可持续性：衡量猪饲料工业生态影响的关键指标及改进方向Sustainability: Key parameters to measure ecological impact of the swine feed industry and ways to improve i

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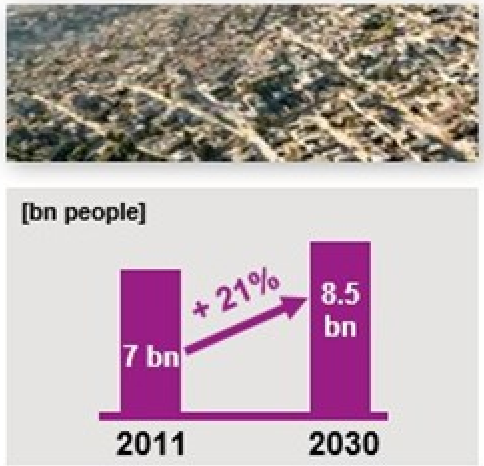
1. 背景：全球畜牧生产对环境的影响 – 尤其是中国养猪业
Setting the scene: Environmental footprint of global livestock production – especially of pigs China

2. 缓解措施：低排放农业（LEF）概念
Mitigation strategies: Low emission farming (LEF) concept

3. 总结和展望Summary and outlook

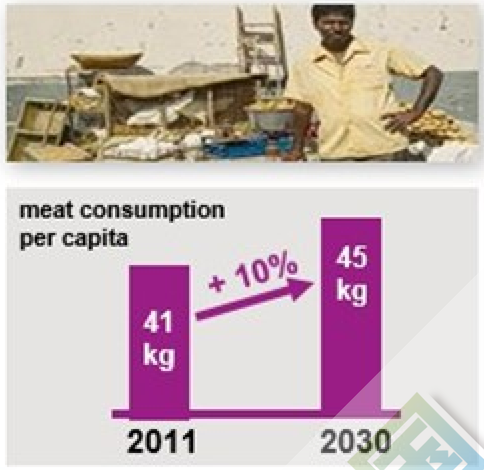
在土地和水资源缺乏的情况下，至2050年需要满足超过90亿人对健康安全便宜食品的需求 2050 over 9 billion people will need healthy and affordable food with scarcer land and water resources

人口增长
Population Growth



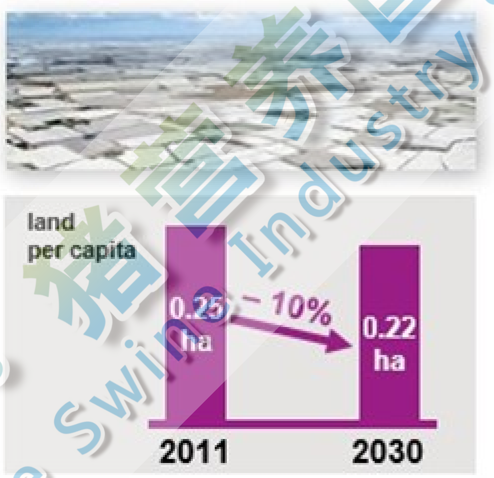
人口

可支配收入
Available Income



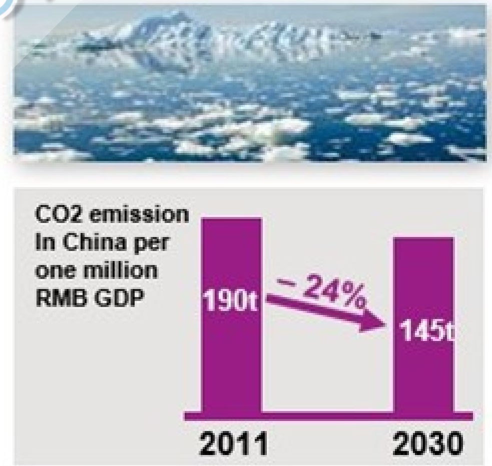
人均肉消费量

资源利用效率
Resource Efficiency



人均土地面积

生态影响
Ecological Footprint



中国二氧化碳排放量/一百万GDP

Higher consumption of animal protein sources, i.e. meat, eggs, milk and fish

动物蛋白消费更多，如肉、蛋、奶和鱼

Source: Evonik HN-M calculations based upon FAO 2006, FAO 2007, FAO 2009, OECD 2009, KPMG (China)

食品产业价值链未来可持续发展取决于三个方面的创新
Future sustainability of food value chain depends on three dimensions of innovation

- 生态影响 Ecological Footprint
- 低排放 Low Emission

生态 Ecology

- 现代营养概念 Modern nutrition concepts
- 家畜养殖和粪肥管理的改进 Improved livestock and manure management
- 低蛋白日粮概念 Low protein diet concepts

- 最低成本的饲料配方 Least cost feed formulation
- 饲料/蛋白质比最优化 Feed/protein optimization
- 营养利用率 Nutrient utilization
- 有效成分 Efficient ingredients

Sustainable Nutrition 可持续营养

Efficiency 效率

- 人口增长 Population growth
- 价格实惠的蛋白来源 Affordable protein

- 动物福利 Animal welfare
- 肠道健康解决方案 Gut health solution concepts
- 安全和健康食品链 Save and healthy food chain
- 生长性能改善和营养性添加剂 Performance and nutritional additives

食品质量和安全 Food Quality and Safety

- 终端消费者的需求 End-consumer needs
- 食品行业道德 Food ethics

- Driver 驱动
- Lever 杠杆
- Solutions 解决方案

环境影响
Environmental Impact Categories

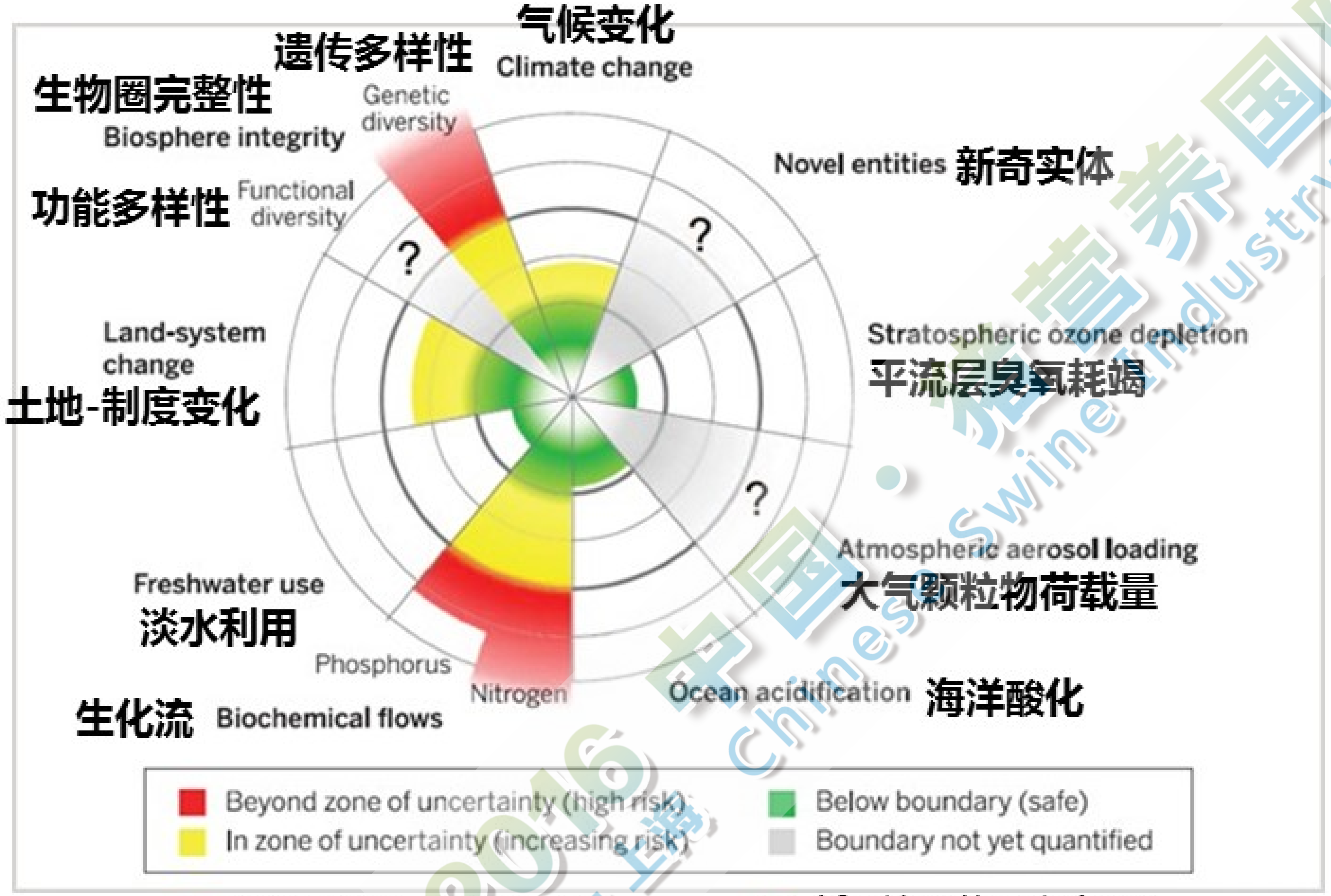
- 气候变化 Climate change
  - 全球变暖趋势 Global Warming Potential
- 能量和资源效率 Energy and resource efficiency
  - 初级能源需求 Primary Energy Demand
- 空气、土壤和水的质量

  Air, Soil and Water Quality
  - 氮和磷的超量排放导致了富营养化

    Excretion of excess nitrogen and phosphorus leading to eutrophication
  - 氨气的排放是造成酸雨的主要原因（鱼类死亡，森林 化，生物多样性）

    Ammonia emissions largely responsible for acidification (fish mortality, forest decline, biodiversity)
- 土地的利用，土地的利用变化 Land use, Land u change
- 水资源污染 Water footprint
- 生物多样性 Biodiversity

畜牧业对4个地球环境边界条件（界限内为安全操作区）起主要作用 Livestock farming plays a major role in all 4 planetory boundaries which left the safe operating zone



临近边界值（高风险区）
介于边界值之间（风险增加）
低于边界值（安全区）
边界值尚未确定

Source: Rockstroem et al. 2009, Steffen et al. 2015

畜牧业影响3个重要类别环境变化的主要化合物，以当量值表示
Compounds contributing to the 3 most critical environmental impact categories for livestock are expressed in equivalents

Impact Categories 影响的类别	Life Cycle Inventory Parameters 影响参数	
Global Warming Potential (GWP) 全球变暖趋势（GWP）	CO_2, N_2O, CH_4	Kg CO_2-e/FU
Acidification Potential (AP) 酸化趋势（AP）	NO_x, NH_3, SO_2, HCl, HF	Kg SO_2-e/FU
Eutrophication Potential (EP) 富营养化趋势（EP）	NH_3, NO_2, COD N & P compounds	Kg PO_4^{3-}-e/FU

FU = functional uni
功能单位

Global Warming Potential in kg CO_2e = kg CO_2 + 23 * kg CH_4 + 296 *kg N_2O

全球变暖趋势当量值，表示为kg CO_2e = kg CO_2 + 23 * kg CH_4 + 296 *kg N_2O

畜牧业占全球温室气体（GHG）排放量的14.5%
Livestock stands for 14,5% of global Green House Gas (GHG) emissions

Global significance of sector's emissions. *GHG emissions values are computed in GLEAM for 2005, while IPCC estimates are for 2004. GLEAM emissions estimate includes emissions attributed to edible products and to other goods and services.*

Source: www.fao.org

不同环节温室气体排放占全球排放的比例. IPCC预计了2004年温室气体排放，*GLEAM在2005年计算了全球温室气体排放值。GLEAM排放量估计数包括来源于食用产品、其他商品和服务的排放量。*

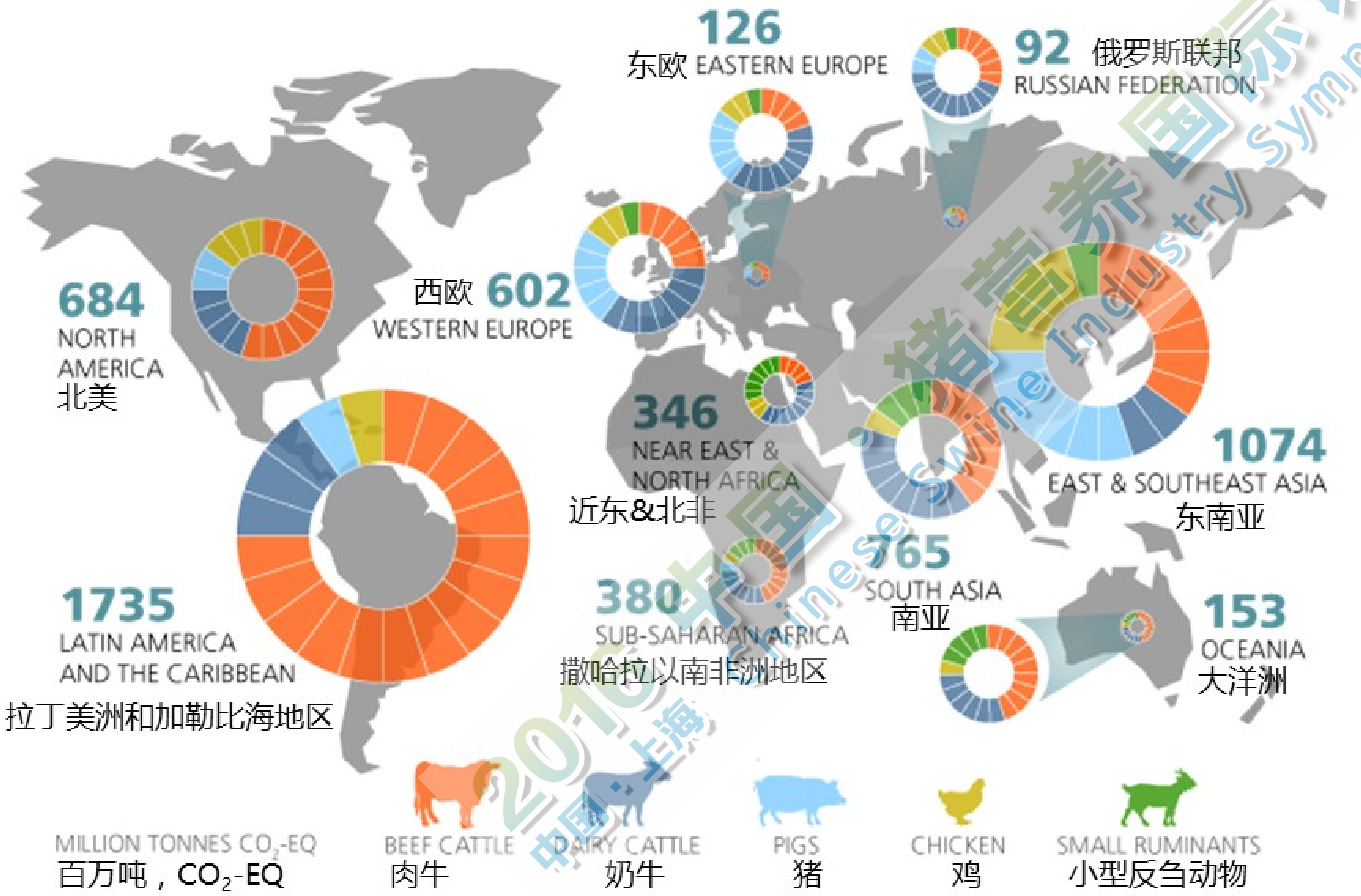
来源：www.fao.org

各畜种全球排放估量：7.1 Gt（71亿 t）CO2-当量
Global estimates of emissions by species:
7.1 Gt (7.1 billion t) CO2-eqivalents

这包含可食用产品和其他商品和服务所带来的排放，如畜力和羊毛。肉牛产出包括的牛肉产品和不可食用部分。奶牛产奶和肉也有不可食用部分产出。 It includes emissions attributed to edible products and to other goods and services, such as draught power and wool. Beef cattle produce meat and non-edible outputs. Dairy cattle produce milk and meat as well as non-edible outputs.

Source: www.fao.org

温室气体的区域性排放情况
Regional emissions of GHG

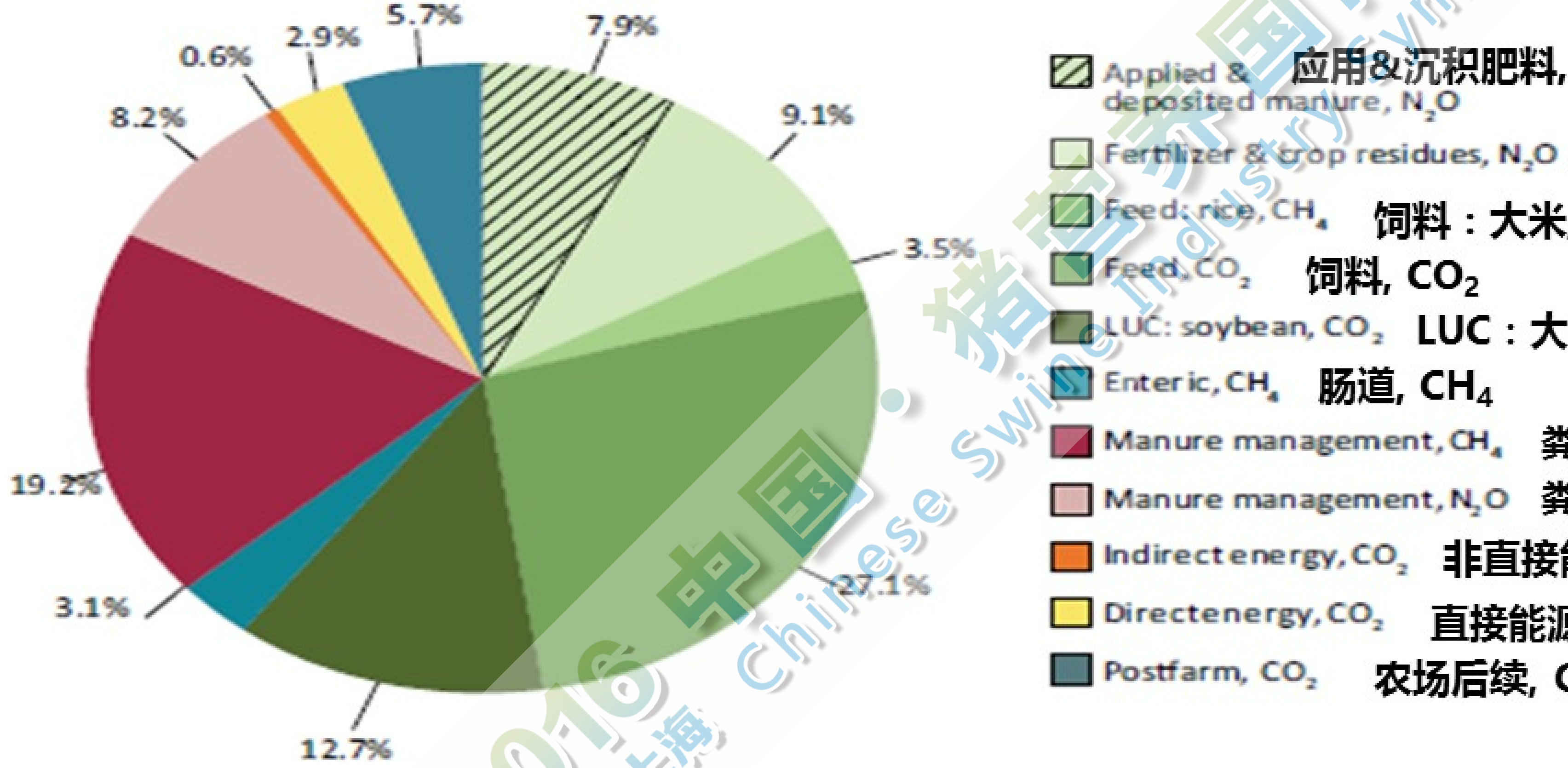


Regional total emissions and their profile by animal species are shown. Results do not include emissions allocated to non-edible products and other services.

区域性总排放量及其针对不同动物的占比分布图。该排放结果不包含因不可食用部分和其他服务造成的排放量数据。

[redacted]

按照养猪供应链划分全球温室气体排放 – FAO 2013
Breakdown of total global GHG emissions by category for pig supply chains – FAO 2013



应用&沉积肥料, N_2O

肥料和作物秸秆, N_2O

饲料：大米, CH_4

饲料, CO_2

LUC：大豆, CO_2

肠道, CH_4

粪污管理, CH_4

粪污管理, N_2O

非直接能源, CO_2

直接能源, CO_2

农场后续, CO_2

[redacted]

中国不同动物种类的温室气体（GHG）排放：猪占比~ 24%!
Green House Gas (GHG) emissions in China by animal species: Pigs stand for ~ 24%!

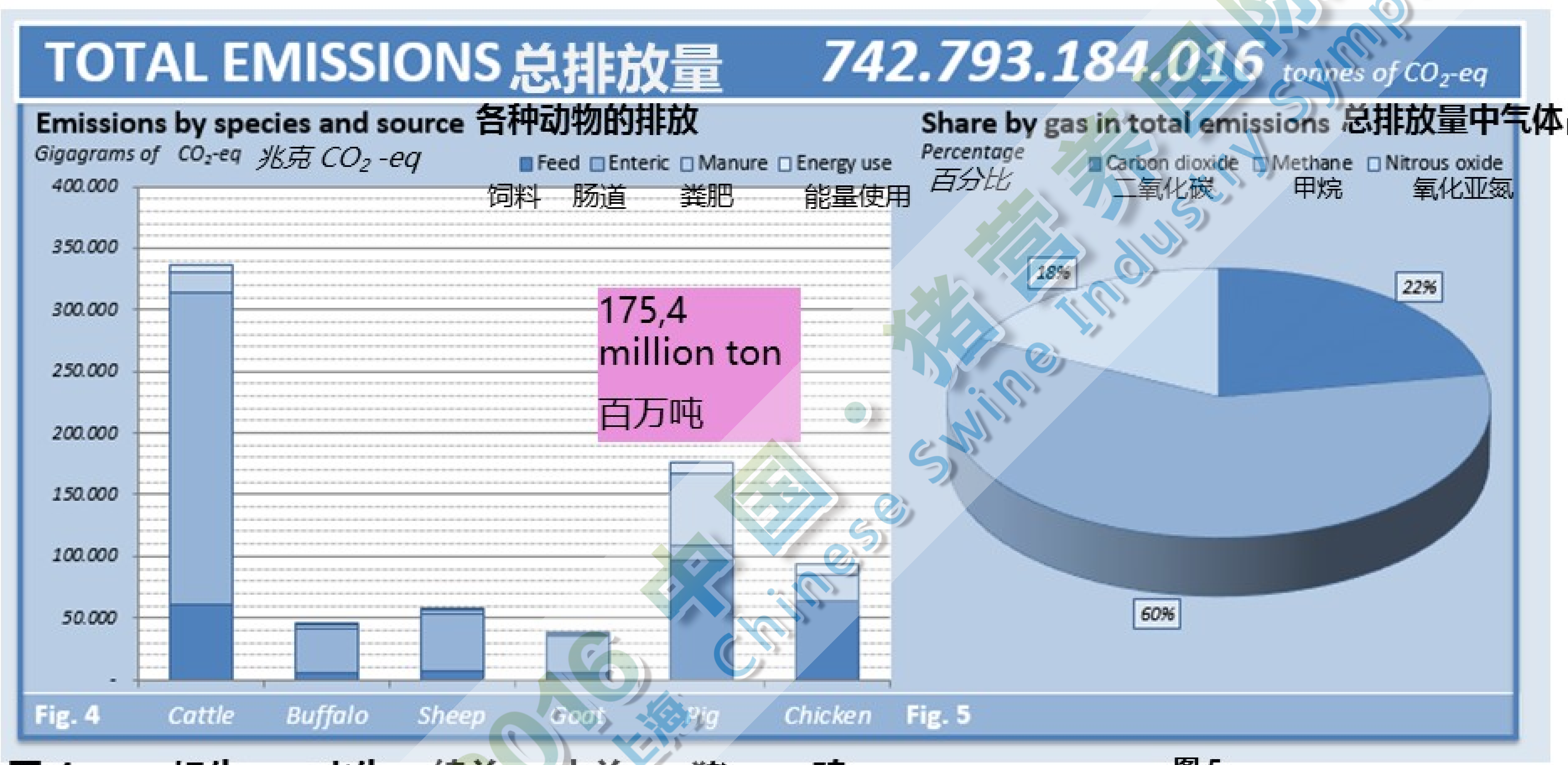
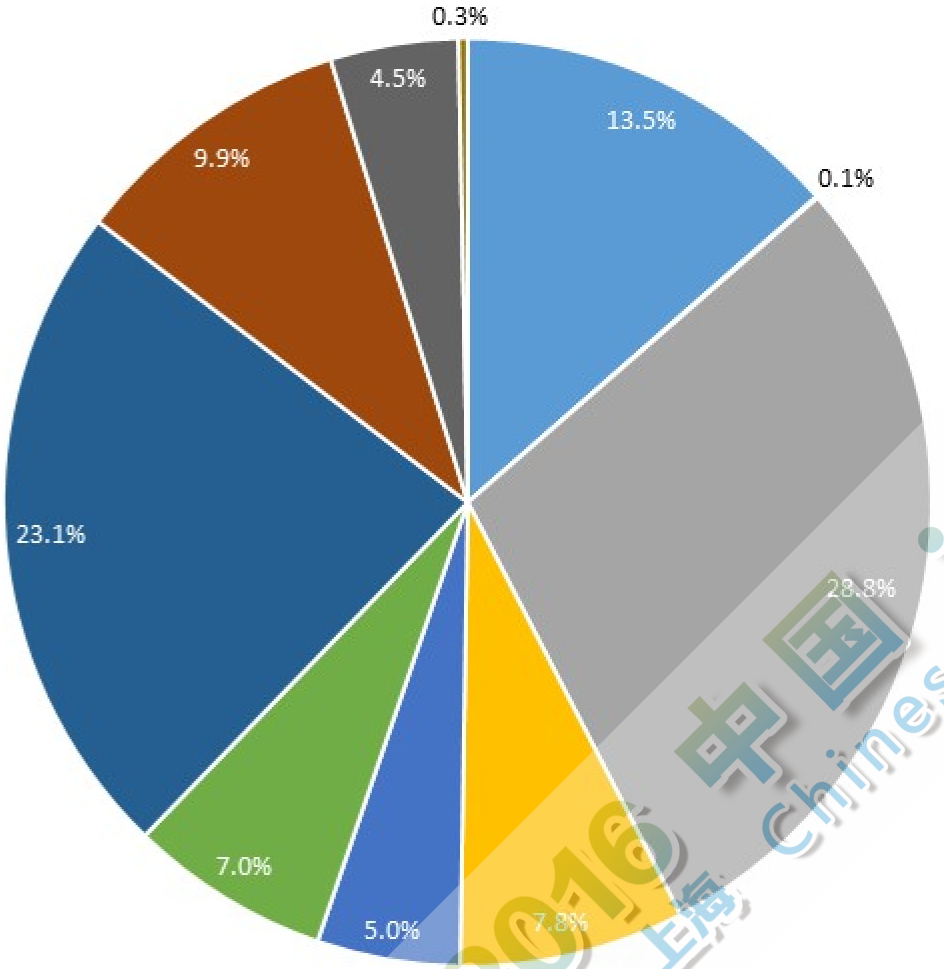


图.4 奶牛 水牛 绵羊 山羊 猪 鸡

图.5

[redacted]

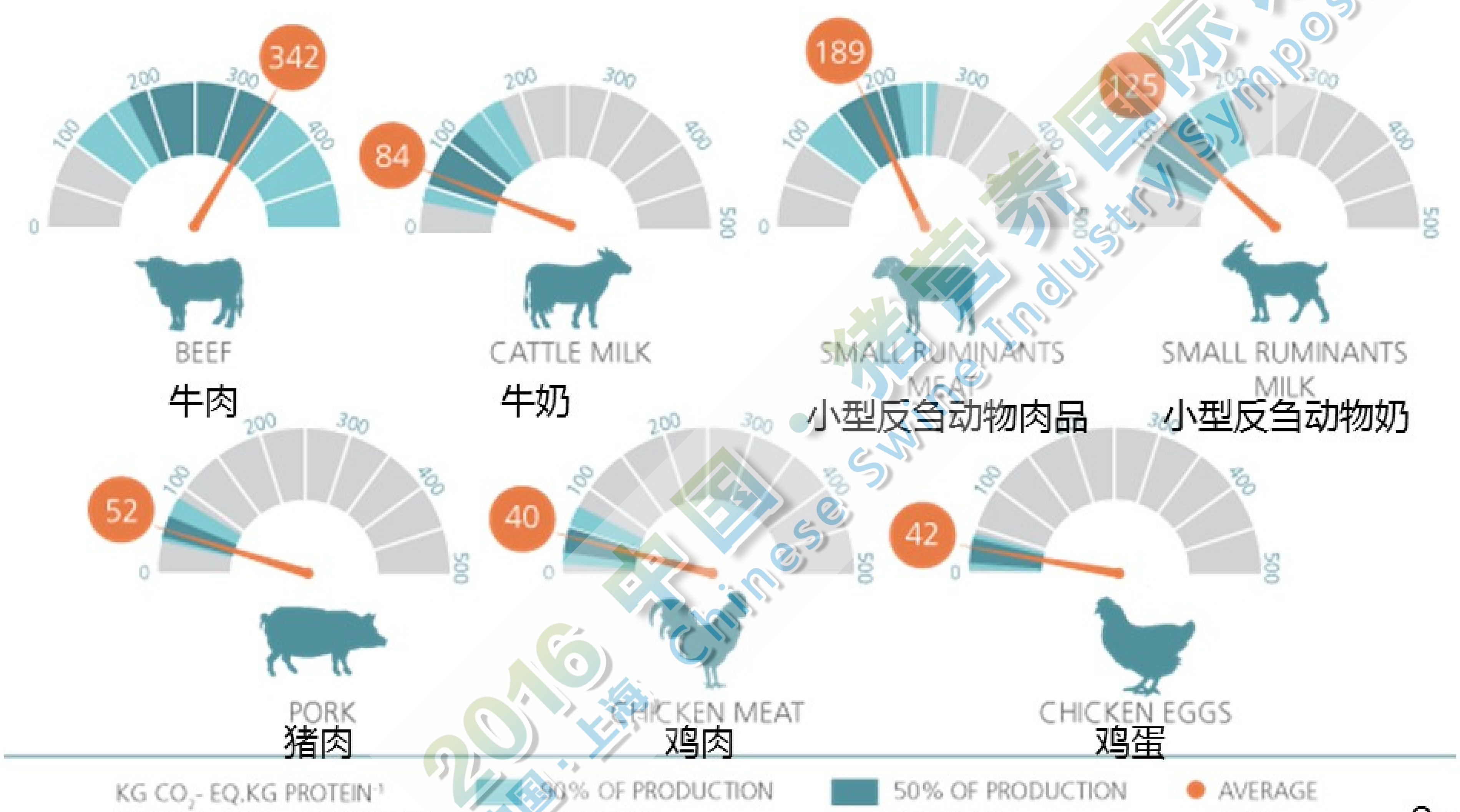
Breakdown of emissions of Chinese pig production
中国养猪生产排放源分解



Feed: N_2O from fertilization and crop residues kg CO_2-eq/year	饲料：施肥和作物秸秆排放的N_2O，kg CO_2-eq/年
Feed: N_2O from manure application and deposition kg CO_2-eq/year	饲料：肥料应用和沉积排放的N_2O，kg CO_2-eq/年
Feed: CO_2 from feed production, transport and processing kg CO_2-eq/year	饲料：饲料生产、运输和加工过程排放的CO_2，kg CO_2-eq/年
Feed: CO_2 from land use change related to soy cultivation kg CO_2-eq/year	饲料：大豆种植改变土地使用方式排放的CO_2，kg CO_2-eq/年
Feed: CH_4 from rice cultivation kg CO_2-eq/year	饲料：水稻种植排放的NH_4，kg CO_2-eq/年
Enteric: CH_4 from enteric fermantation kg CO_2-eq/year	肠道：肠内发酵排放的CH_4，kg CO_2-eq/年
Manure: CH_4 from manure management kg CO_2-eq/year	粪肥：粪污管理排放的CH_4，kg CO_2-eq/年
Manure: N_2O from manure management kg CO_2-eq/year	粪肥：粪污管理排放的N_2O，kg CO_2-eq/年
Energy: CO_2 from direct energy use kg CO_2-eq/year	能源：直接使用能源排放的CO_2，kg CO_2-eq/年
Energy: CO_2 from indirect energy use kg CO_2-eq/year	能源：简介使用能源排放的CO_2，kg CO_2-eq/年

[redacted]

Global emission intensities by commodity
不同商品全球排放强度



All commodities are expressed in a per protein basis. Averages are calculated at global scale and represent an aggregated value across different production systems and agro-ecological zones

所有商品都以蛋白质含量为基础计算。均值是全球范围计算值，代表不同生产系统和农业生态区域的总值。

Source: www.fao.org

Pigs are one of the most efficient protein producing animal species in China
在中国，猪是蛋白质产出最高效的动物种类之一

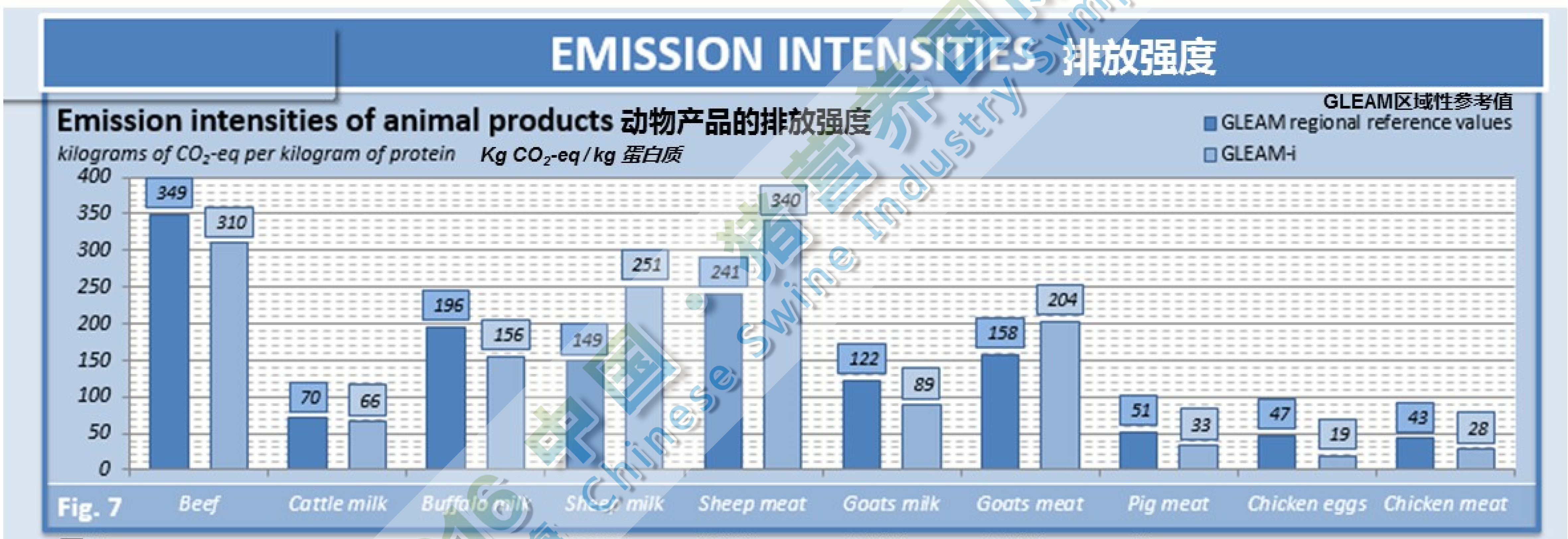


图.7 牛肉 奶牛牛奶 水牛牛奶 绵羊羊奶 绵羊羊肉 山羊羊奶 山羊羊肉 猪肉 鸡蛋 鸡肉

Animal food sources have a comparatively high water footprint
动物源性食品具有相对较高的水足迹

食品种类 Food item	m³/吨 m³/ton	升/千卡 liter/kcal	升/g 蛋白质 liter/g protein
Beef 牛肉	15,415	10.19	112
Sheep/goat meat 绵羊/山羊肉	8763	4.25	63
Pig meat 猪肉	5988	2.15	57
Butter 黄油	7692	0.72	0
Chicken meat 鸡肉	1440	3.00	34
Eggs 鸡蛋	3265	2.29	29

食品种类 Food item	m³/吨 m³/ton	升/千卡 liter/kcal	升/g 蛋白质 liter/g protein
Milk 牛肉	1020	1.82	31
Nuts 坚果类	9063	3.63	139
Pulses 豆类	4055	1.19	19
Oil crops 油料作物	2364	0.81	16
Cereals 谷物	1644	0.51	21
Fruits 水果	962	2.09	180
Starchy roots 淀粉类根茎	387	0.47	31
Vegetables 蔬菜	322	1.34	26

[redacted]

Water footprint (m^3/t) of pig and poultry farming systems in China
中国养猪和养鸡系统的水足迹（ m^3/t ）

Animal products 动物产品		Farming system 养殖系统	China 中国		
			Green 绿水	Blue 蓝水	Grey 灰水
Pig meat 猪肉	放养	Grazing	11,134	205	738
	混养	Mixed	5,401	356	542
	工厂养殖	Industrial	3,477	538	925
	加权平均	Weighted average	5,050	405	648
Chicken meat 鸡肉	放养	Grazing	4,695	448	1,414
	混养	Mixed	3,005	297	905
	工厂养殖	Industrial	1,940	195	584
	加权平均	Weighted average	2,836	281	854
Egg 鸡蛋	放养	Grazing	3,952	375	1,189
	混养	Mixed	2,351	230	708
	工厂养殖	Industrial	2,086	206	628
	加权平均	Weighted average	2,211	217	666

Blue water: consumption of surface and groundwater
蓝水：消耗的地表水和地下水量
Green water: rainwater, no run-off
绿水：保存在土壤中的雨水量
Grey water: volume of freshwater required to assimilate pollutants
灰水：排放的污染水及稀释污染水所需的淡水量

Source: Mekonnen and Hoekstra, 2012

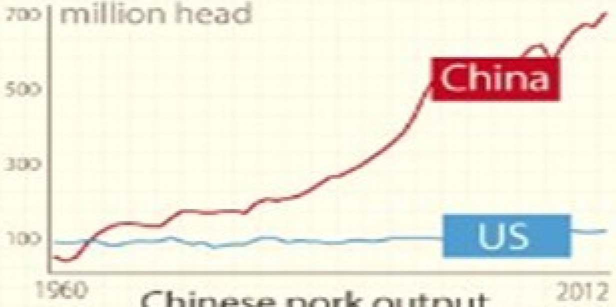
THE PORK INDUSTRY IN CHINA

Wilson Center
CHINA ENVIRONMENT FORUM
@wilsoncef

65% of the meat consumed by China is pork.

81 LBS Per Capita Annual Pork Consumption in China

China consumes about **HALF** of the world's pork.



Chinese pork output has increased by 15 times over the past five decades.

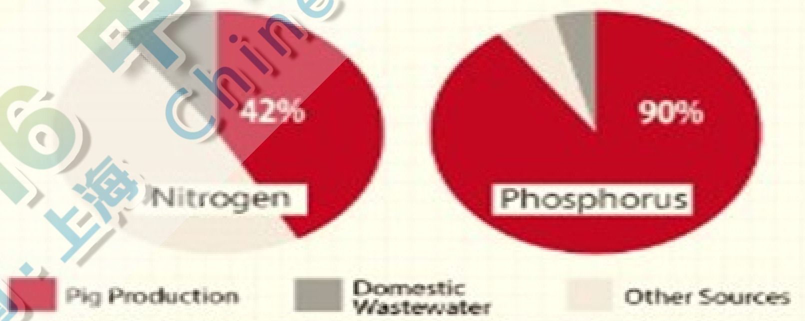
High hog population density in China has tightened supplies of feed and damaged the environment.

China: 94 pigs VS US: 20 pigs

per 100 acres of cropland

The average pig in China produces 5.3 kg of waste each day, which contains nutrients, heavy metals, and pharmaceutical residues.

Pig production accounts for an estimated 42% of nitrogen and 90% of phosphorus flows into the South China Sea.*



*Including the Pearl River basin in Guangdong Province, the Chao Phrya River basin in Thailand, and the Red River and Dong-Nai River basins in Vietnam.

- Eutrophication of surface water damages wetlands and fragile coastal ecosystems
- Leaching nitrates and pathogens contaminate soil and water
- Excess nutrients and heavy metals damage soil fertility and shrink arable land
- Ammonia, methane, and other gases cause pollution and contribute to greenhouse effect
- Diseased pigs are not always disposed of properly – 16,000 carcasses were found in the Huangpu River in 2013

Livestock farm waste is about **3 TIMES** the amount emitted from industries.

1.29 BILLION metric tons of waste is produced by the Chinese pork industry per year.

Source: USDA ERS, FAO. Special Thanks to Fred Gale. Designed by Siqi Han 02/27/2014 © CEF


中国猪肉产业的环境影响
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65% 的中国肉类消费为猪肉
中国年人均猪肉消费量 37 KG
中国猪肉消费量约占世界 1/2
亿头
中国
美国
1960
2012
在过去50年中，中国猪肉产量增长了15倍
中国生猪饲养密度过大，加剧了饲料供应紧缺，并造成了极大的环境负面影响。
中国：94头
美国：20头
一头猪平均每天会产生约5.3kg废物。除了含有丰富的养分以外，还有大量的重金属、农药、及兽药残余，对环境产生极大影响。
引起地表水富营养化
破坏湿地和脆弱的沿海生态系统
硝酸盐和病原体向地下渗透
污染土壤和水质
含有过量养分和重金属
降低土壤肥力，导致耕地面积减少
排出氨气、甲烷以及其他气体
造成空气污染，加剧温室效应
病死猪收集处理不规范
2013年上海黄浦江捞出16000头死猪
在排入南海的污染物中，42%的氮和90%的磷来自于生猪养殖的生产过程。*
42%
氮污染物
90%
磷污染物
生猪养殖生产
畜牧业废物总排放量约为工业排量的
三倍
中国猪肉产业每年产生废物
12.9亿吨
数据来源：USDA ERS, FAO. 特别感谢：Fred Gale. 设计：韩思琦 02/27/2014 © 中国环境论坛

How to feed 10 billion farm animals….and how to use their manure….?
如何饲养100亿头家畜….如何利用粪肥….?

In February of 2010, the Chinese government released results of the first national pollution census. The most startling finding of this nearly three-year, 737 million RMB ($10 million USD) investigation was that agriculture today is a bigger source of pollution in China than industry.

Researchers found that farming was responsible for 44 percent of chemical oxygen demand (the main measure of organic compounds in water), 67 percent of phosphorus discharges, and 57 percent of nitrogen discharges into bodies of water. Manure from industrial livestock farms is the most important source of this pollution—in 2008 China's livestock produced 4.8 billion tons of waste. As the livestock industry grows, so too will the amount and problems of manure.

2010年2月，中国政府公布了首次全国污染源普查结果。结果惊人的发现，近三年花费7370百万元人民币（1000万美金）调查得出如今中国的农业污染源比工业污染源更大。

研究表明，44%的化学需氧量（水中有机物含量的主要指标）来自农业，67%磷排放，57%氮排放至水体。来自产业化畜禽养殖场的粪肥是这一污染的最主要来源-2008年中国畜牧业产出48亿吨废弃物。随着畜牧业的发展，污染的量和粪肥的问题也将随之增长。

"The pig is a fertiliser factory on four legs" (Mao Zedong)

"每头猪都是一个在四条腿上的有机化肥厂" (毛泽东)

Source: Global Meat Complex: The China Series
China's Pork Miracle? Agribusiness and Development in China's Pork Industry

China - Environmental Situation 2014
中国 – 2014年环境状况

Environmental damages 2014 published for the first time.
2014年首次公布环境破坏情况。

- **16%** of soil polluted 土地污染
- **20%** of farmland unusable 农田不可用
- **60%** of groundwater not suitable for consumption
  地下水不适于饮用

203 cities under investigation showed 44% relatively poor underground water, 15.7 % very poor.
从203个参与调差的城市结果显示，44%的地下水相对较差，15.7%的地下水非常差。

Source: the guardian, 2014, April 25 – China´s-Choice

China – Response by 2015
中国 – 2015年的相应措施

Revision of China´s 25 years old country´s environmental law
修订中国25年前旧的国家环境法

- Concrete environmental standards
  具体的环境标准
- Strict penalties as important principle
  严格的惩罚力度作为重要原则
- In case of hurting the law
  若触犯环境法，则：
  - Companies will be published 公布违法企业信息
  - Responsibles will be prisoned 负责人将被拘留
  - Officials can be fired 开除行政官员
  - High fines for polluters 污染者承担高额罚款

Source: the guardian, 2014, April 25 – China´s-Choice

1. Setting the scene: Environmental footprint of global livestock production – especially of pigs China

背景：全球畜牧生产对环境的影响-尤其是中国养猪业

2. Mitigation strategies: Low emission farming (LEF) concept

缓解措施：低排放农业（LEF）概念

3. Summary and outlook

结论和展望

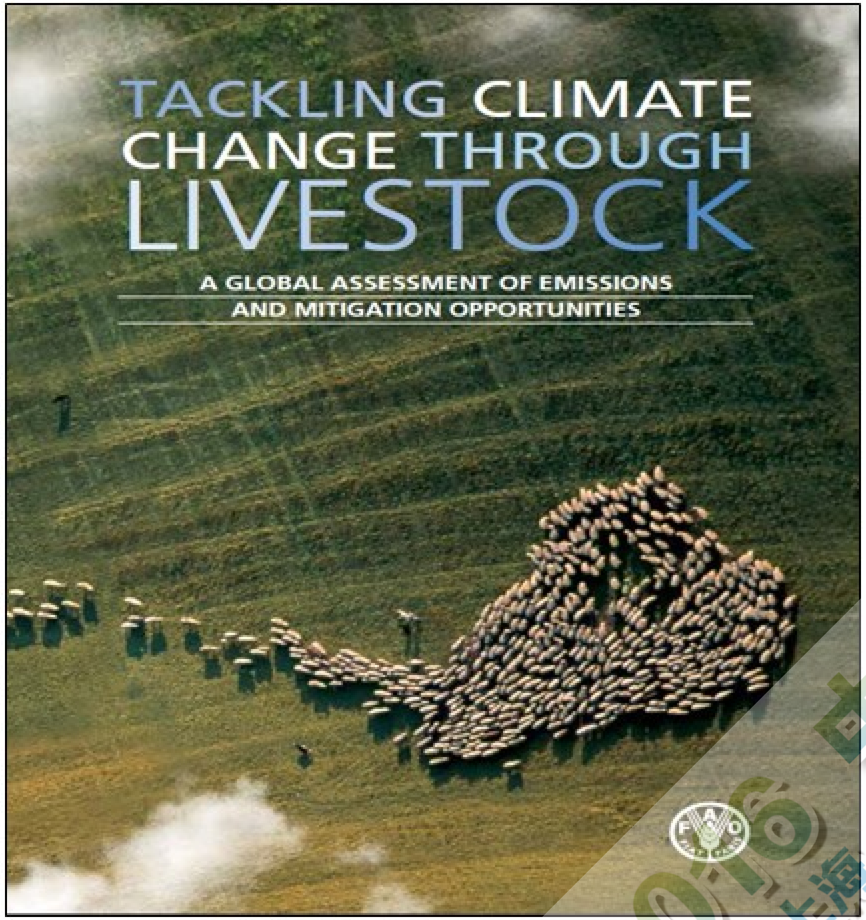
Mitigation potential of the global livestock sector by applying best practises
应用最好的实践措施减轻全球畜牧业的潜在污染

The mitigation potential estimate excludes changes between farming systems and assumes the overall output remains constant

减轻潜在污染的评估不包括农业系统间的变化并假定总产量保持不变。

[redacted]

Sustainability in the livestock sector – concrete mitigation potential: FAO 2013
畜牧业的可持续性 – 具体的减轻潜能：FAO 2013



- Improving production efficiency (FCR, yield..)
  改善生产效率（饲料转化率，产量…）
- Improving breeding (longevity, piglets raised) and animal health
  改良育种（延长生产年限，提高带仔数）和动物健康
- Using **manure management practices** to recycle and recover nutrients and energy contained in manure
  采用粪肥管理措施循环利用粪中的养分和能量
- Sourcing low emission feed commodities (no LUC!)
  寻求低排放的饲料产品（无LUC）
- **Use of feed additives like amino acids, enzymes (NSP, Phytase), gut modulating products, organic trace elements, alternatives for AGP**
  使用饲料添加剂，如氨基酸，酶（NSP，植酸酶），肠道调节产品，有机微量元素，抗生素替代品

Low emission farming (LEF): an integrated system solution to optimize environmental impact mitigation of livestock farming
低排放农业（LEF）：集约化系统解决方案减轻并优化畜牧业对环境的影响

Basic idea: 基本理念：

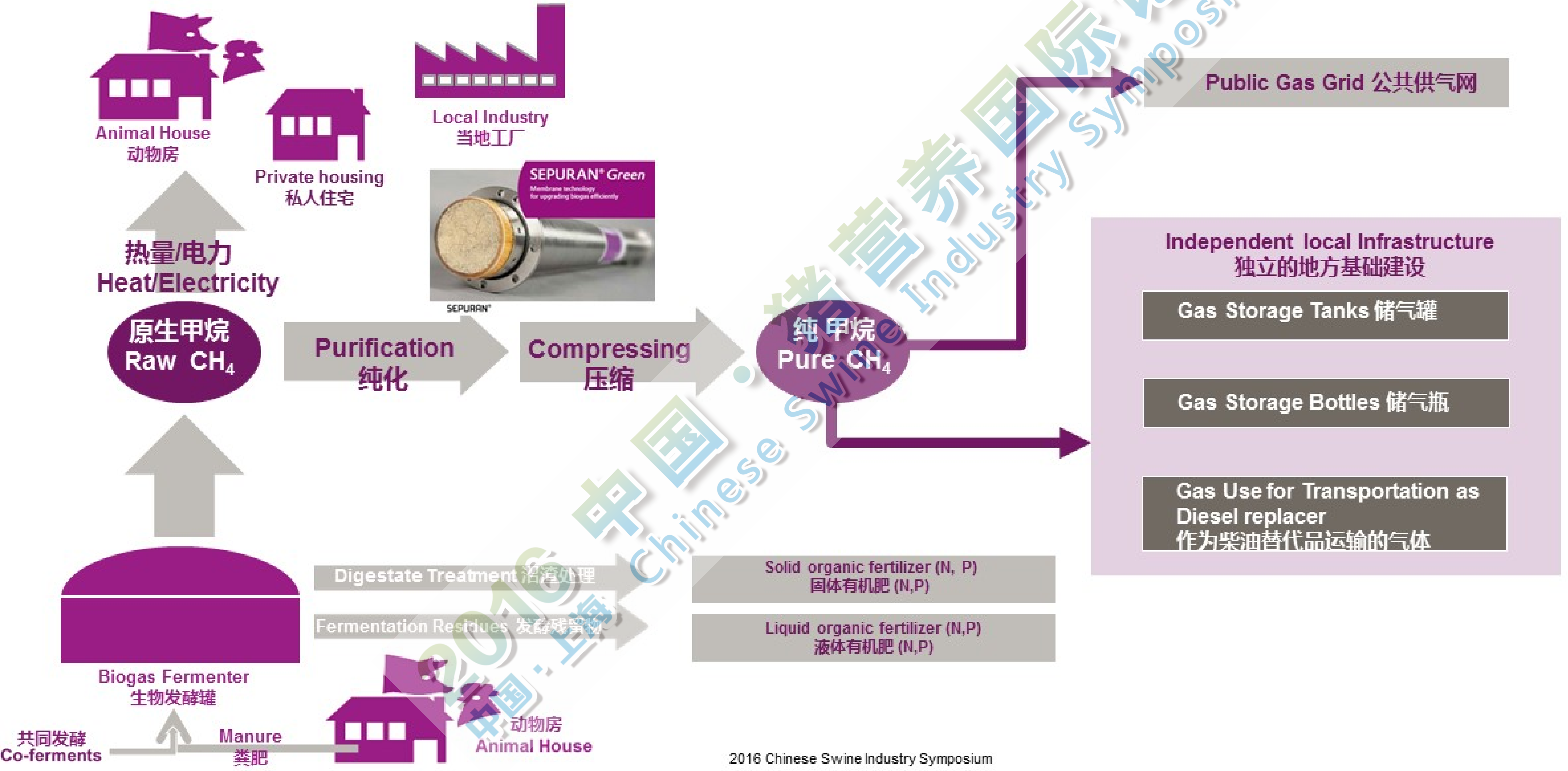
Combination of 涵盖

- **NUTRIENT** management 营养管理
- **EMISSION** and **WASTE** management 排放与废物管理
- Recycling of energy and increased energy efficiency 能量回收利用，提高能量效率
- Closed Nutrient Cycle 封闭的营养素循环
- Additional use of further processed as P / N – fertilizer on farm level
  进一步加工处理和利用，如磷/氮 – 农田肥料
- Additional business opportunities 附加商机

„Combination leads to more efficient and sustainable reduction of emissions and waste and creates new business opportunities and thus increases profitability in animal production“

“综合措施会导致更有效及可持续减少排放和废物，并创造了新的商业机会，从而在动物生产中提高盈利能力”

低排放农业内容 – 商业模式
LEF Concept – Business Options



拖拉机驾驶用于猪粪管理
Tractor driving on pig manure

政府间气候变化委员会提出改进饲养管理和厌氧消化作为农业温室气体排放的缓解措施 IPCC proposes improved feeding practice and anaerobic digestion as a mitigation measure for agricultural GHG emissions

措施 Measure	举例 Examples	缓解效应 Mitigative effects[a]			净缓解（置信度） Net mitigation[b] (confidence)	
		CO_2	CH_4	N_2O	Agreement 协议	Evidence 证据
Livestock management 畜牧管理	Improved feeding practices 改进喂养做法		+	+	***	***
	Specific agents and dietary additives 特效药物和饲料添加剂		+		**	***
	Longer term structural and management changes and animal breeding 长期结构和管理变化及动物养殖		+	+	**	*
Manure/biosolid management 肥料/生物固体管理	Improved storage and handling 改进存储和处理		+	+/-	***	**
	Anaerobic digestion 厌氧消化		+	+/-	***	*
	More efficient use as nutrient source 作为营养源更有效地使用	+		+	***	**
Bio-energy 生物能源	Energy crops, solid, liquid, biogas, residues 能源作物、固体、液体、沼气、残留物	+	+/-	+/-	***	**

Notes: 注：

a + denotes reduced emissions or enhanced removal (positive mitigative effect); a+表示减少排放量或增强去除（正缓解效应）；

- denotes increased emissions or suppressed removal (negative mitigative effect); -表示增加排放量或抑制去除（负缓解效应）；

+/- denotes uncertain or variable response. +/-表示不确定或可变的反应。

b A qualitative estimate of the confidence in describing the proposed practice as a measure for reducing net emissions of greenhouse gases, expressed as CO_2-eq: b 描述提出的做法作为衡量减少温室气体排放量，表现为CO_2-eq的定性估计置信度。

Agreement refers to the relative degree of consensus in the literature (the more asterisks, the higher the agreement); Evidence refers to the relative amount of data in support of the proposed effect (the more asterisks, the more evidence). 协议之文献中相对程度的共识（星号越多，协议越多）；证据指支持拟议效果数据量（星号越多，证据越多）

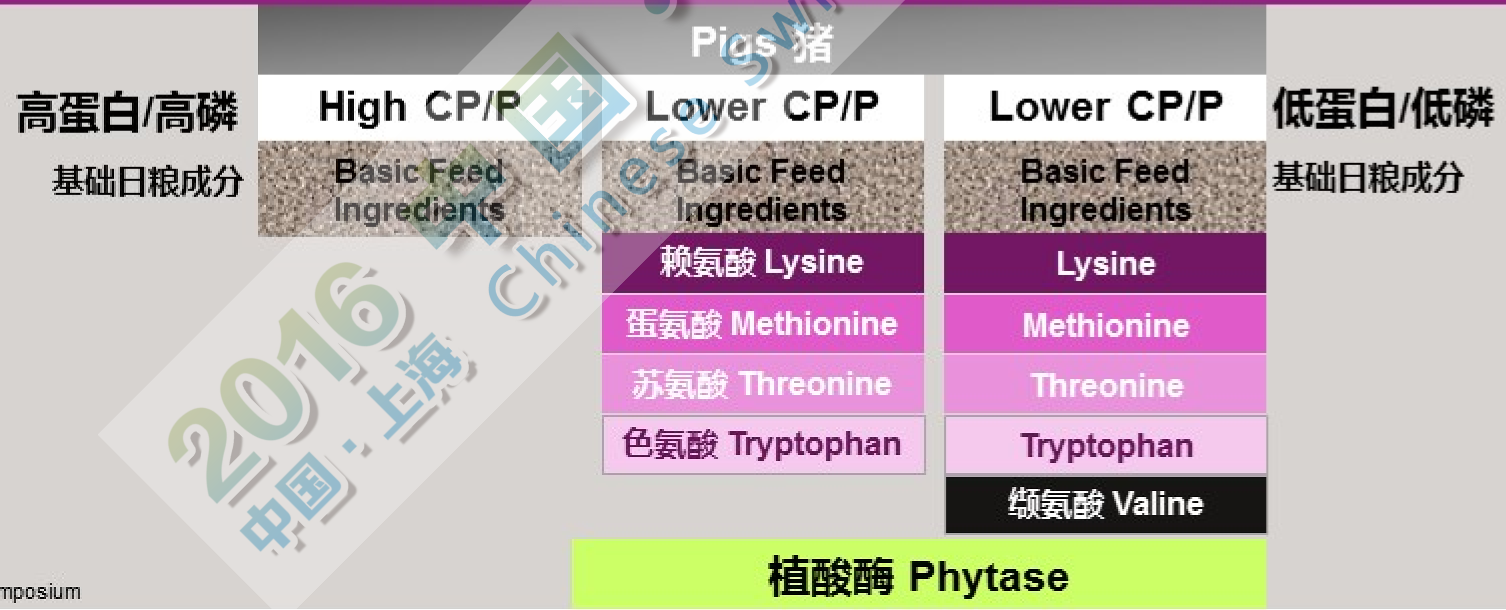
Source: adapted from Smith et al., 2007a. 来源：改编自Smith et al.,2007a。

Smith, P., et al., 2007: Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
http://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch8.html

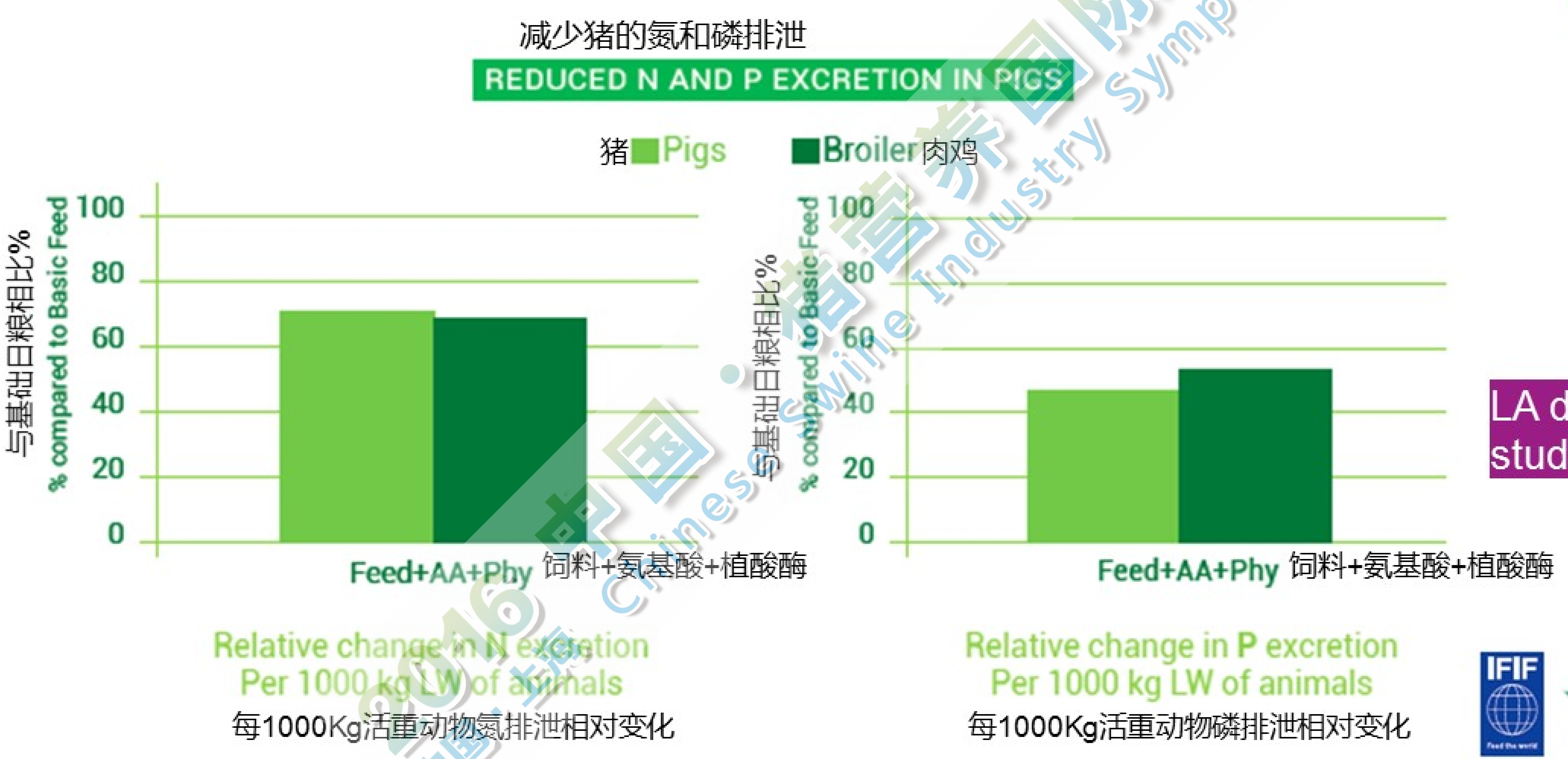
低蛋白和低磷日粮– 低农业排放的营养部分
Low protein and low phosphor diets– the nutrition part of LEF

- 高蛋白日粮氨基酸组分比例失调
  High protein diets are imbalanced in the amino acid profile
- 补充饲料氨基酸恢复平衡，降低粗蛋白
  Supplementing feed amino acids (AA) restore the imbalance and leads to crude protein (CP) reduction
- 降低粗蛋白，减少粪便中蛋白含量（蛋白降低1%，氮排放减少约10%）
  CP reduction lowers nitrogen content in excreted manure (~ 10% by 1% lower CP)
- 降低动物的水消耗，从而减少粪便体积（蛋白降低1%，粪便减少约3-5%）
  lowers water consumption of animals and thus manure volume (~ 3-5% by 1% lower CP)
- 植酸酶减少磷排泄高达60%磷酸，并节省有限的矿物资源
  Phytase reduces phosphorus excretion by up to 60% and saves finite mineral phosphate sources

CP reduction



氨基酸和植酸酶有助于减轻饲养猪和家禽对环境的影响
Amino Acids and Phytase help mitigating the environmental impact of feeding pigs and poultry



LA diets, SFIS study 2015

Evonik 2015年关于饲料氨基酸生命周期评估– 证实事实和数字-结果
Evonik LCA 2015 for feed amino acids – certified facts and figures - Results

相比不含氨基酸饲料的改善系数
Improvement Factor compared to feed without amino acids

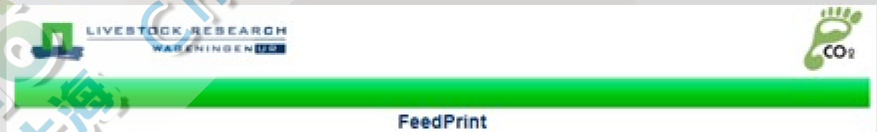
全球变暖趋势 Global Warming Potential	CO_2	13
富营养化趋势 Eutrophication Potential	PO_4	17
酸化趋势 Acidification Potential	SO_2	20

Source: Evonik 2015, certified LCA acc. ISO14044:2006

生态平衡：转向第三维度的可持续日粮
Ecological balancing: Towards the third dimension of a sustainable diet

1. 满足动物需求的饲料配方
Feed formulation to meet the animal demand !
2. 饲料原料的实用性（基础饲料原料）
Availability of feed raw materials (basic feed ingredients)
3. 优化配方成本以降低饲料成本
Optimized cost formulation to reduce feed costs

- 饲料1 Feed 1
- 饲料2 Feed 2
- 饲料3 Feed 3
- 饲料4 Feed 4
- 饲料... Feed...



饲料2 Feed 2

- 营养均衡 Nutritionally balanced
- 经济平衡 Economically balanced
- 生态平衡 Ecologically balanced

Case study: 案例研究：
Gestating Sow: Ecological impact of Chinese Standard diet vs. low-CP diet 怀孕母猪：中国标准日粮vs低蛋白日粮对生态的影响

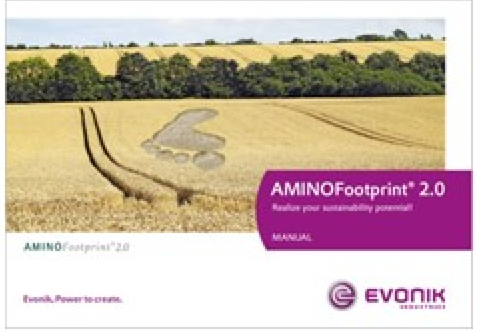
中国怀孕母猪 China Sow gestating		饮食净影响饲料 Diet Net Impact Feed	中国低蛋白怀孕母猪 China Sow gestating low CP	
-901.1	CO_2		CO_2	-906.7
3.27	SO_2		SO_2	3.23
1.34	PO_4		PO_4	1.36
132.175	CP		CP	120.905
Shandong 山东				Shandong 山东

If you use
China Sow gestating low CP
instead of
China Sow gestating
you get the following ecological differences:

如果中国怀孕母猪使用低蛋白日粮，将有以下生态差异：

-15.0 kg CO_2e/mt
-1.90 kg SO_2e/mt
-0.35 kg PO_4e/mt

Source of data: thinkstep



Case study:案例研究：
Lactating Sow: Ecological impact of Chinese Standard diet vs. low-CP diet 哺乳母猪：中国标准日粮vs低蛋白日粮的生态影响

中国哺乳母猪 China Sow lactating	饮食净影响饲料 Diet Net Impact Feed	中国低蛋白哺乳母猪 China Sow lactating low CP
CO_2 413.6	If you use China Sow lactating low CP instead of China Sow lactating you get the following ecological differences:	CO_2 -225.8
SO_2 4.68	如果中国哺乳母猪使用低蛋白日朗，将有以下生态差异：	SO_2 3.89
PO_4 2.63	-658.5 kg CO_2e/mt	PO_4 2.38
CP 186.438	-4.53 kg SO_2e/mt	CP 163.665
Shandong 山东	-0.99 kg PO_4e/mt	Shandong 山东

Source of data: thinkstep

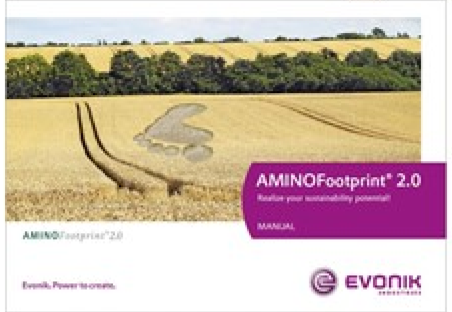
如果没有涉及土地利用变化,降低蛋白轻微影响二氧化碳当量!
If there is no land use change involved, lowering CP has a minor effect on CO_2e!

中国哺乳母猪 w/o 土地利用变化猪 China Sow lactating w/o LUC	饮食净影响饲料 Diet Net Impact Feed	中国低蛋白哺乳母猪 w/o 土地利用变化猪 China Sow lactating low CP w/o LUC
CO_2: -846.6		CO_2: -831.3
SO_2: 3.55		SO_2: 3.36
PO_4: 2.47		PO_4: 2.30
CP: 186.438		CP: 163.665
Shandong 山东		Shandong 山东

If you use
China Sow lactating low CP w/o LUC
instead of
China Sow lactating w/o LUC
you get the following ecological differences:

如果中国哺乳母猪使用低蛋白w/o土地利用变化，将有以下生态差异：

Source of data: thinkstep



生长猪：中国标准日粮vs低蛋白日粮的生态影响 ；FU:mt饲料
Growing Pig: Ecological impact of Chinese Standard diet vs. low-CP diet; FU: mt feed

中国标准蛋白猪 China Pig Standard CP		循环净影响饲料 Cycle Net Impact Feed		中国低蛋白猪 China Pig low CP
-403.8	CO_2	-156.5 kg CO_2e/mt	CO_2	-542.3
8.45	SO_2	-3.36 kg SO_2e/mt	SO_2	8.62
3.39	PO_4	-0.79 kg PO_4e/mt	PO_4	3.30
163.179	CP		CP	141.686
2.780	FCR		FCR	2.780
Shandong 山东				Shandong 山东

If you use
China Pig low CP
instead of
China Pig Standard CP
you get the following ecological differences:

如果中国猪使用低蛋白日粮，将有以下生态差异：

生长猪：中国标准日粮vs低蛋白日粮的生态影响 ；FU:mt活重
Growing Pig: Ecological impact of Chinese Standard diet vs. low-CP diet; FU: mt live weight

中国标准蛋白猪 China Pig Standard CP		循环净影响活重 Cycle Net Impact Live Weight		中国低蛋白猪 China Pig low CP
-403.8	CO_2	-434.3 kg CO_2e/mt	CO_2	-542.3
8.45	SO_2	-9.33 kg SO_2e/mt	SO_2	8.62
3.39	PO_4	-2.20 kg PO_4e/mt	PO_4	3.30
163.179	CP		CP	141.686
2.780	FCR		FCR	2.780
Shandong 山东				Shandong 山东

If you use

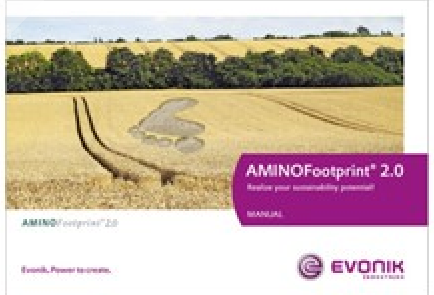
China Pig low CP

instead of

China Pig Standard CP

you get the following ecological differences:

如果中国猪使用低蛋白日粮，将有以下生态差异：



通过降低中国猪日粮蛋白来减少环境影响
Reduction of environmental footprint by lowering %CP in Chinese pig diets

	肥育猪 Fattening pigs	怀孕母猪 Gestating sows	哺乳母猪 Lactating sows	合计 Total
标准蛋白/低蛋白 %CP Standard/Low CP	15.9/13.8	13.0/12.0	18.0/16.0	
吨 CO_{2e} tons CO_{2e}	29.093.350	445.500	10.075.050	39.613.900
吨 SO_{2e} tons SO_{2e}	624.624	56.430	69.309	750.363
吨 PO_{4e} tons PO_{4e}	146.861	10.395	15.147	172.403

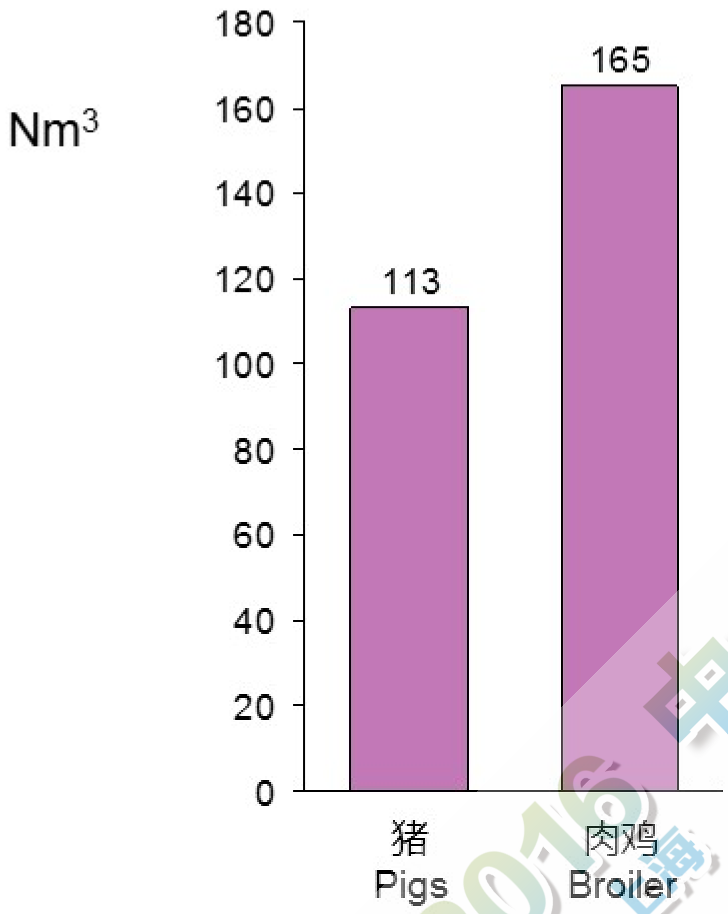
→ 中级汽车每行驶20000 km/a 产生约7.000.000吨 ~ 17.000.000 middle class cars each driving 20000 km/a

要正确看待它*：
To put it in perspective*:

	每千克活重** Per kg liveweight**	每头猪100千克末重 per pig of 100 kg final weight	吨/年 65亿头 Tons/y 650 mil. head	低蛋白日粮节省物吨/年 Savings by low protein diets in t/a	降低比例% Savings in %
千克或吨 CO_{2e} Kg or tons CO_{2e}	3 - 4	300 - 400	195.000.000 -260.000.000	29.093.350	11,2% - 14,9%
千克或吨 SO_{2e} Kg or tons SO_{2e}	0,035	3,5	2.275.000	624.624	27,5%
千克或吨 PO_{4e} Kg or tons PO_{4e}	0,02	2	1.300.000	146.861	11,3%

*Growing pigs only! ** average from different literature sources

欧洲每吨毛猪和肉鸡的沼气生产潜力 biogas creation potential per 1.000 kg LW pigs and broiler in Europe



每吨活重的产沼气潜能
Biogas potential per 1.000 kg LW

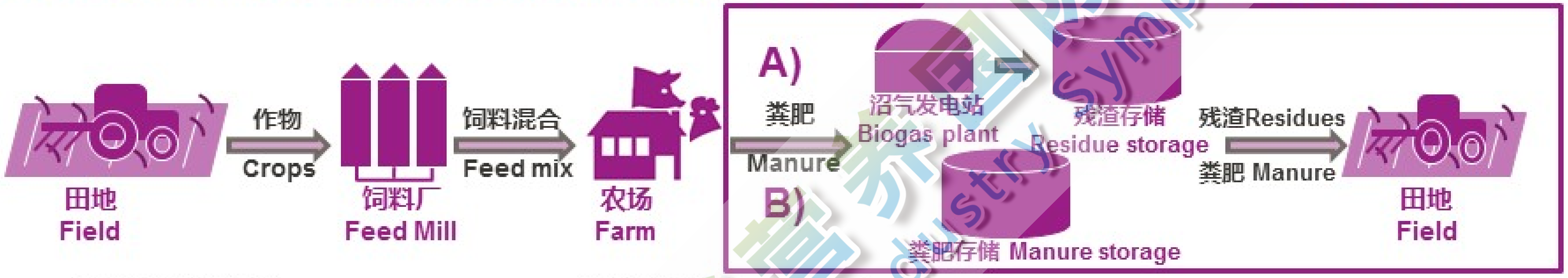
Pigs:
28 Nm³ / t fresh mass* ~ 4.1 t fresh mass / 1.000 kg LW**
Broiler:
140 Nm³ / t fresh mass*
~ 1.2 t fresh mass / 1.000 kg LW**

猪:
28 Nm³ / t 鲜质量* ~ 4.1 t 鲜质量/ 1.000 kg 活重**
肉鸡:
140 Nm³ / t 鲜质量*~ 1.2 t 鲜质量/ 1.000 kg 活重**

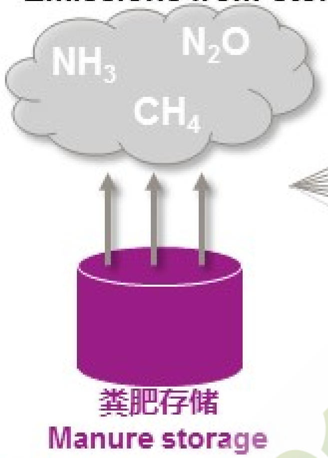
* FNR_Leitfaden_Biogas_2013
** Calculated from SFIS study data

生命周期评估方法：使用公认数据和基准参考
LCA approach: use accepted data and always benchmark against reference

我们的目标是比较不同方法效果，如果可能的话获得功能相依性
Our objective is to compare options and derive functional dependencies if possible



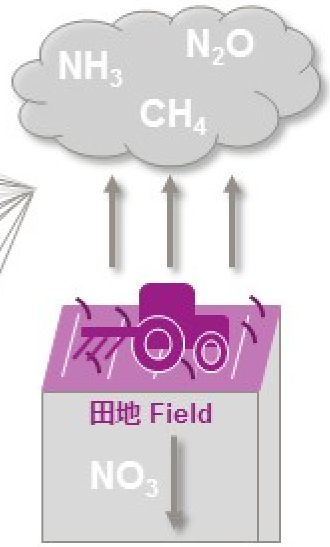
存储中的排放物
Emissions from storage



影响因素 Influencing factors

- 存储时间 Time of storage
- 温度 Temperature
- 气候带 Climate zone
- 覆盖/未覆盖多媒体信息服务 Covered/uncovered MMS
- 自然地壳覆盖 Natural crust cover
- 液体/固体存储/混合体制 Liquid/solid storage /mixing regime
- 降雨量、气候 Rainfall, weather
- 土壤类型 Soil type
- 土地里的作物/植物 Crops / plants on field
- 残留组分 Residue composition
- 施用粪肥的应用技术/推广季节点 Application technology/spreading Saisonal point of manure application

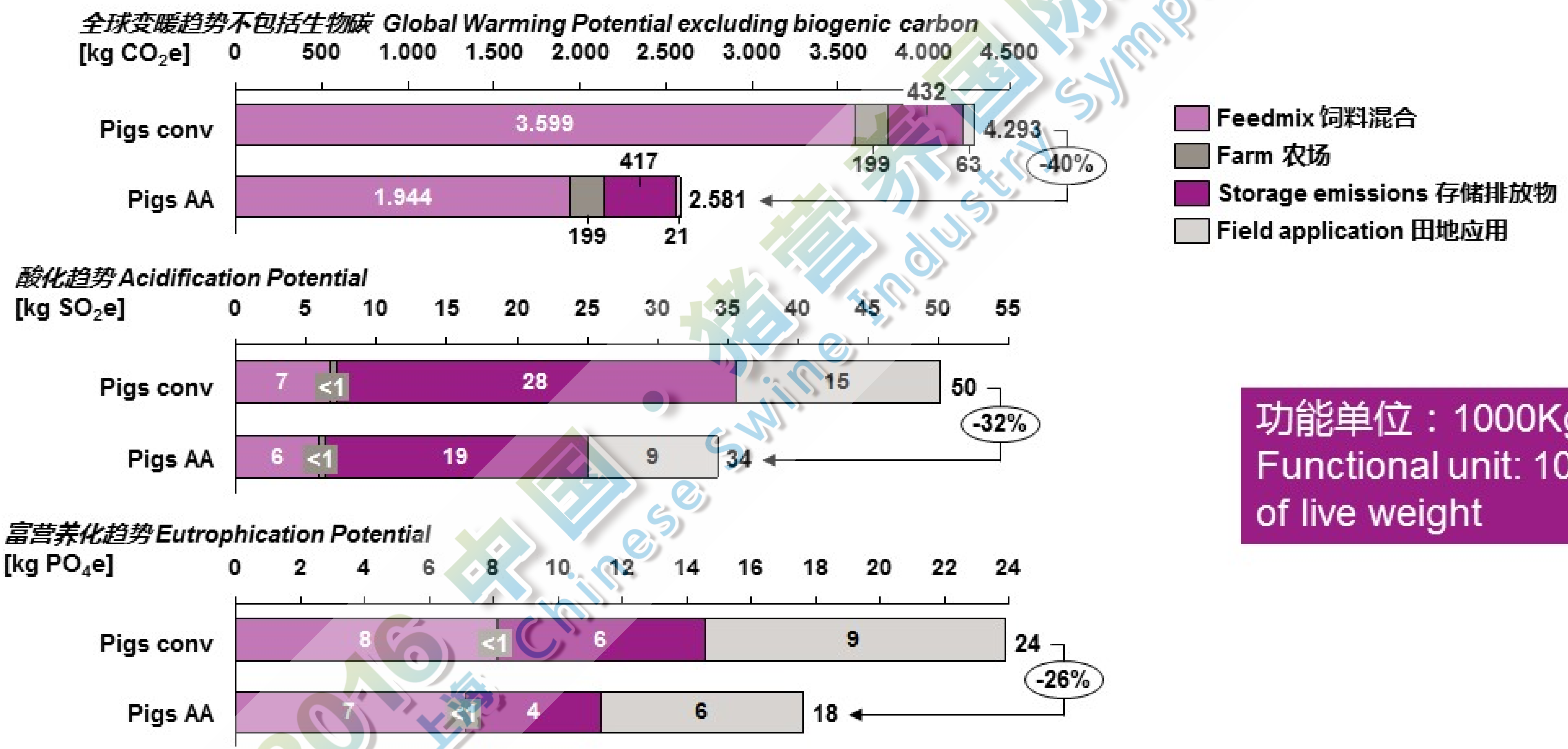
田地应用中的排放物 Emissions from field application



第一种方法：采用IPCC数据用于排放物
1st approach: use IPCC data for emissions

[redacted]

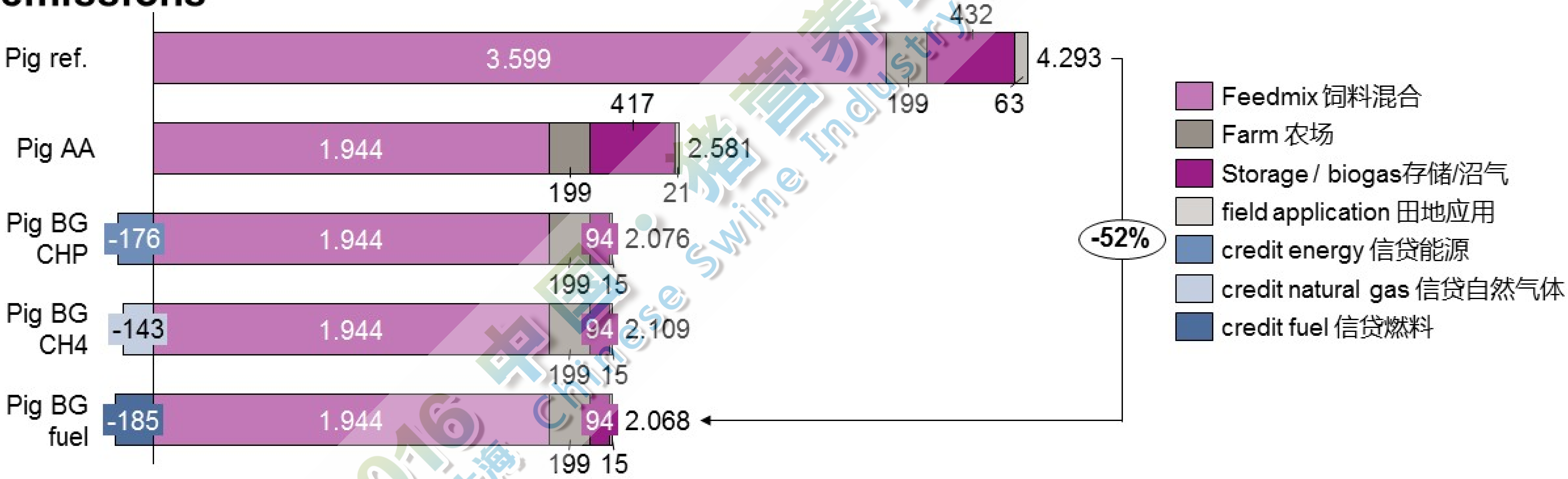
Pigs EU:
Effect of amino acid use compared to a reference diet without amino acid supplementation on environmental impact categories GWP , AP, EP (including dLUC emissions)欧盟猪：与对照日粮相比，使用氨基酸对环境影响类别GWP、AP、EP（包括dLUC排放）的效果



功能单位：1000Kg活重
Functional unit: 1000 kg of live weight

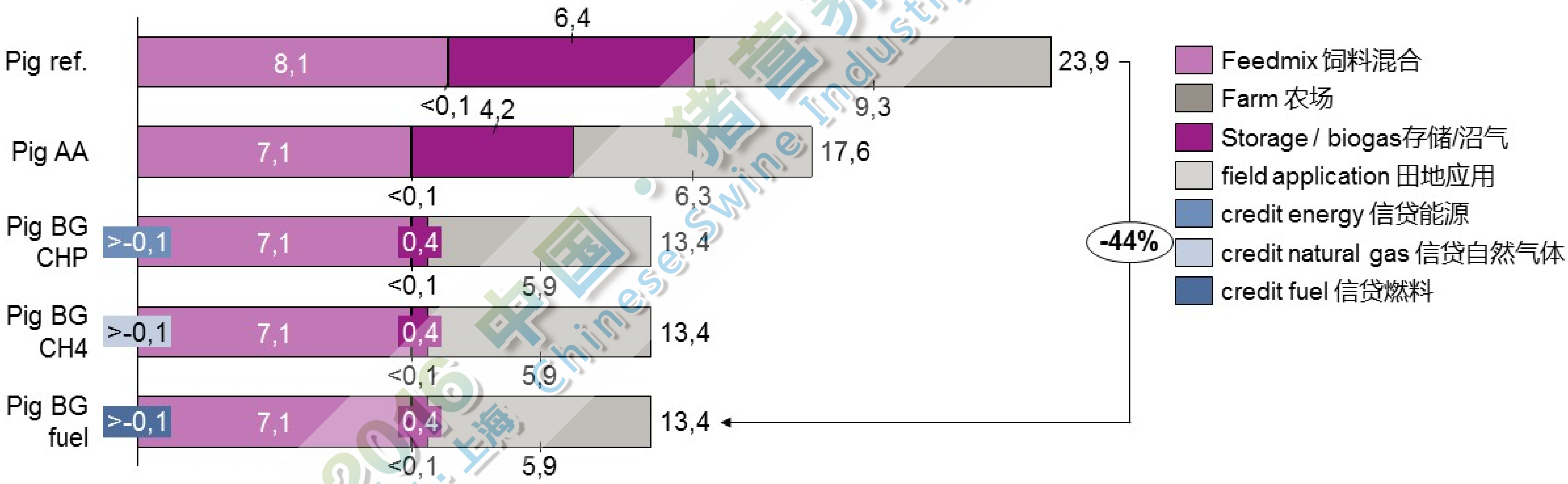
养猪中使用氨基酸和不同沼气生产方式降低全球变暖趋势的潜力
GWP reduction potential by using amino acids and different biogas options: Pigs

全球变暖趋势当量值(100)不包括生物碳[kg CO_2e/1.000 kg 活重] 包括dLUC 排放
GWP (100) excl. biogenic carbon [kg CO_2e/1.000 kg live weight] incl. dLUC emissions



养猪中使用氨基酸和不同沼气生产方式降低富营养化的潜力
Eutrophication reduction potential by using amino acids and different biogas options: Pigs

富营养化趋势 [kg PO_4e/1.000 kg 活重]
EP [kg PO_4e/1.000 kg live weight]

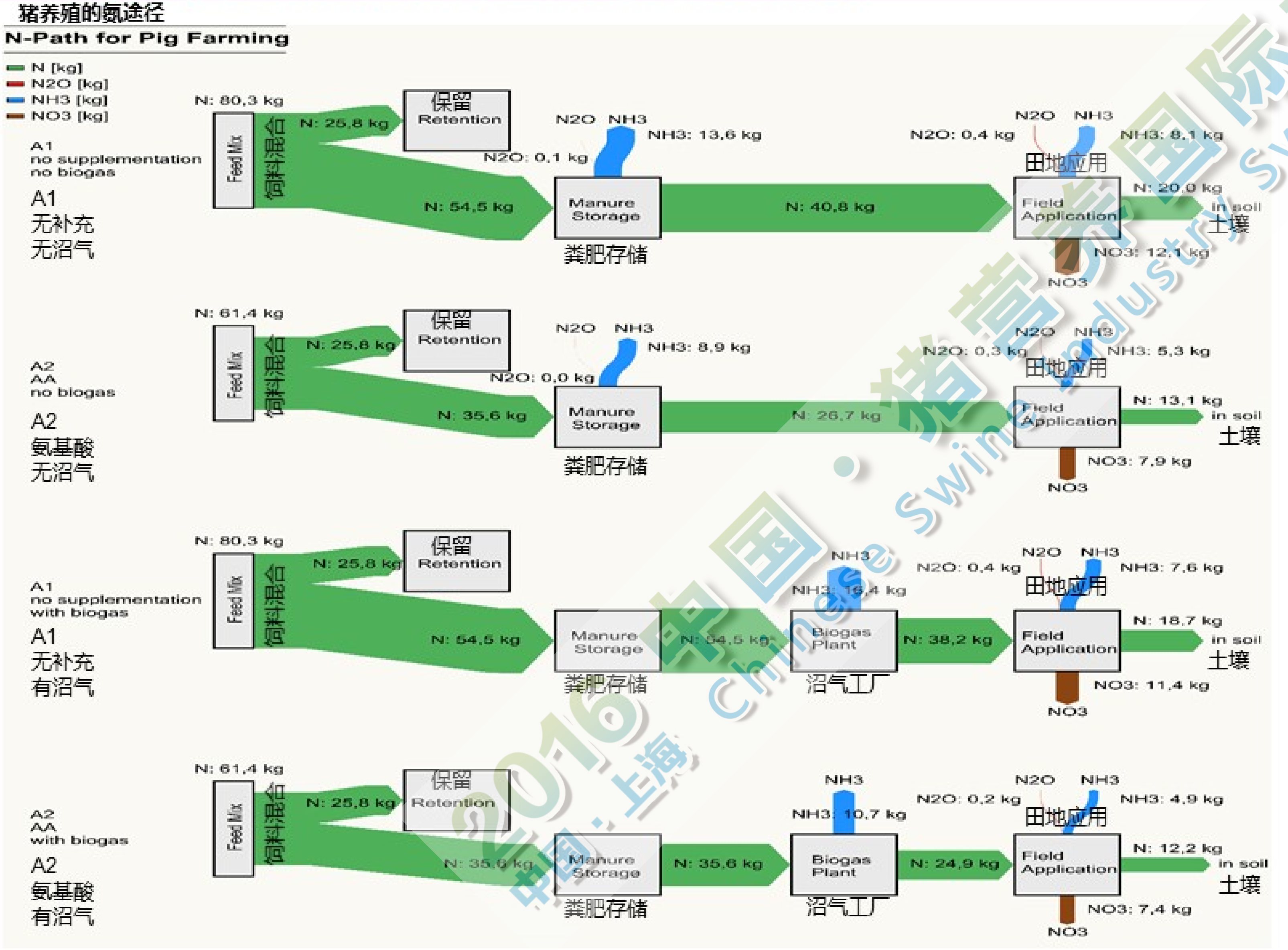


使用氨基酸和不同沼气处理方法：使土地酸化趋势减少
Acidification reduction potential by using amino acids and different biogas options

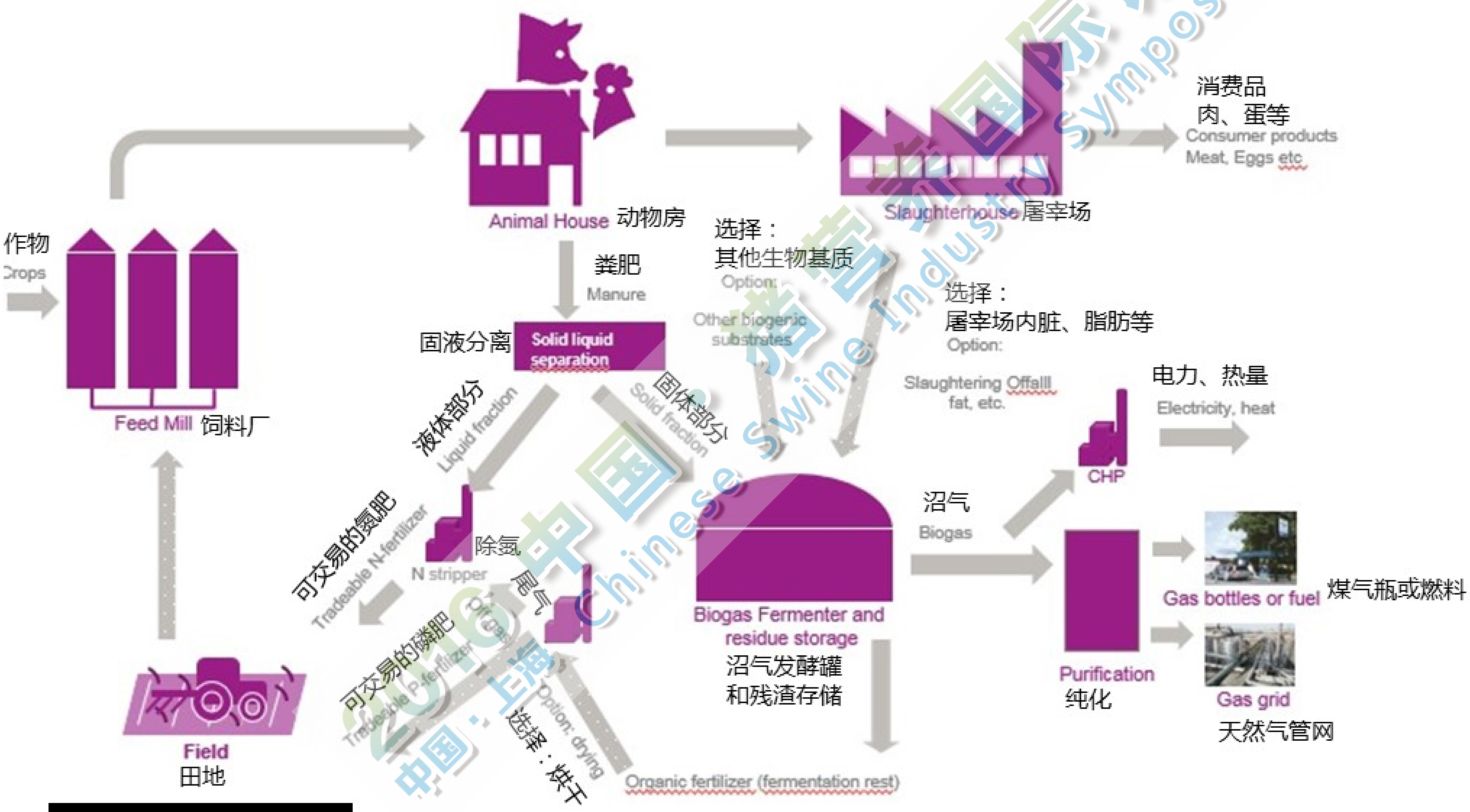
酸化趋势[kg SO_2e/1.000 kg 活重]
AP [kg SO_2e/1.000 kg live weight]

	猪 Pigs
参考(AA-) Reference (AA-)	50.1
AA+	34.3 (-31.5%)
BG CHP	16.3 (-67.5%)
BG CH4	17.0 (-66.1%)
BG Fuel	16.9 (-66.3%)

SFIS研究：饲料中添加氨基酸和粪污沼气处理对欧盟养猪业每吨活重氮平衡的的影响 Mass Balance Nitrogen Pigs per 1 t of live weight produced based on European diets from SFIS study: effect of amino acids in feed and biogas production with manure as feedstock



仍有待进一步考察其他处理的影响，包括沼渣处理效果（正在进行中） Future concepts still to be examined including effects digestate treatment (in process)



[redacted]

1. 背景：全球畜牧产业生产对环境影响—尤其是中国养猪业
Setting the scene: Environmental footprint of global livestock production – especially of pigs China

2. 缓解措施：低排放农业(LEF)概念
Mitigation strategies: Low emission farming (LEF) concept

3. 总结和展望
Summary and outlook

总结和展望
Summary and outlook

- 农业占全球温室气体排放的20%，畜牧业占 3/4
  Agriculture is responsible for about 20% of global GHG emissions, ¾ of that for lifestock
- 全球温室气体排放以反刍动物为主：中国猪产业份额为24%，远高于全球9%的平均值，家禽和猪的氮磷排放显著
  Globally GHG emissions are dominated by ruminants; share of pigs in China with ~24% much higher than global share of ~9%, significant N and P emissions from poultry and swine
- 粪肥管理措施和温度对在粪肥存储期间温室气体的形成有显著影响→有必要掩盖存储罐
  Manure management practice and temperature have a dominant influence on GHG formation during manure storage → cover for storage tanks necessary
- 含氨基酸的日粮可显著减少氮排放和相关酸化及富营养化趋势；温室气体减排的意义与LUC和南美大豆紧密相连
  Diets with amino acids have a significant reduction potential for N emissions and related acidification and eutrophication potentials; GHG reduction's significance is strongly connected with LUC and Soy from South America
- 一些措施有助于减少每个生产阶段产生的影响；例如农业和化肥的使用，低蛋白日粮应用补料策略，植酸酶和有机微量元素；粪便管理以回收能量并避免存储排放
  Several measures can help to reduce impacts on every production stage; e.g. farming and fertilizer use and application, feeding strategies applying low protein diets, phytase and organic trace minerals; manure management to recover energy and avoid emissions from storage
- 沼气可显著减少粪肥存储的排放，并通过电力/热量、天然气或者甚至是柴油替代品（也就是用于卡车或拖拉机的生物燃料）来抵消农场排放。
  Biogas can significantly reduce emissions from manure storage and offset farm emissions by credits for electricity/heat, natural gas or even diesel replacement (i.e. biofuel for trucks and tractors)
- 进一步使用更多的氨基酸降低饲料蛋白含量和沼渣处理可进一步减排
  Lowering feed protein content further using more AA and digestate treatment offer further emission reduction potential

建议政策制定者、畜牧业和动物养殖户推进低排放畜牧业的概念
Suggestions to policy makers, livestock industry and animal farmers to push towards low emission animal farming concepts

评估当今已客观化的畜牧生产系统的全部环境成本Assess the full environmental costs of current livestock production systems which today are externalized

- 清理环境污染成本(水、土壤、空气)，包括粪肥和农药流失及污染，生活损失导致costs of cleaning up environmental pollution (water, soil, air), including manure and agrochemical runoff and contamination, and livelihood losses that result
- 从工业畜牧生产整个阶段温室气体排放相关的成本costs associated with greenhouse gas emissions from all stages of industrial livestock production
- 作为农田营养和有机物来源的粪肥的流失，增加了生产成本和使用商业化肥成本 loss of manure as a source of nutrients and organic matter on croplands, and increased costs of manufacturing and using commercial fertilizers

利用现有全部潜能的最佳做法制定低环境影响饲料Exploit the full potential of best available practice in formulating low environmental impact feed

- 低蛋白日粮以标准回肠消化率为基础，结合NE配制，设置最大蛋白水平而不是最小值！low protein diets formulated based on %SID combined with NE, set maximum CP-level instead of min.!!!!!
- 在高性能奶牛中使用受保护的氨基酸 use protected aa in high performance dairy cows
- 低磷日粮中使用植酸酶 low phosphorus diets using phytase
- 尽量少用土地利用变化起源的饲料原料 minimize use of feed ingredients of land-use-change origin
- 利用有机微量元素 use organic trace minerals

创建一个有利于以粪便和食品副产品作为原料的沼气厂投资的框架条件 Create framework conditions which favor investments in biogas plants with manure and food by-products as feedstock

- 更具吸引力的信贷/借额系统用于不同沼气的选择（CHP、供气网、燃料）包括CO_2定价 More attractive credit/debit system for different biogas options (CHP, gas grid, fuel) incl. CO_2 pricing

创建一个积极沟通的畜牧业重要公共平台 Create a positive communication for the livestock critical public

- 低排放农业–应用循环生物经济处在最佳状态 ！ LEF – applied circular bioeconomy at its best!!!

LEF概念关于未来集约化低排放农场 – 探索和推广最佳做法以减小畜牧生产足迹、养分循环闭环和生产不需土地的昆虫蛋白饲料 LEF idea about integrated Low Emission Farm of the future - explore and promote best practice to shrink footprints of livestock production, close nutrient cycles and produce landless insect protein feed