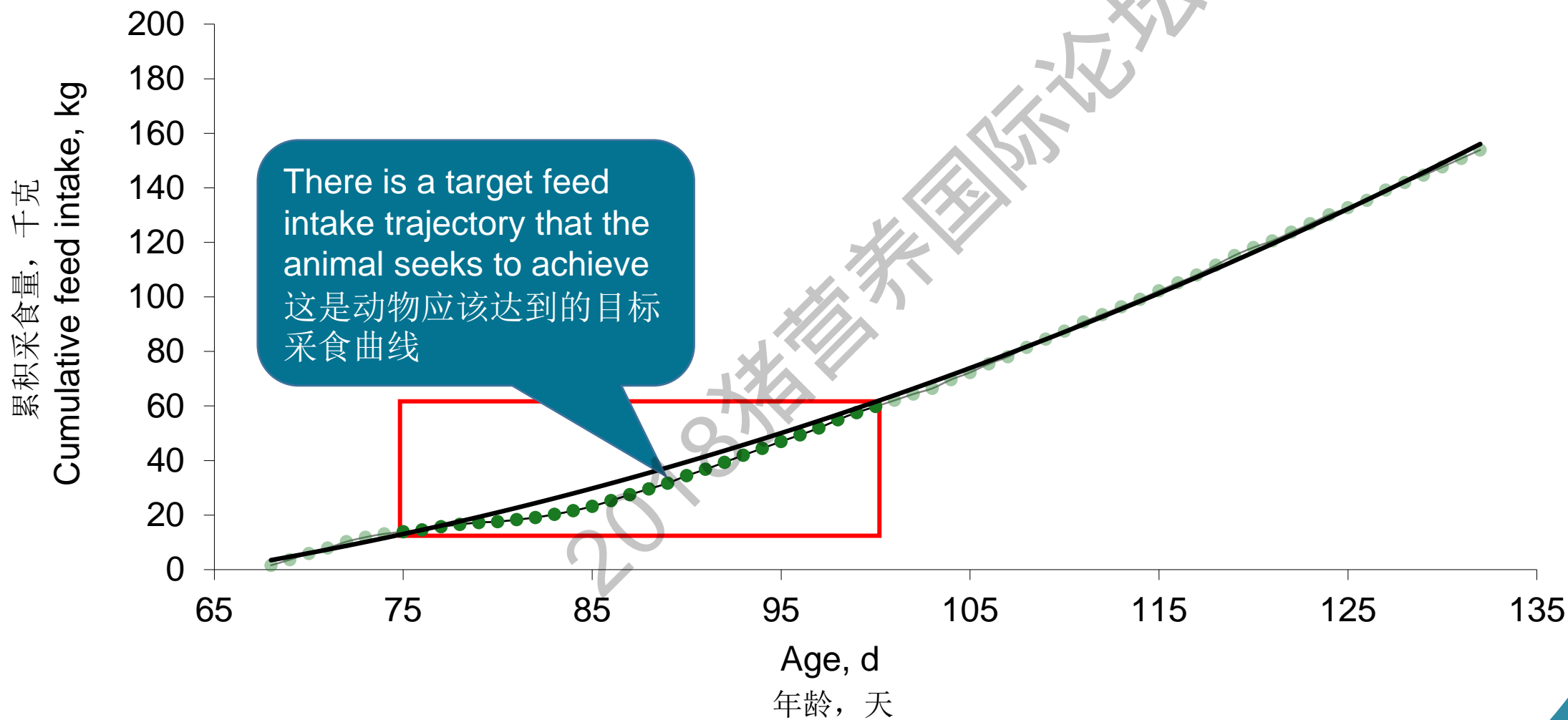


Modeling perturbations in feed intake patterns 建立采食模式中意外变动的预测模型



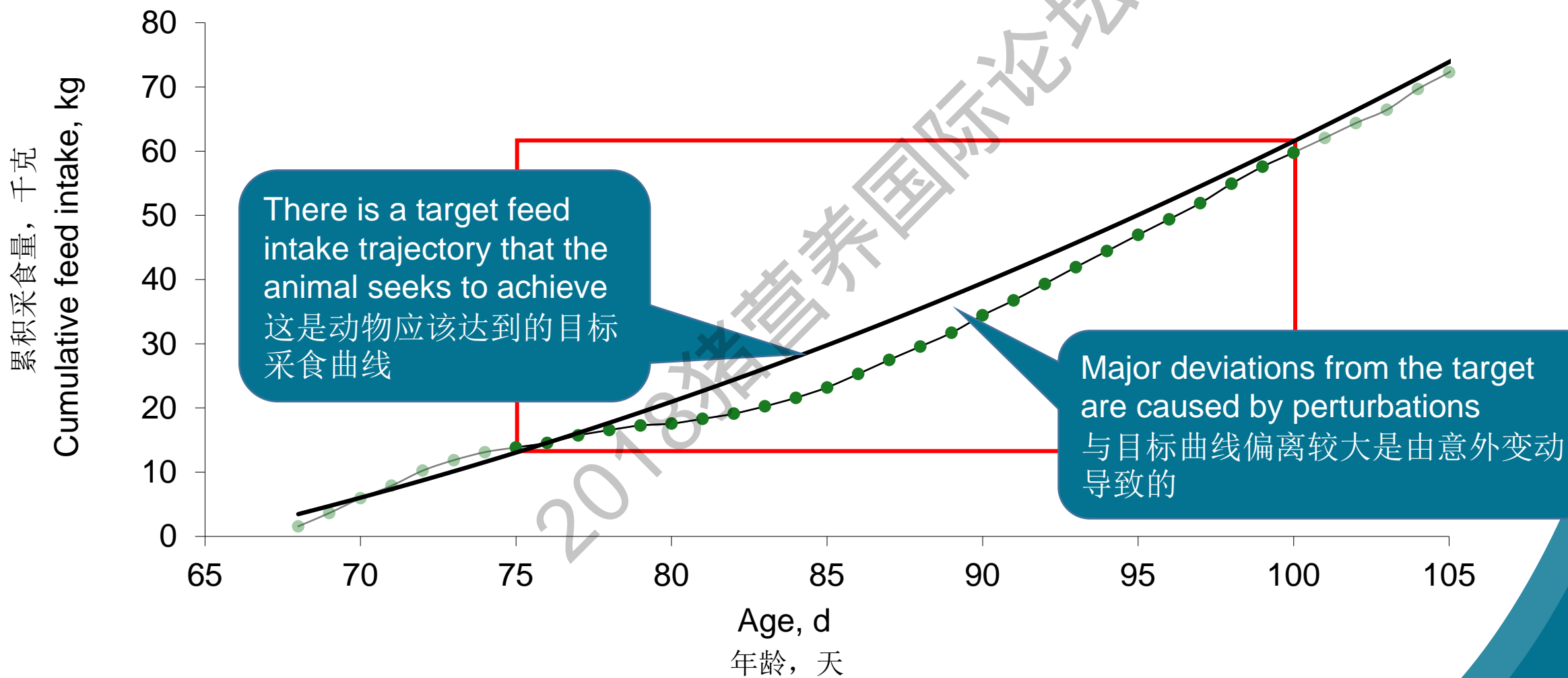


Modeling perturbations in feed intake patterns 建立采食模式中意外变动的预测模型



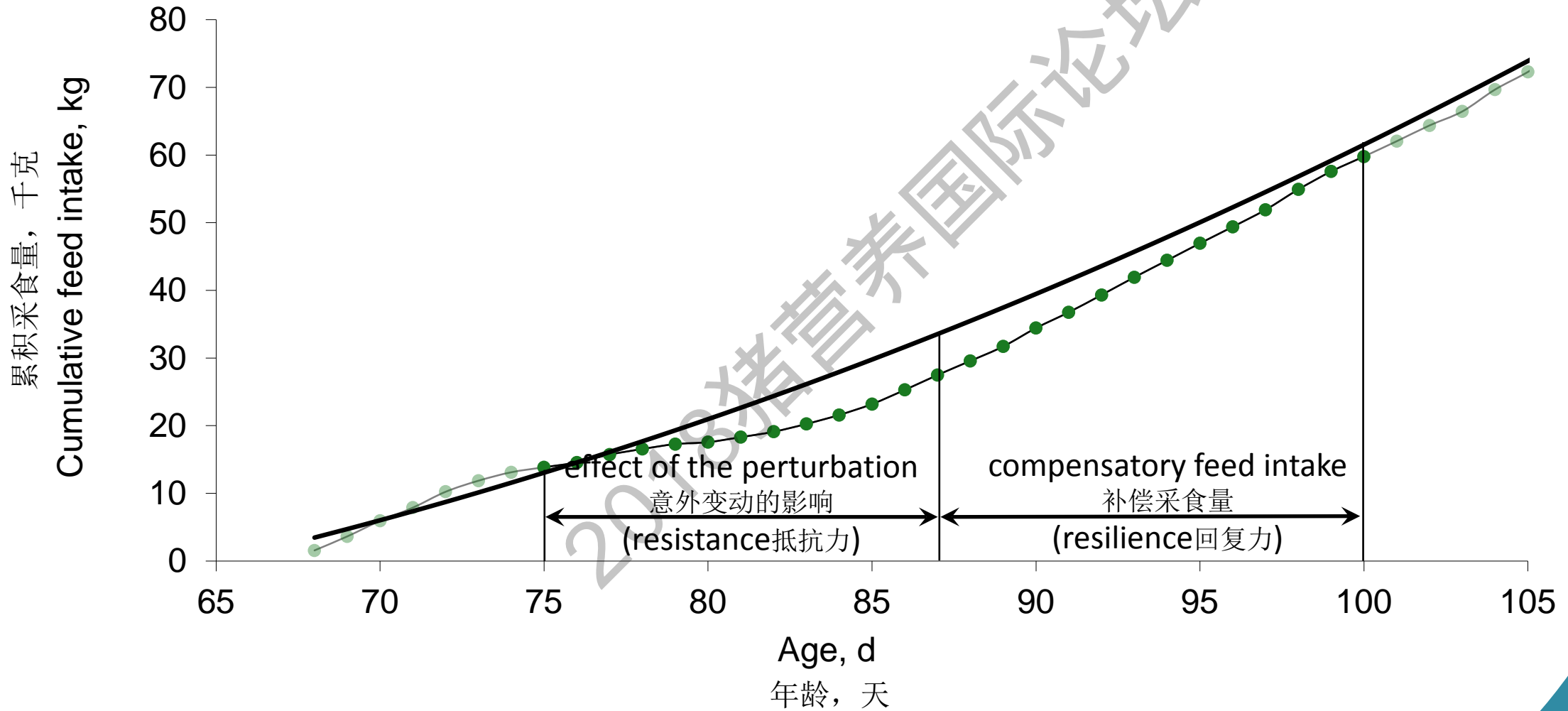


Modeling perturbations in feed intake patterns 建立采食模式中变动的预测模型



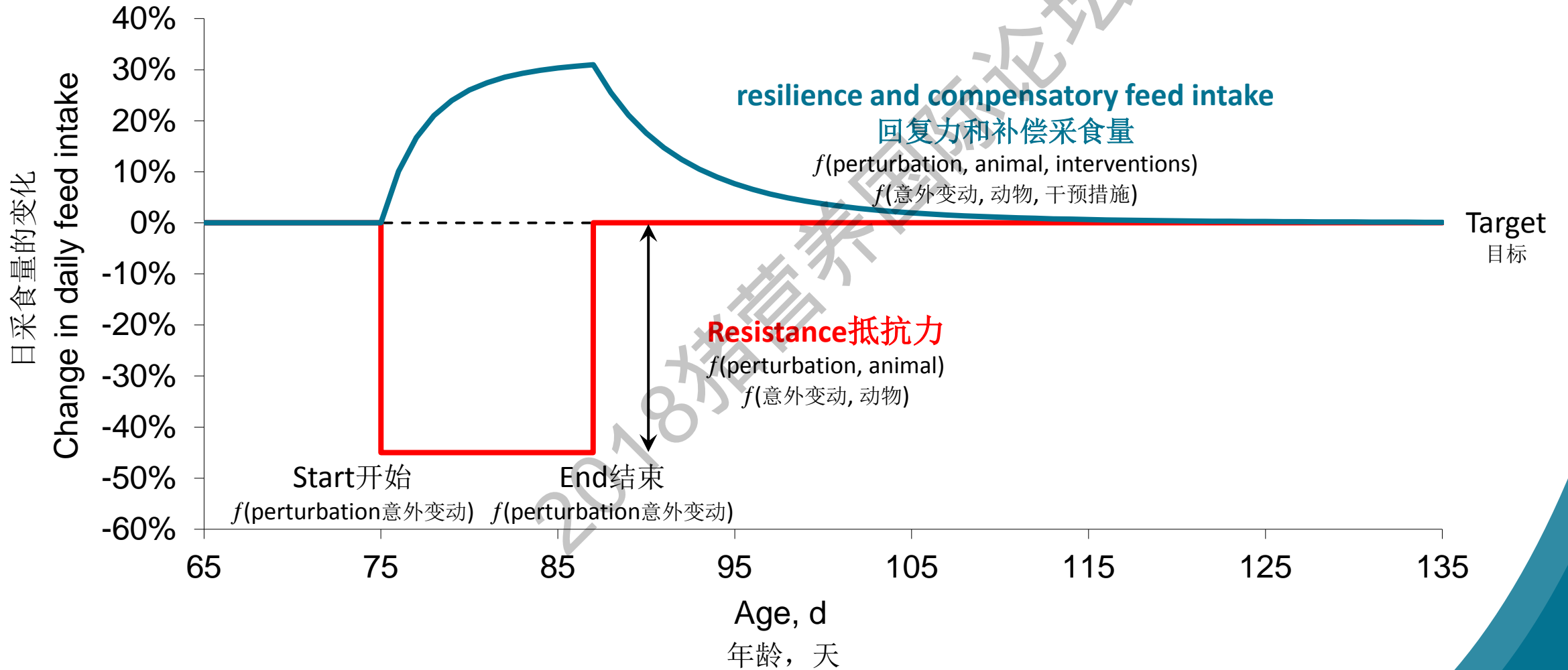


Modeling perturbations in feed intake patterns 建立采食模式中意外变动的预测模型





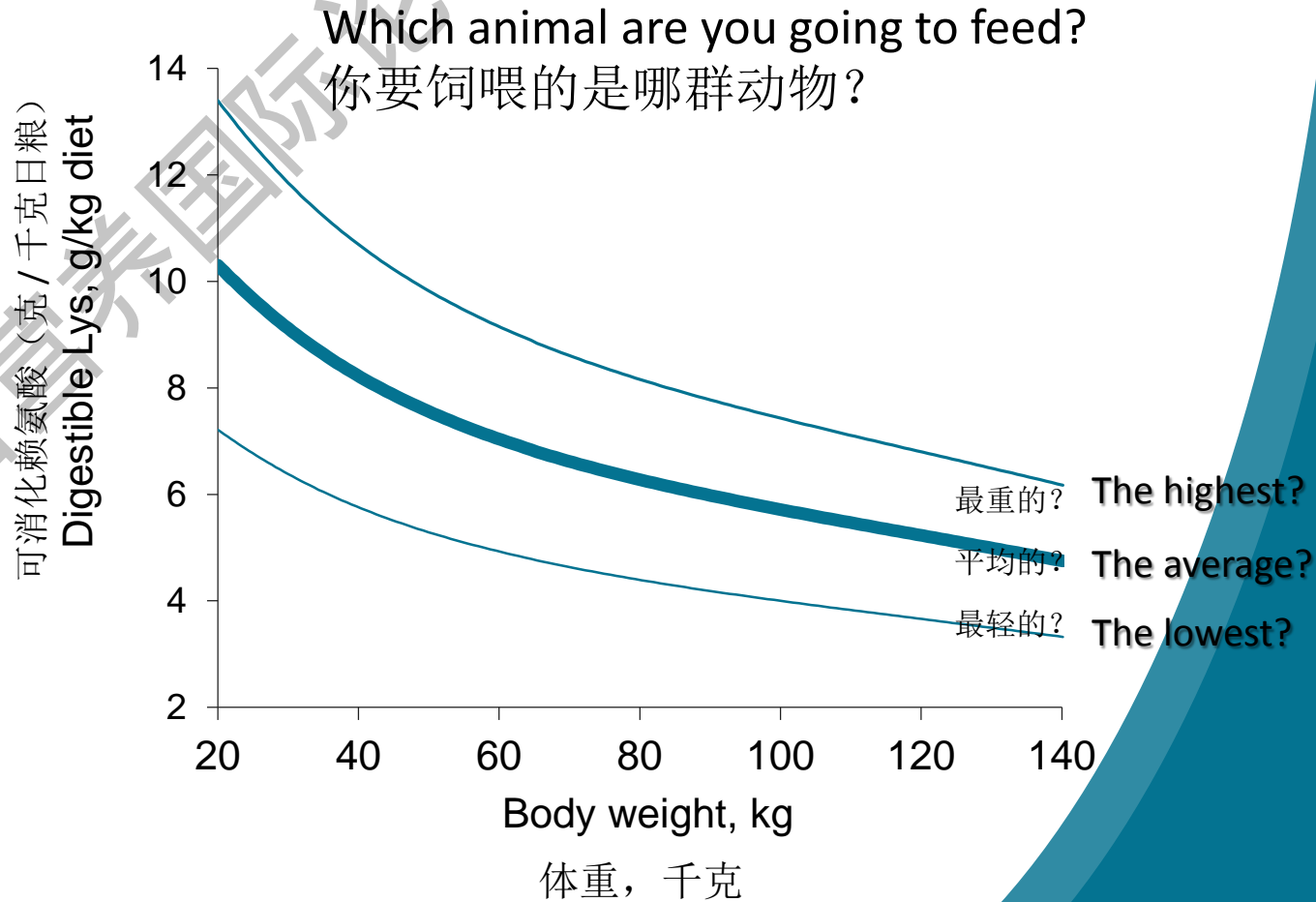
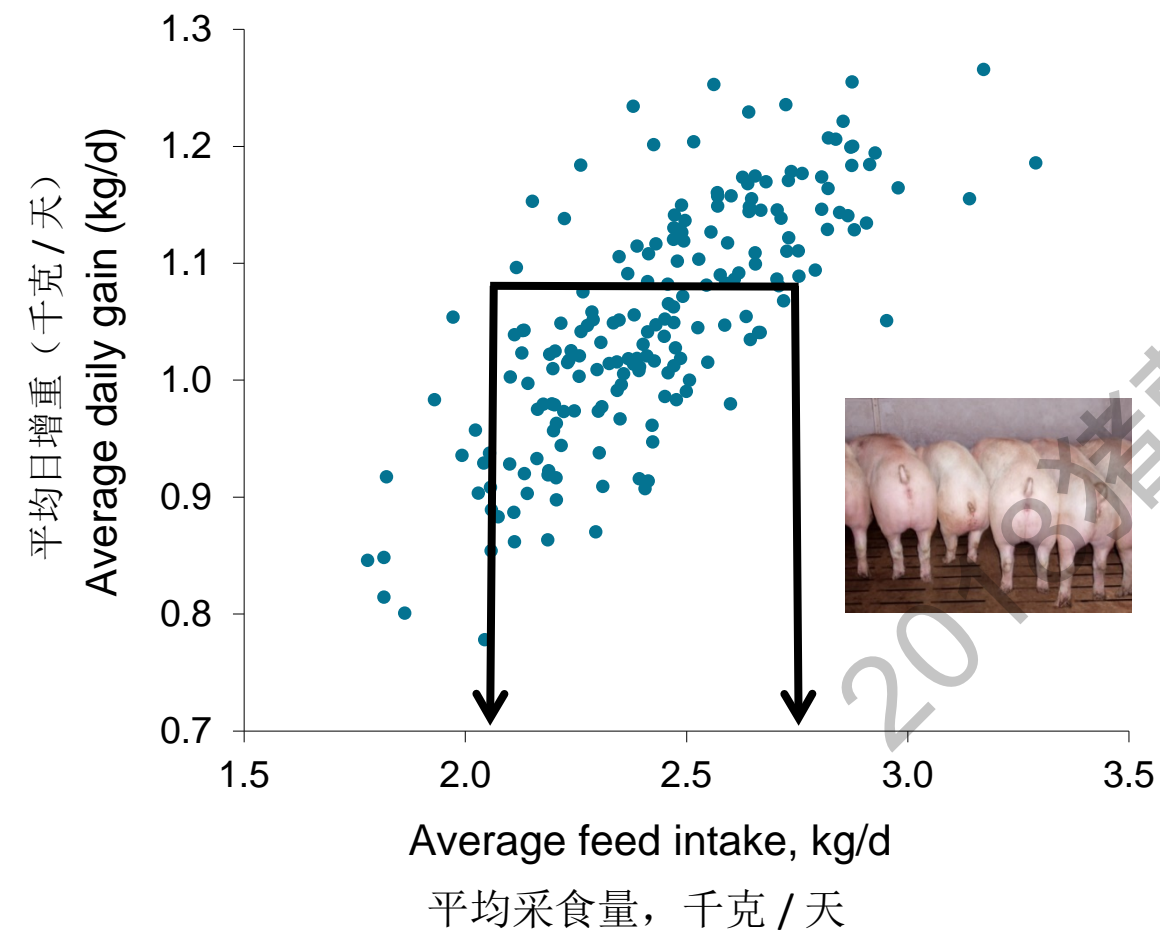
Modeling perturbations in feed intake patterns 建立采食模式中变动的预测模型





Managing variation among individuals through precision livestock feeding

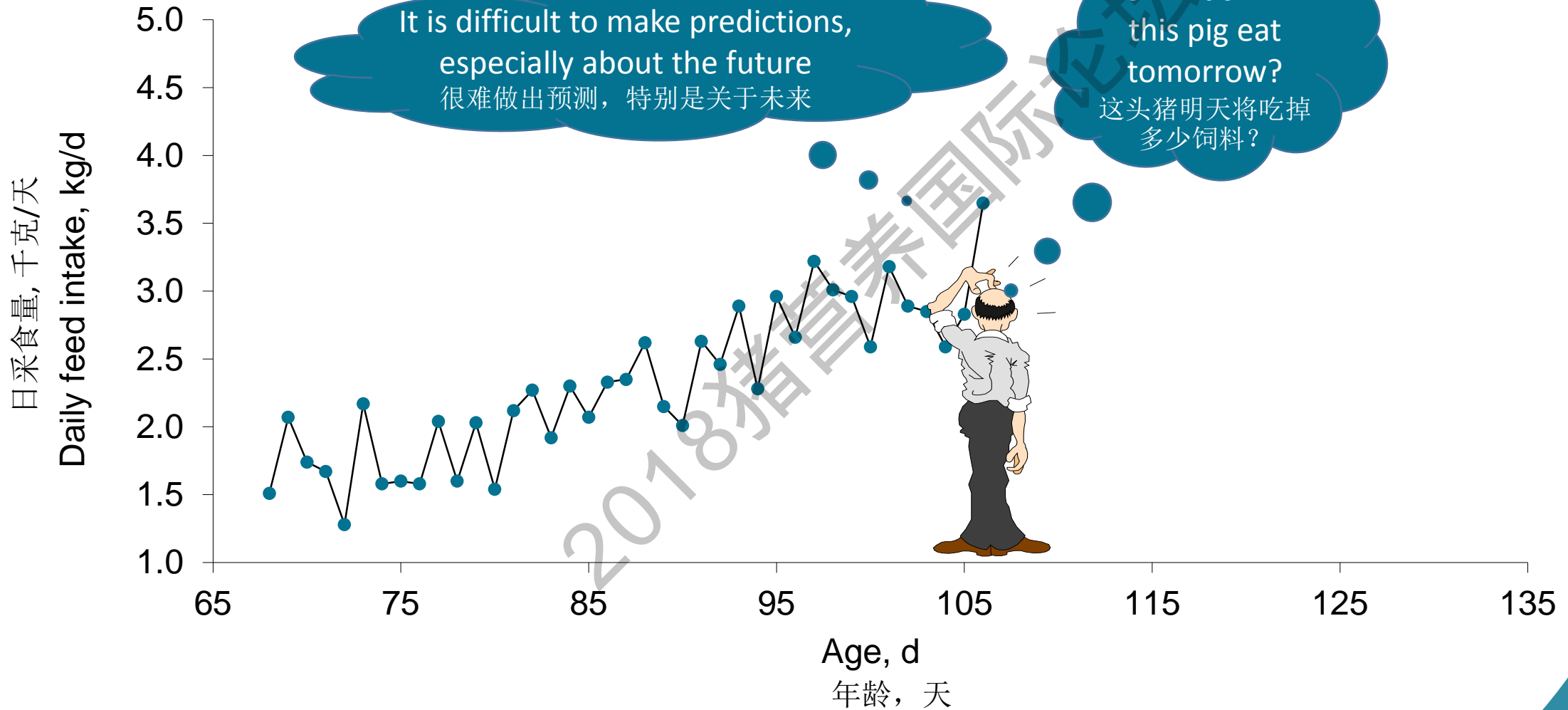
通过牲畜精准饲养管理个体间的差异





Precision livestock feeding is about observing, predicting, and control

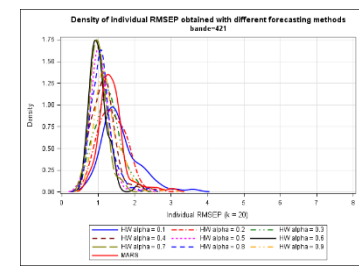
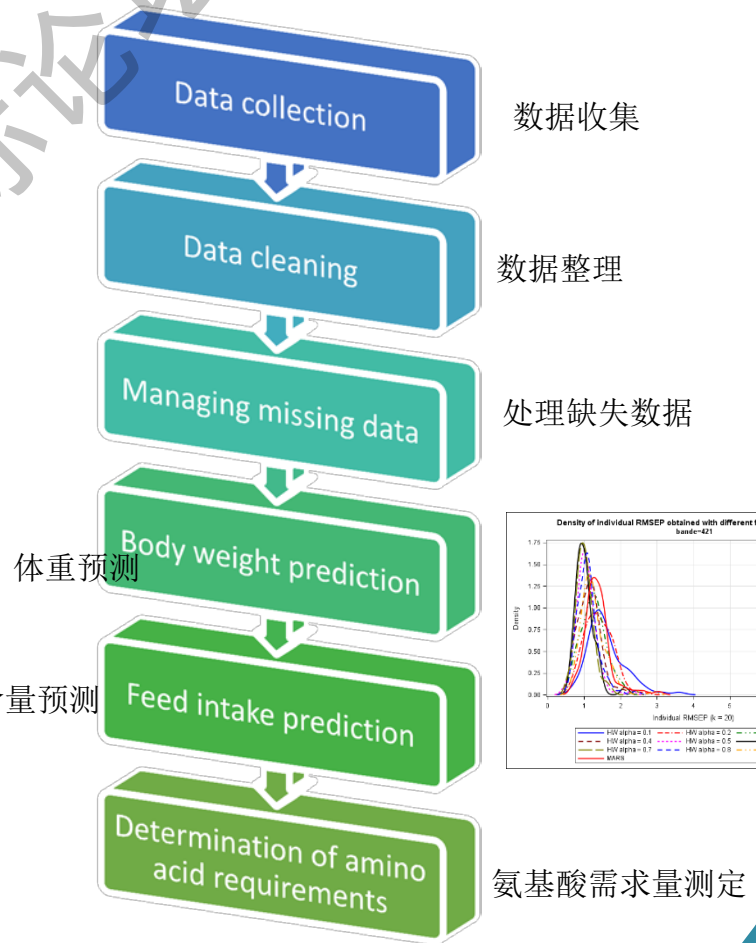
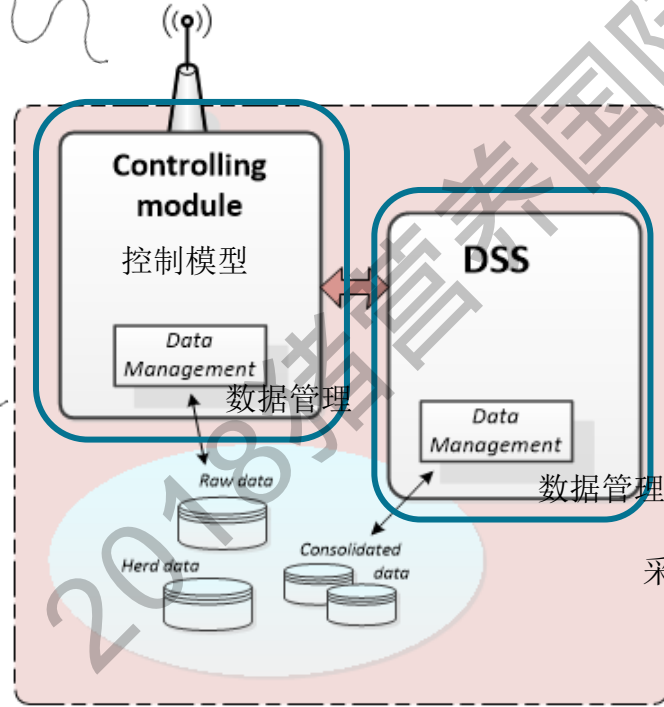
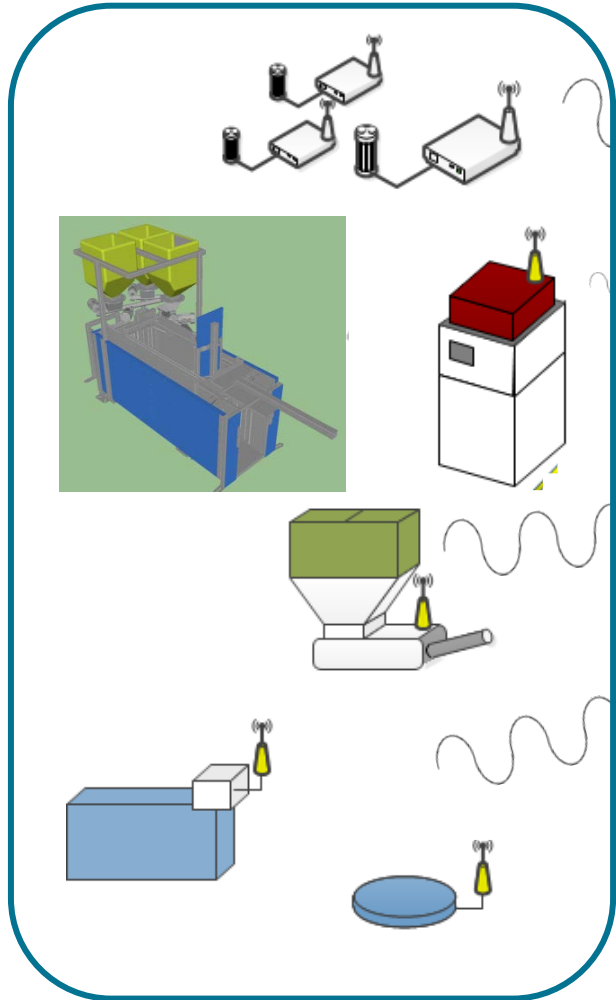
牲畜精准饲养管理需要检测、预测并控制





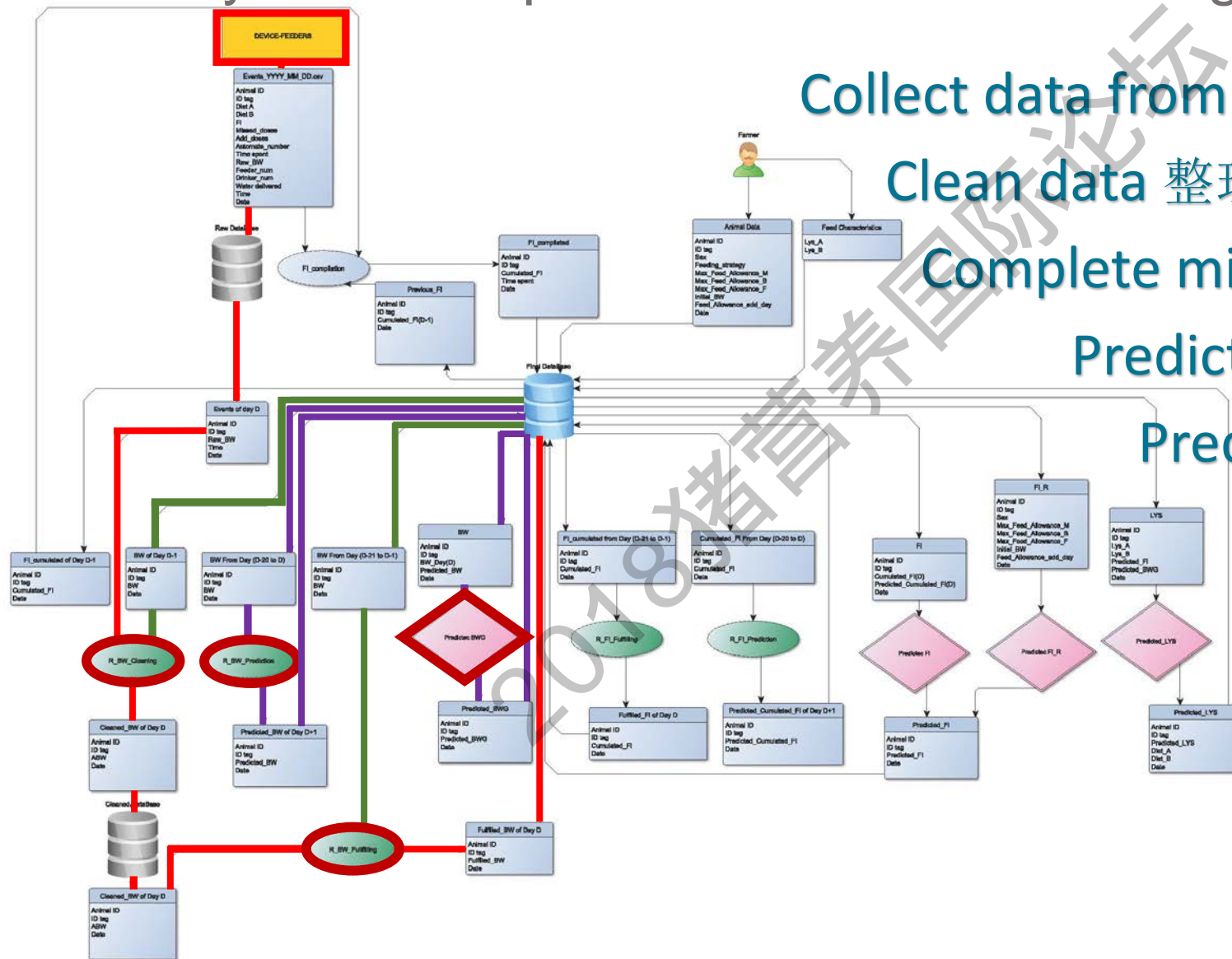
Management systems for precision livestock feeding

牲畜精准饲养管理系统





Management systems for precision livestock feeding 牲畜精准饲养管理系统



Collect data from devices 从设备收集数据

Clean data 整理数据

Complete missing data 补充缺失的数据

Predict body weight 预测体重

Predict daily gain 预测日增重

Etcetera 等等



System prototypes are now being tested 目前正在测试系统原型

► Growing pigs 生长猪

► Restricted feeding 限量喂养

限量喂养

► Ad-libitum feeding 自由采食

自由采食



► Sows 母猪

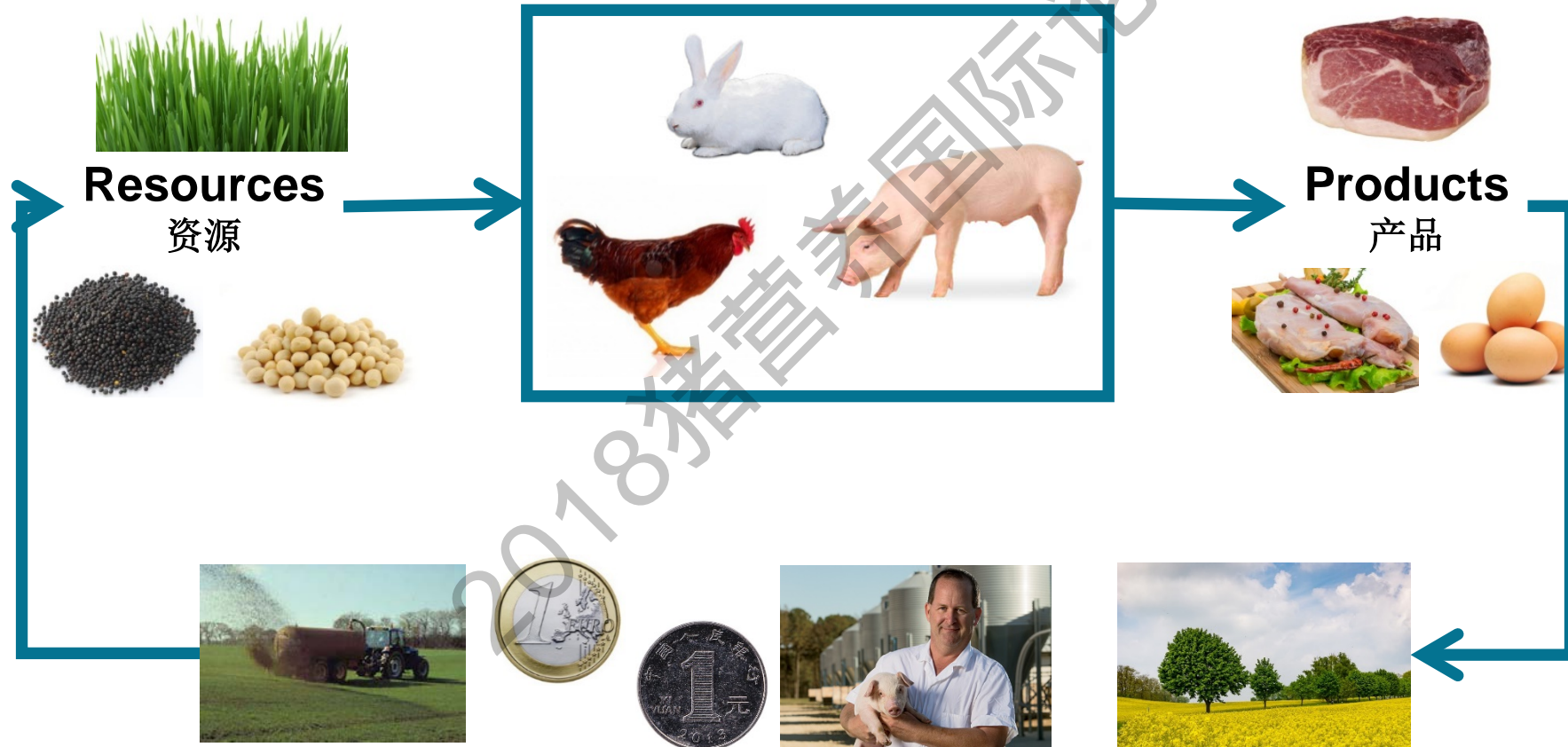
► Gestation 妊娠期

► Lactation 哺乳期



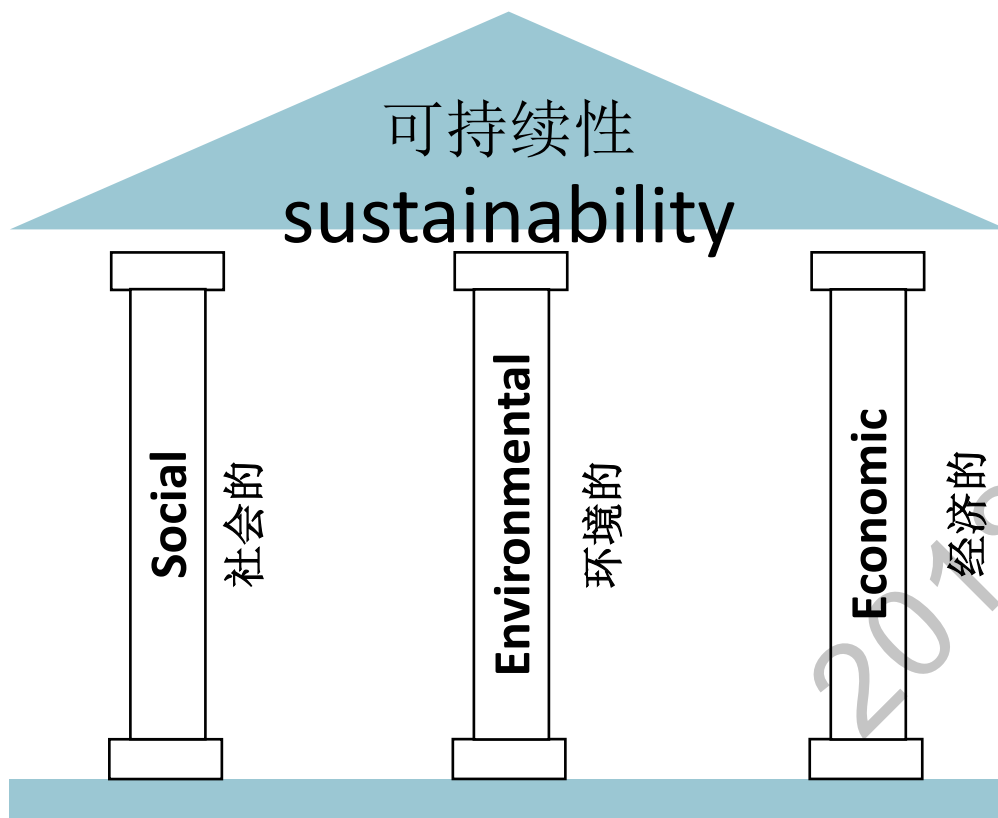


Sustainability evaluation 可持续性评估





Sustainability evaluation 可持续性评估



- Identification of sustainability indicators
确定可持续性指标
- Life Cycle Assessment of some of the proposed management systems
对一些已经提出的管理系统的生命周期进行评估
- Cost-benefit analysis 成本效益分析
- Evaluation of consumer and farmer attitudes
评估消费者和农民的态度
- Overall sustainability appraisal
整体可持续性评估



Conclusions 总结

- ▶ Livestock production and animal-derived products are part of a sustainable food supply 畜牧生产和动物源性产品是可持续食物供给的一部分
- ▶ There is a potential to increase the efficiency and robustness of livestock production systems 畜牧生产系统的效率和稳健性有提升空间
- ▶ There is no “one-size-fits-all”: 没有“万全之策”：
Variation (among animals and systems), differentiation (of products), and segmentation (of markets) are essential
变异（动物和系统之间）、差异化（产品）和细分（市场）是基础
- ▶ Information-based technologies (e.g., precision livestock farming) have a great potential and are inevitable.
基于信息的技术（例如精准畜牧业）具有巨大的潜力并且是不可避免的
Are we ready for it? 我们准备好了吗？



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Gilles Tran (法国动物生产协会)*

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Lisanne Verschuren (荷兰托佩克种猪-Norsvin)

Olivier Zemb (法国农科院)