中美养猪技术合作前景
Synergism Between Chinese & American Swine Industry

Deb Hamernik, PhD

美国动物科学学会(ASAS)主席 President, American Society of Animal Science
农业研究院副院长 Associate Dean, Agricultural Research
内布拉加斯州农业试验站副院长 Associate Director, Nebraska Agricultural Experiment Statio
内布拉斯加-林肯大学动物科学院教授 Professor, Department of Animal Science University of Nebraska-Lincoln, USA

Chinese Swine Industry Symposium | ASAS China Meeting
Shanghai, China
October 2016

AGRICULTURAL RESEARCH

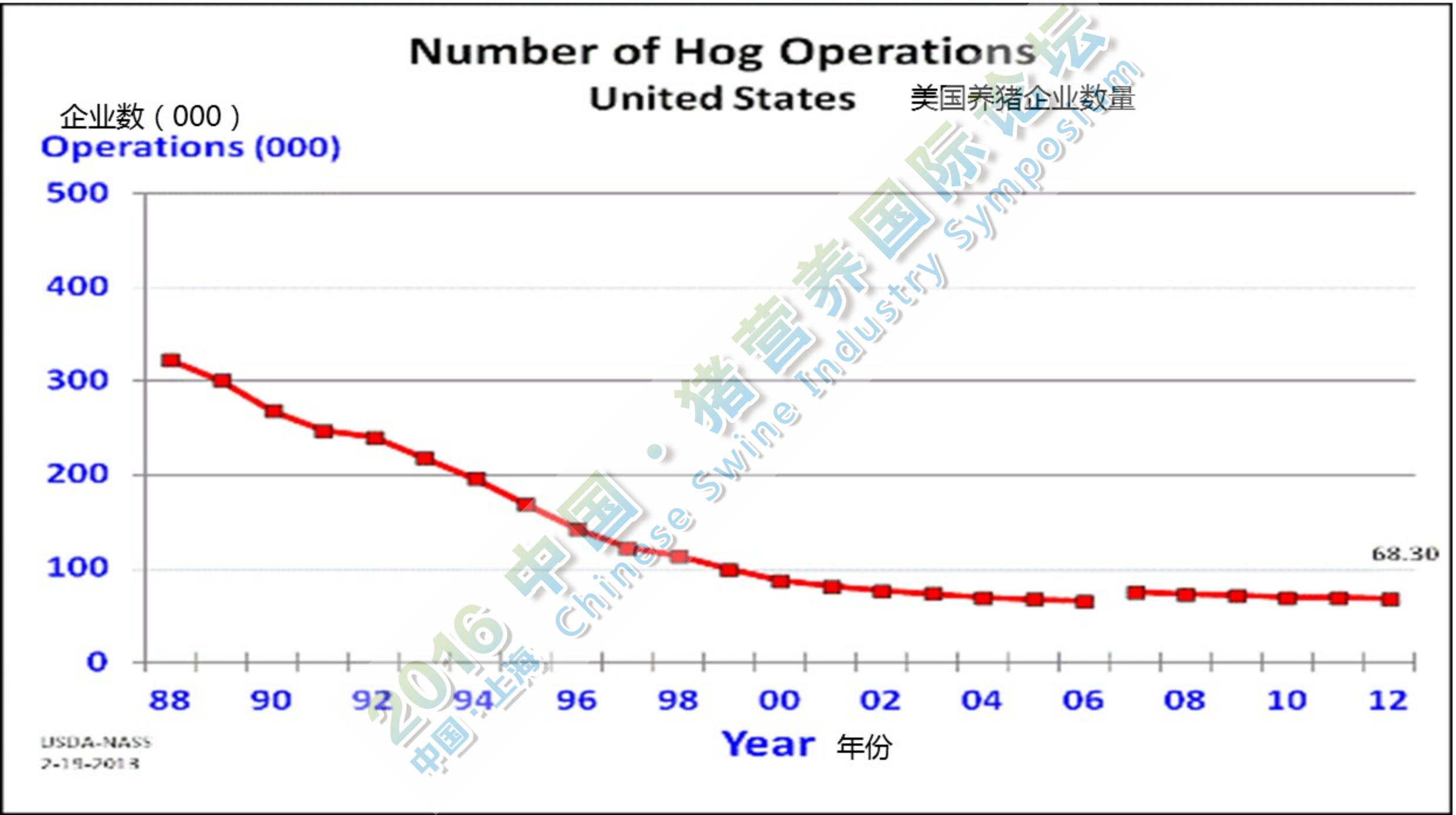
21世纪的巨大挑战
Grand Challenges for 21st Century

- 到2050年全球人口预计达到90亿
  World population expected to reach 9 billion by 2050
- 发展中国家的财富增长导致对动物源食品的需求增加
  Increased wealth in developing countries leads to increased demand for animal-sourced foods
- 额外需要70-100%的食物 Need 70-100% more food (FAO 2013)
  - 10%通过作物产量提高 10% improved crop yields
  - 20%通过种植面积增加 20% more land (?)
  - 70%通过提高生产效率新技术的应用 70% from new technologies to increase efficiency of production
- 农业不足以保证营养安全 Agriculture as usual won't be enough to provide nutritional security
  - 全球气候改变可能限制生产 Global climate change may limit production
  - 水资源可能被限制 Water resources may be limiting
- 必须提高生产效率 MUST increase production efficiency
  - 更少的投入和自然资源 Fewer inputs and natural resources
  - 提高饲料效率&繁殖效率&遗传 Increased feed efficiency & reproductive efficiency + genetics

食品安全/营养安全
Food Security / Nutritional Security

- 多学科研究、教学、推广/拓展合作、伙伴关系和创新
  Multidisciplinary research, teaching, extension/outreach collaborations, partnerships, and innovation
- 公-私合作伙伴关系 Public-Private Partnerships
- 国际合作 International Collaborations

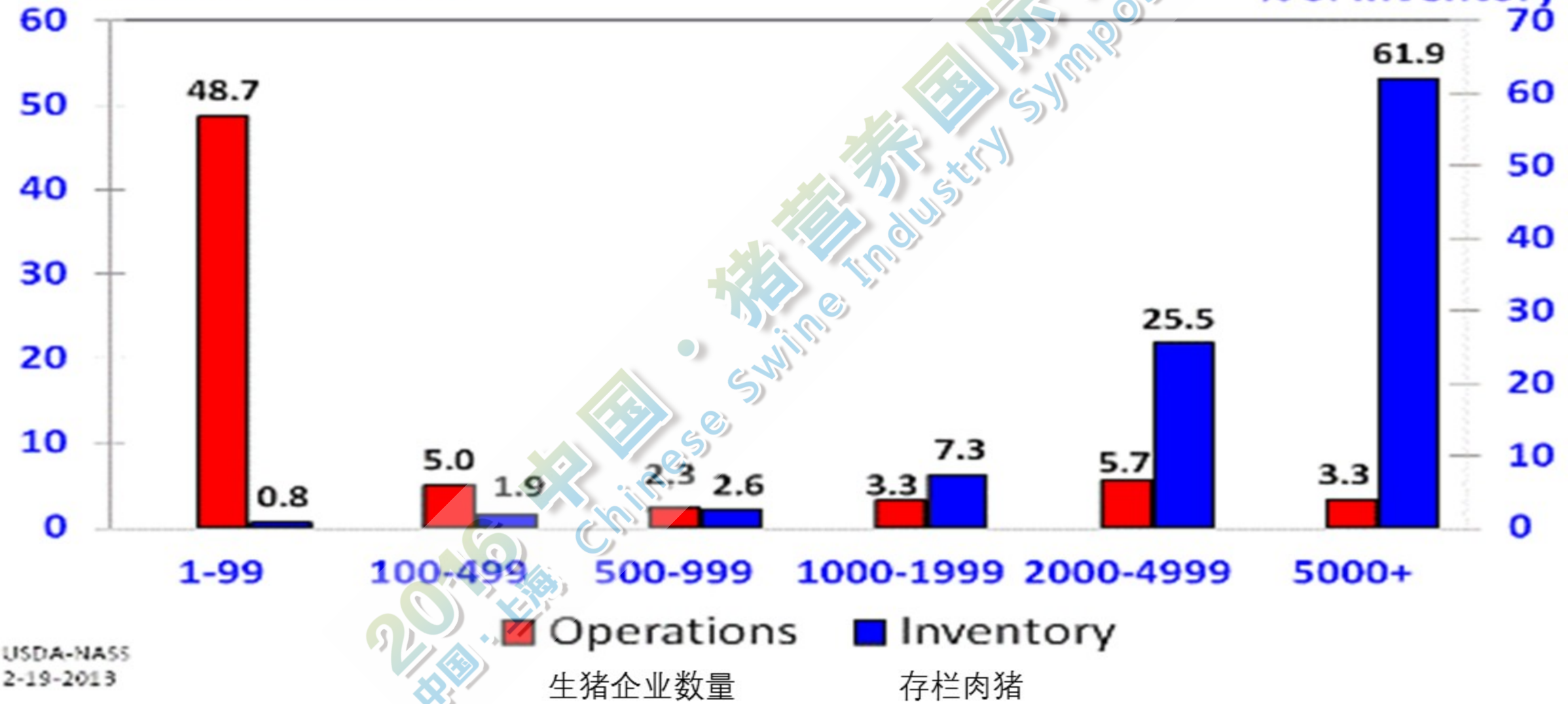
AGRICULTURAL RESEARCH


Number of Hog Operations
United States
美国养猪企业数量
企业数（000）
Operations (000)
500
400
300
200
100
0
68.30
88
90
92
94
96
98
00
02
04
06
08
10
12
Year
年份
USDA-NASS
2-19-2013

U.S. Hog Operations

Number of Operations and Percent of Inventory, 2012

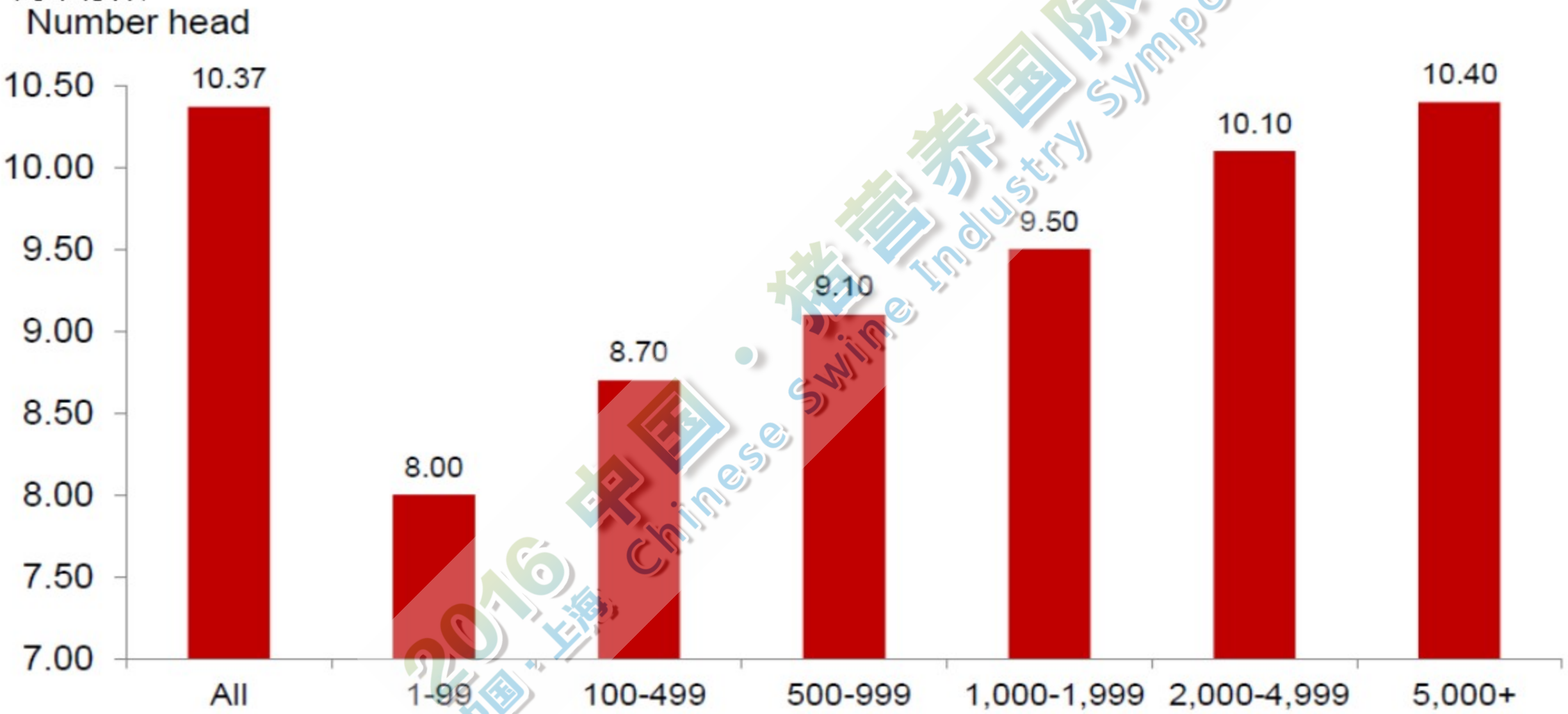
2012年美国生猪企业数量及存栏肉猪占比



USDA-NASS
2-19-2013

不同规模企业窝带仔数——美国：2015,3月-5月

Pigs per Litter by Size of Operation – United States: March-May 2015



可持续畜牧生产
"Sustainable" Livestock Production

公众接受度 Socially Acceptable

- 动物福利 Animal Welfare
- 技术（生长促进剂、抗生素、基因工程）
  Technologies (growth promotants, antibiotics, genetic engineering)

环境责任 Environmentally Responsible

- 水质和数量 Water quality and quantity
- 土壤质量 Soil quality
- 空气质量 Air quality
- 生物多样性 Biodiversity

经济上可行 Economically Viable

- 多样化管理系统 Diverse management systems
- 高附加值产品/利基市场 Value-added products/niche markets

AGRICULTURAL RESEARCH

50年间美国养猪业碳排放和资源利用的比较：1959-2009

REPORT:

A 50-Year Comparison of the Carbon Footprint and Resource Use of the US Swine Herd: 1959 - 2009

日期：2012年05月22日

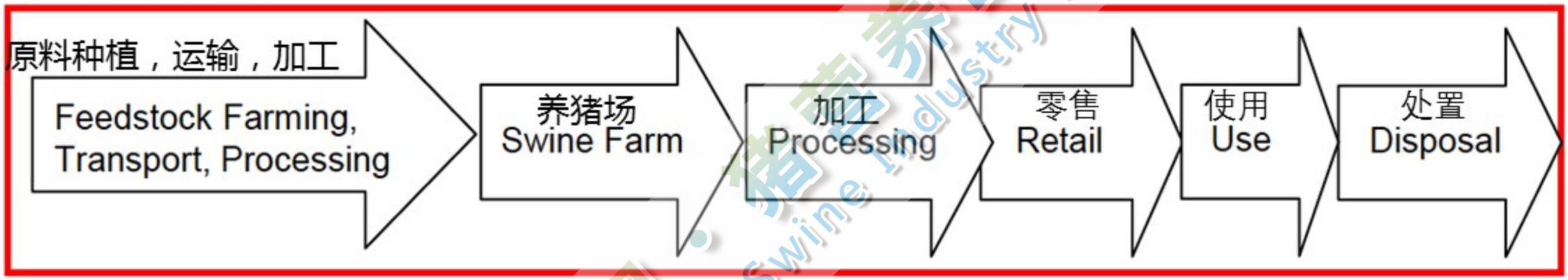
Date: May 22nd, 2012

Lead Authors: Garth Boyd, Ph.D., PAS, Sr. Vice President Agricultural Services, Camco

Roger Cady, Ph.D, Sr. Technical Advisor & Sustainability Lead, Elanco

1959 – 2009年的生命周期分析（LCA）
Life Cycle Analysis (LCA) from 1959 -- 2009

出生-死亡
Cradle-to-Grave



作物生产运输
Crop production Transportation

活畜准备屠宰
Live animal ready to harvest

- 温室气体排放 GHG emissions
- 土地利用 Land use
- 水利用 Water use
- 能源利用Energy use

AGRICULTURAL RESEARCH

1959 – 2009年的生命周期分析（LCA）
Life Cycle Analysis (LCA) from 1959 -- 2009

1959:

- 可靠的数据记录 Reliable data available
- 已经使用集约化养猪体系、饲料抗生素、分娩笼、全年分娩、人工授精...

  Precedes use of intensive housing systems for swine, feed antibiotics, farrowing crates, year-round farrowing, artificial insemination, …
- 生产方法与现在类似，一些的关键因素都具备：集约化猪舍，技术，创新的和现代化的生产系统

  Production methods resemble those desired by some that are critical of intensive housing, technologies, innovative and modern production systems

AGRICULTURAL RESEARCH

1959 – 2009年的生命周期分析（LCA）
Life Cycle Analysis (LCA) from 1959 -- 2009

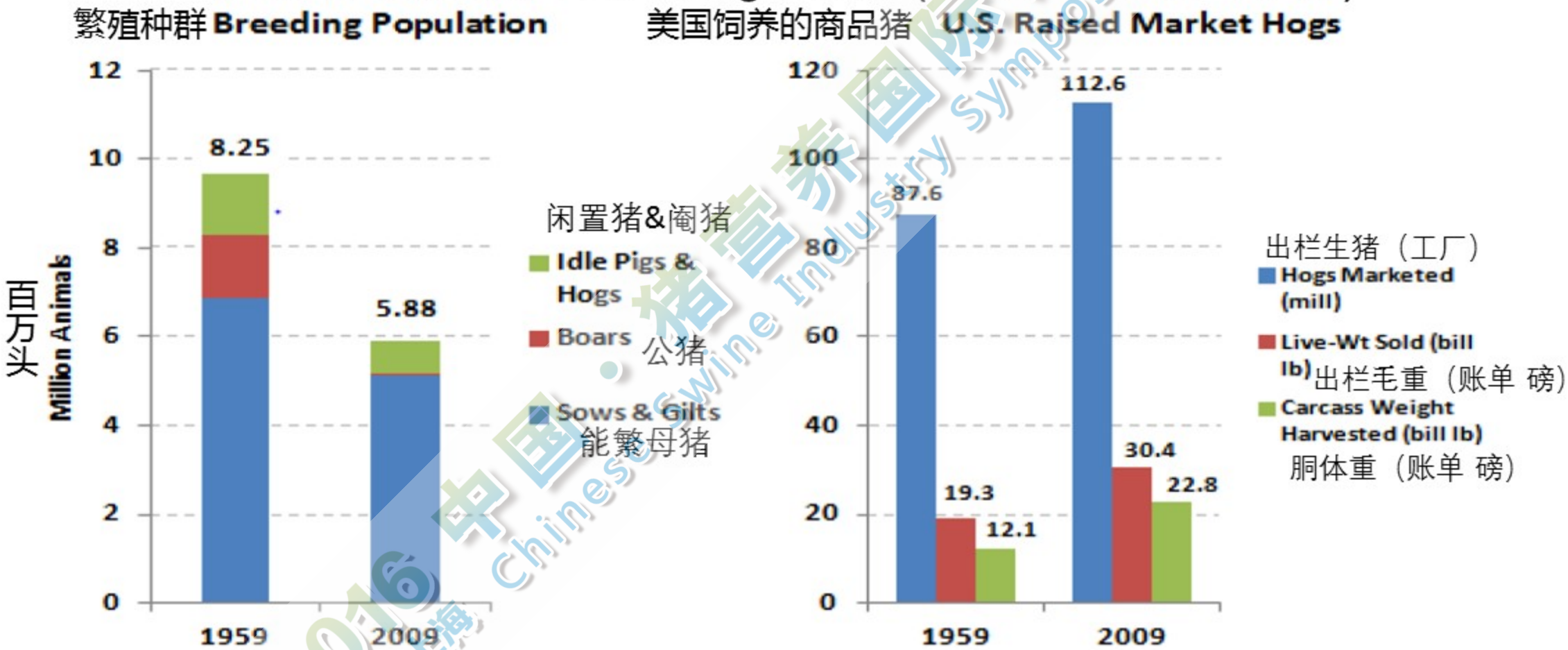
主要指标评估： Key Indicators Evaluated:

- 产胴体重量 Dressed carcass weight produced
- 能繁种畜禽和出栏畜禽数量
  Number of animals in breeding herd and market herds
- 饲料利用率 Feed utilization
- 土地利用 Land use
- 化学和能源利用 Chemical and energy utilization
- 水利用（动物消耗和作物灌溉）
  Water utilization (animal consumption & crop irrigation)
- 粪污产量Manure production
- 全球变暖潜势：由CO_2，CH_4，N_2O测量
  Global warming potential: measured by CO_2, CH_4, N_2O

AGRICULTURAL RESEARCH

小群种猪出栏更多生猪，生产更多猪肉（2009 vs 1959）

More Hogs Marketed and More Pounds of Pork from a Smaller Breeding Herd (2009 versus 1959)



来源：USDA-NASS,USDA-ERS&1959 US Ag Census

Source: Adapted from USDA-NASS, USDA-ERS & 1959 US Ag Census

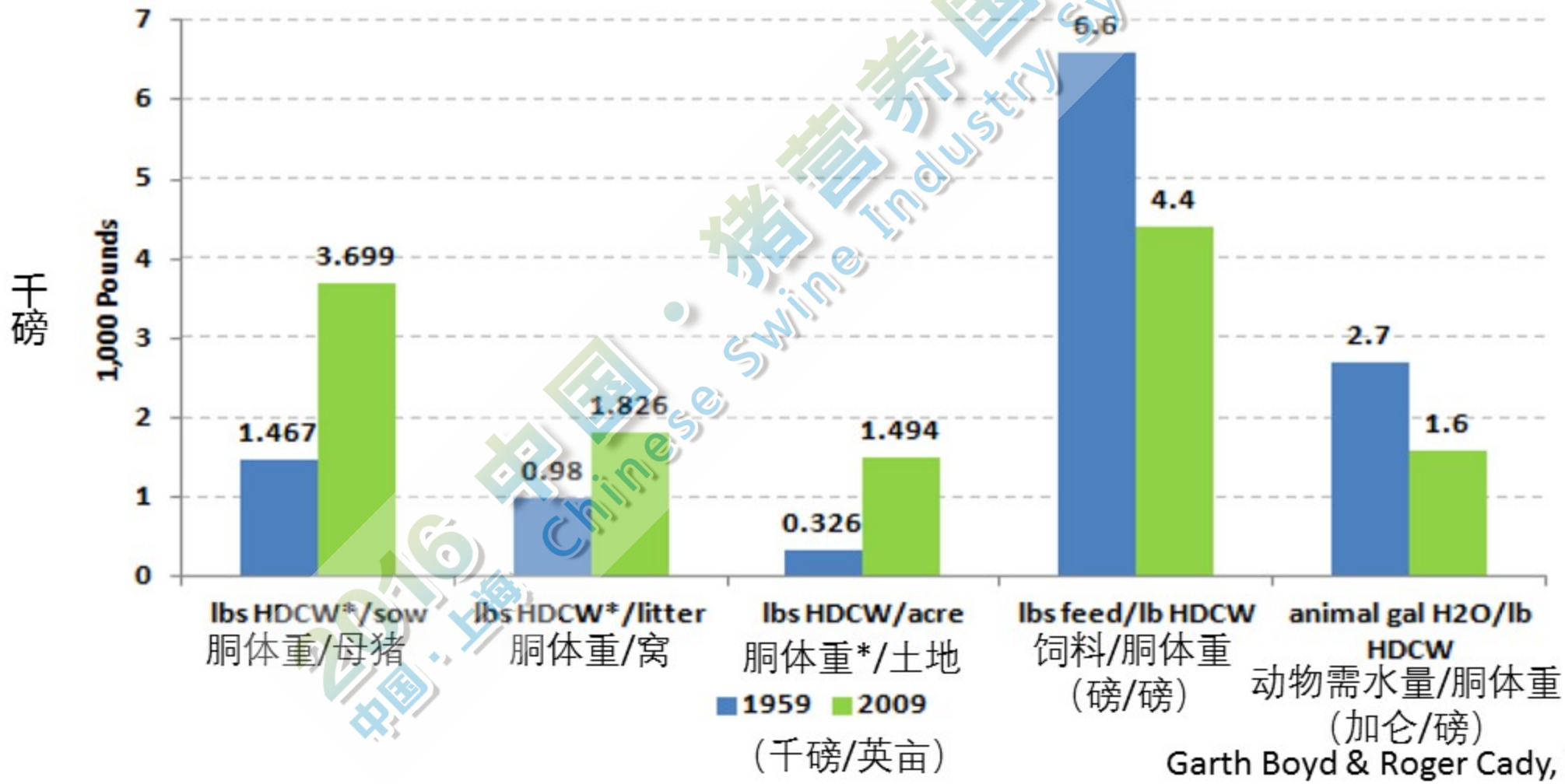
Garth Boyd & Roger Cady, CAMCO, 2012

猪需要的饲料和水更少(2009 versus 1959)

Pigs Require Less Feed and Less Water (2009 versus 1959)

注意：*胴体重只包括美国出生的商品猪；不包括进口猪

NOTE: *Hot Dressed Carcass Weight from U.S. born market pigs only; imported grower and feeder pigs excluded



Garth Boyd & Roger Cady, CAMCO, 2012

2009年，只需要5头猪就能生产1,000磅胴体重，同样的重量在1959年则需要8头猪。

In 2009, only **5** hogs are needed to produce the same 1,000 pounds of dressed carcass weight that required **8** hogs in 1959.

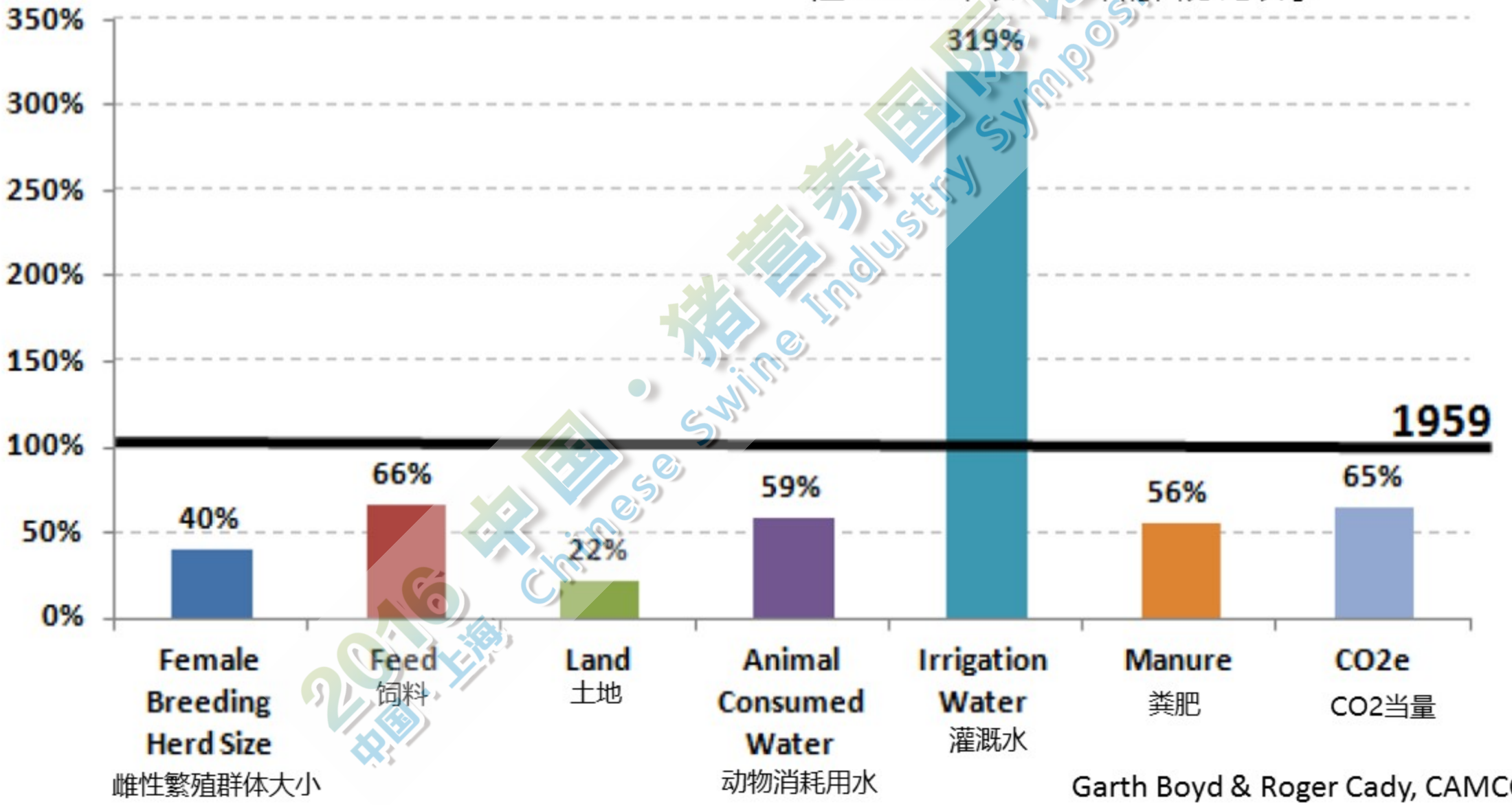
Garth Boyd & Roger Cady, CAMCO, 2012

Figure 1: Comparison of Key U.S. Swine Industry Environmental and Resource Use Measures (per 1,000 lbs. of hot dressed carcass weight produced)

NOTE: 2009 expressed as a percent of 1959.

美国养猪业主要环境和资源利用的比较(每1000磅胴体重需要量)

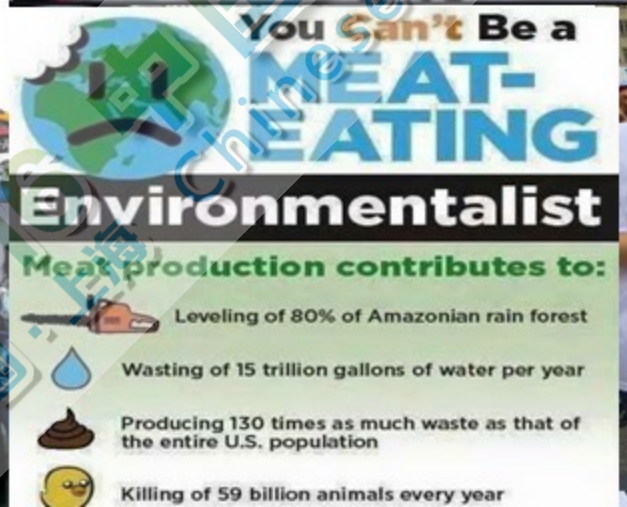
注：2009年以1959年的百分比表示



Garth Boyd & Roger Cady, CAMCO, 2012

公众接受度？

Socially Acceptable?



公众接受的养猪生产
Socially Acceptable Swine Production

- 动物福利(第三方审计在美国工业中很常见)

Animal Welfare (third party audits common in US industry)

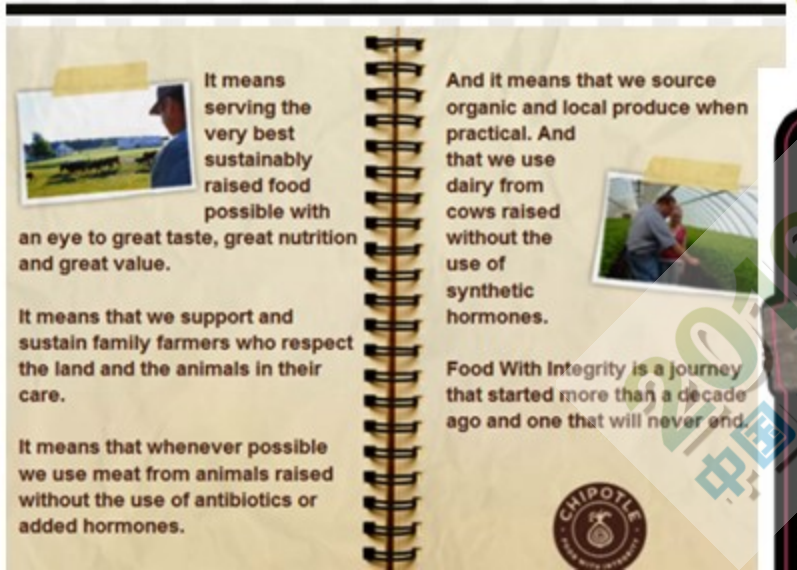
  - 妊娠栏 vs 群养Gestation crates vs group housing
  - 分娩栏 vs 室外/牧场 Confinement vs outdoor/pasture
  - 阉割 Castration
  - 安乐死 Euthanasia

- 生长促进剂 Growth Promotants
  - β-激素 Beta-agonists
  - 抗生素 Antibiotics

- 基因工程 Genetic Engineering
  - 唾液腺中植酸酶的超表达(减少磷排泄)

  Overexpression of phytase in salivary glands (decrease P excretion)
  - 改变猪肉的营养成分

  Change nutrient composition of pork meat



中美之间的合作
Synergism Between China & America

可持续猪生产 Sustainable Swine Production:

- 勿重复美国养猪业犯下的错误

Do not repeat mistakes made by US swine industry

- 必须应对不断变化的消费者需求

Must respond to changing consumer demands

- 必须以越来越少的投入增加生产效率

Must use fewer inputs to increase production efficiency

- 与公众坦率沟通相关生产方法

Must have transparent communication about production methods

- 鼓励和培养更多推广教育者，以将技术传授给生产者

Encourage more Extension Educators to transfer technology to producers

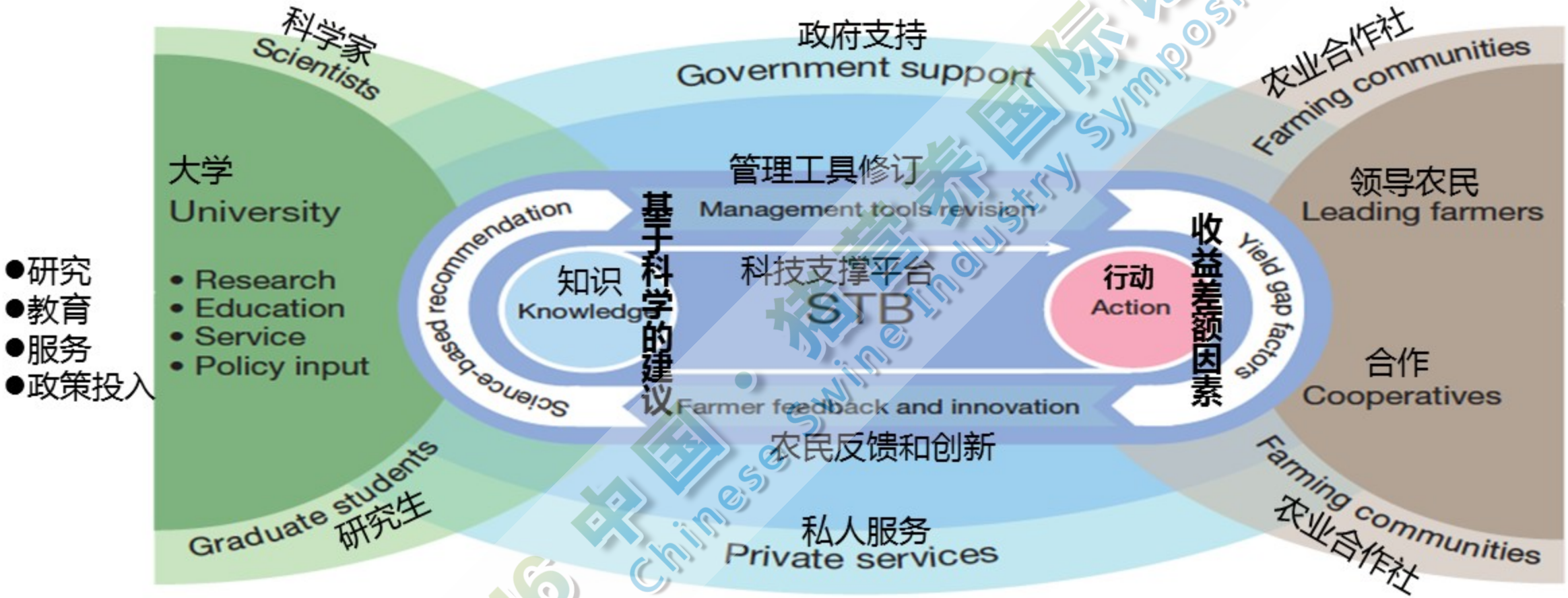
- 招募和培养学生从事农业工作

Recruit and train students for careers in agriculture

AGRICULTURAL RESEARCH

培训小型养殖户以缩小中国产量差距 *

Closing yield gaps in China by empowering smallholder farmers*



- ●研究
- ●教育
- ●服务
- ●政策投入

STB:科技支撑平台(=在美国的分部) **STB: Science & Technology Backyard** platform (= Extension in US)

- 农业科学家生活在村庄中，与农场主一起 Ag scientists live in villages among farmers
- 提前参与创新&技术转让 Advance participatory innovation & tech transfer
- 获得公共&私人支持 Obtain public & private support

*Weifeng Zhang, et. al., (29 September 2016) *Nature* 537: 671

科技支撑平台
Science and Technology Backyard (STB)

衢州市(2009 – 2014) Quzhou County (2009 – 2014):

- 中国农业大学的教授&研究生

Professors & graduate students from China Agricultural University

- 调查了150位农民 Surveyed 150 farmers
- 确定小麦&玉米产量差距>5%的因素

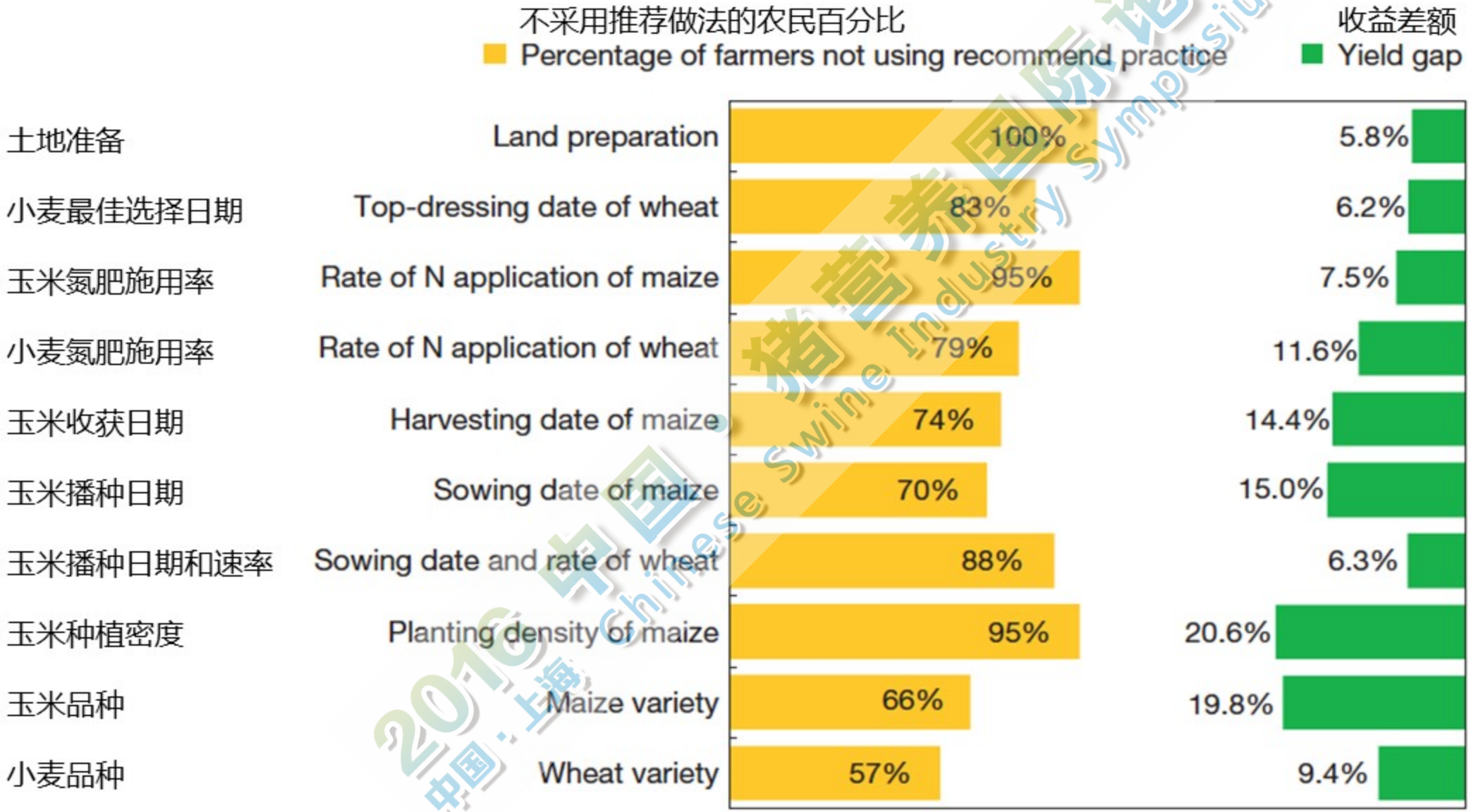
Identified factors with >5% yield gap* for wheat & maize

*产量差距：农民的实际产量和该地区可实现的产量之间的差异

*Yield gap: difference between farmers' yields and yields attainable for the region

AGRICULTURAL RESEARCH

影响产量差距的主要因素
Major Factors Contributing to Yield Gaps



*Weifeng Zhang, et. al., (29 September 2016) *Nature* 537: 671

科学技术支撑平台
Science and Technology Backyard (STB)

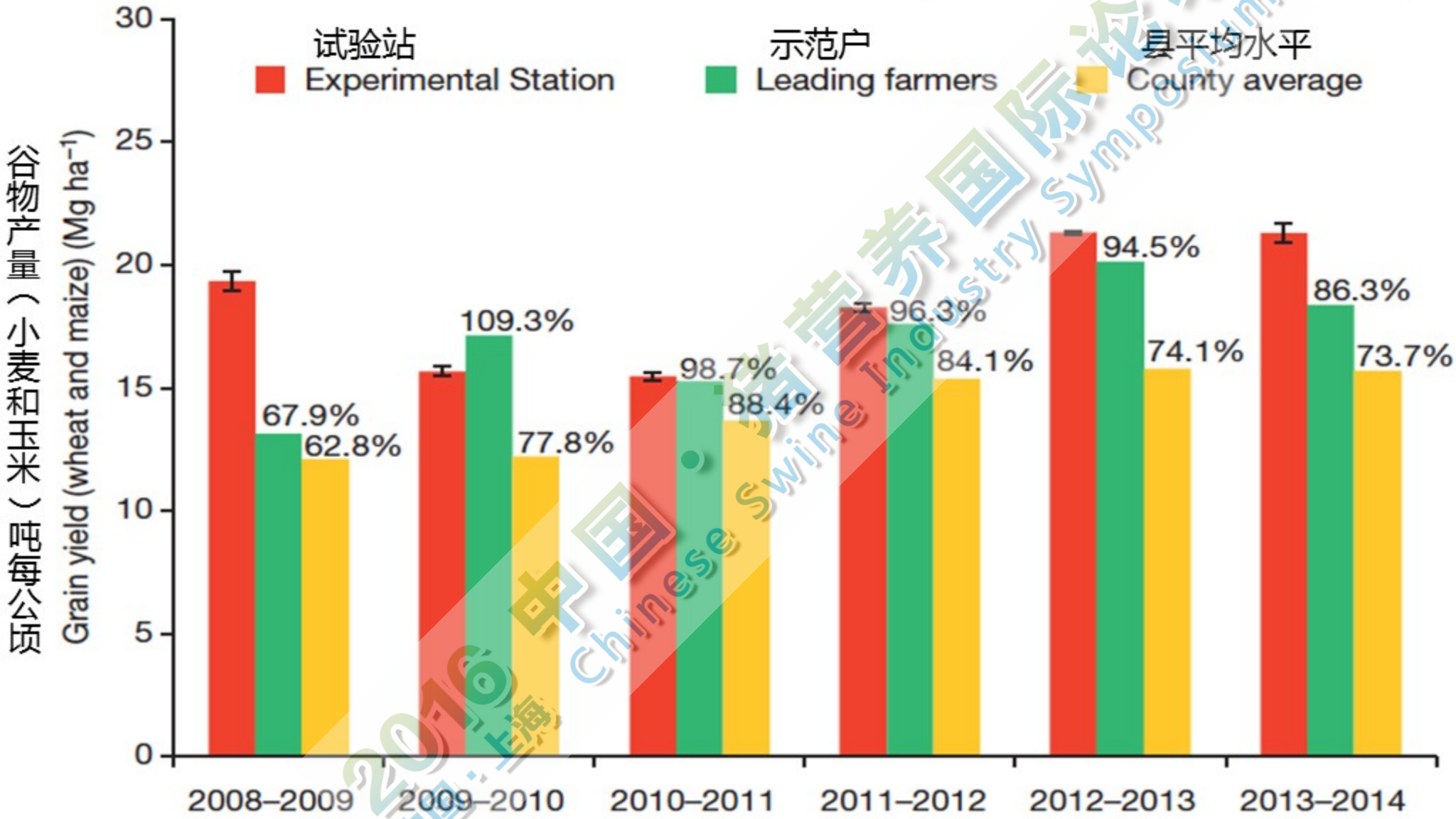
衢州市（2009-2014）：Quzhou County (2009 – 2014):

- 制定了克服产量限制的10项建议
  Developed 10 recommendations to overcome limited yields
- 签约示范户（n=45, 2009年）
  Engaged leading farmers* (n=45 in 2009)
- 教育推广计划:Extension education programs:
  - 现场演示，农业学校，产量竞争
    Field demonstrations, farming schools, yield contests
  - 海报，定制挂历
    Posters, customized calendars
  - 现场咨询，面对面沟通，社会文化联系
    On-site advice, in-person communication, social-cultural bonding

*示范户：具有良好养猪技术和新观念的人
Leading farmers: good farming skills and open to new ideas

AGRICULTURAL RESEARCH

小麦和玉米产量（2008-2009年开始SBT）
Combined Wheat & Maize Yields (SBT started 2008-2009)



*Weifeng Zhang, et. al., (29 September 2016) *Nature* 537: 671

扩展数据表8：2001 - 2014年衢州市统计

Extended Data Table 8 | Statistics for Quzhou County during 2001–2014

农民人均收入　　总农业产值

Year 年	Grain production (1,000 Mg) 谷物产量	Irrigation area (1,000 ha) 灌溉面积	Total power of agricultural machinery (10,000 kW) 农业机械功率	Fertilizer consumption (1,000 Mg) 化肥消耗	Total population (1,000) 总人口	Rural per capita agriculture income ($)	Total agricultural output value (Million $)
2001	294	39	71	37	400	539	126
2002	287	40	72	39	398	547	127
2003	257	40	75	41	404	539	118
2004	271	40	82	41	410	602	136
2005	287	40	83	43	413	673	149
2006	282	41	85	43	420	738	164
2007	305	41	85	43	423	860	190
2008	303	41	86	44	433	944	200
2009	314	41	87	46	450	1,003	218
2010	326	41	88	47	450	1,119	278
2011	408	41	90	47	460	1,177	299
2012	432	42	93	48	469	1,359	322
2013	428	41	90	49	483	1,534	374
2014	414	42	98	50	499	1,694	360

增加2倍

3X increase

Data from ref. 26. Currency exchange rate in 2012: 1 US Dollar ($) = 6.312 RMB Yuan (¥).

数据参考2012年货币汇率：1美元=6.312人民币

*Weifeng Zhang, et. al., (29 September 2016) *Nature* 537: 671

STB效率总结:
Summary of STB Efficiency:

STB组与邻村或对照村的养殖者相比：

Compared to neighboring or control villages, farmers from STB:

1) 更好的农业知识 Better agronomic knowledge
   -- 35.2%的人可以计算作物营养需求（相对10.9%）
   --35.2% can calculate crop nutrient requirements (versus 10.9%)
2) STB的建议采纳更高（53.5%对应31.4%）
   Higher adoption of STB recommendations (53.5% versus 31.4%)
3) 小麦和玉米的产量更大（高5.5-8.5%）
   Greater yields of wheat & maize (5.5 - 8.5% higher)
4) 营养和水利用效率更高（效率高12.5 - 47.0%）
   Greater nutrient and water-use efficiencies (12.5 - 47.0% more efficient)
5) 经济回报更高（2.9-47.0%）
   Greater economic returns (2.9 - 47.0%)

AGRICULTURAL RESEARCH

STB效率总结:
Summary of STB Efficiency:

STB平台将上-下和下-上两种方法结合起来：
STB platform combined top-down approaches with bottom-up approaches to:

1）允许大学、政府和企业共同努力，避免与资本资源，利润分享和知识产权相关的问题
Allow university, government, and industry to work together to avoid issues associated with capital resources, profit-sharing, and intellectual property

2）确定促成产量差距的因素和解决方案
Identify factors & solutions that contribute to yield gaps

3）鼓励农民，公众和私营部门改善种植、养殖方法
Engage farmers, public, and private sector to improve farming practices

4）培养学生为农业服务
Train students for careers in agricultural services

AGRICULTURAL RESEARCH

中美之间合作实例：
Examples: Synergism Between China & America:

- 中国文化和农业教育学习 Chinese Culture & Ag Education Study Abroad Programs
  - 内布拉斯加学生参加NWAFU学习中国文化（5-6月）
    Nebraska students attend NWAFU to learn Chinese culture (May-June)
- NWAFU本科生交流研究 NWAFU Research Exchange for Undergraduate Students
  - 20名NWAFU学生/年在内布拉斯加进行研究
    20 students/year NWAFU students conduct research at Nebraska
- 3 + 1食品科学计划 3+1 Food Science Program
  - 双学位项目（ NWAFU + UNL ）每年50名NWAFU学生：3年在NWAFU +1年在Nebraska
    Dual degree program (NWAFU + UNL) 50 NWAFU students/year: 3 years at NWAFU + 1 year at Nebraska
- 内布拉斯加州扩展农场项目 Nebraska Extension Farm Project
  - 陕西农业开发区作物试验场使用内布拉斯加州建造的农业设备，提高产能
    Crop testing site in Shaanxi Agricultural Development Zone with Nebraska-built farm equipment to increase production capacity
- UNL - 华中农业大学生命科学系合作 UNL-HuaZhong Agricultural University Life Sciences Partnership
  - 交换研究生，华中农大召开的植物学会议 Exchange graduate students, conference on Plant Biology at HZAU

Questions?

Deb Hamernik
DHamernik2@UNL.edu