

# 中美养猪技术合作前景

## Synergism Between Chinese & American Swine Industry

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Chinese Swine Industry Symposium | ASAS China Meeting

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# 21世纪的巨大挑战

## Grand Challenges for 21<sup>st</sup> 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

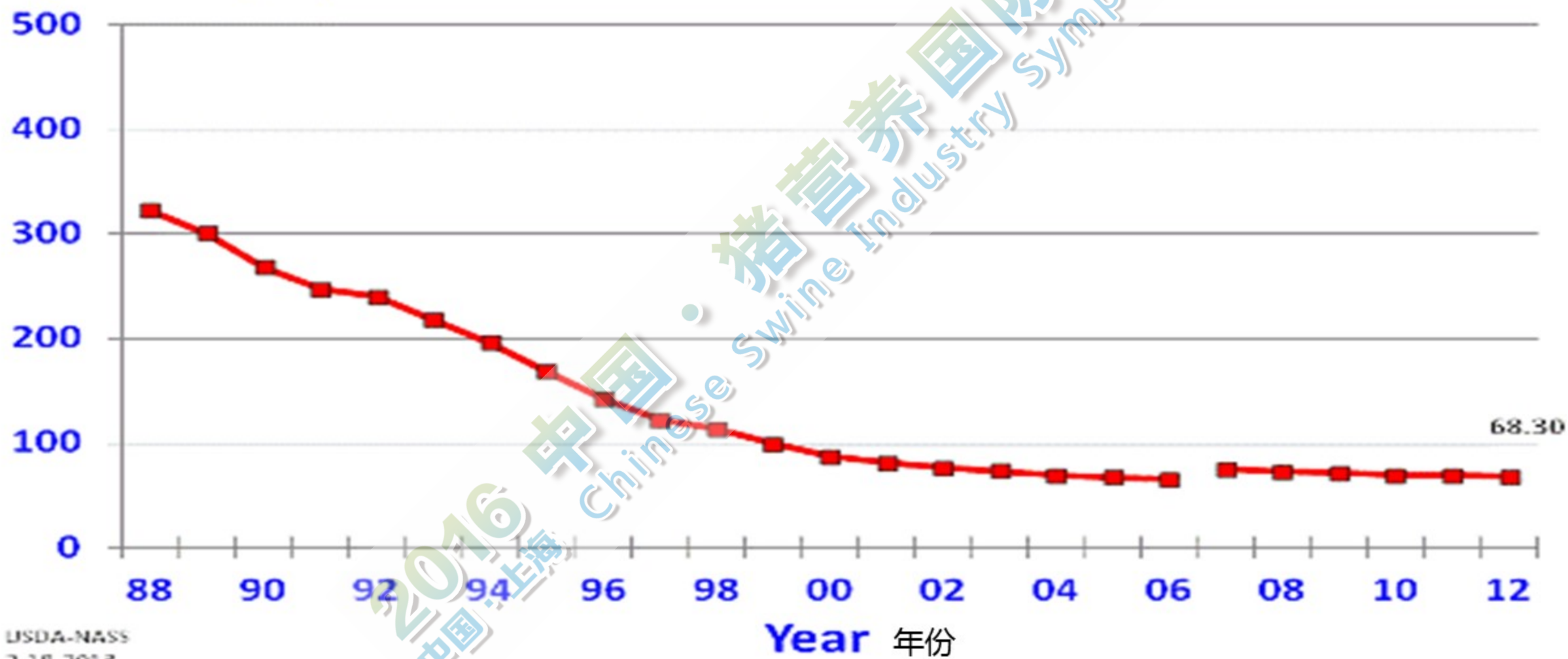
2016  
中国·上海  
Chinese Swine Symposium

# Number of Hog Operations

United States

美国养猪企业数量

企业数 (000)  
Operations (000)



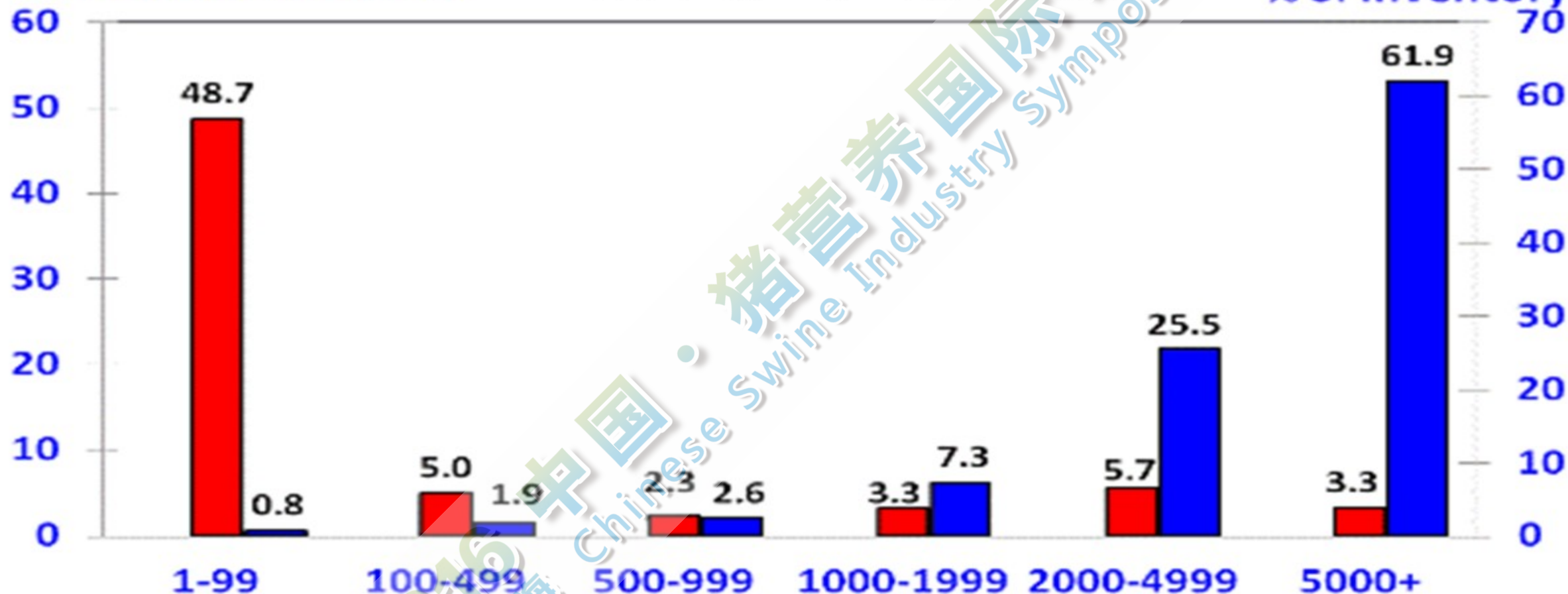
# U.S. Hog Operations

## Number of Operations and Percent of Inventory, 2012

# of Operations (000)

2012年美国生猪企业数量及存栏肉猪占比

% of Inventory



Operations

Inventory

生猪企业数量

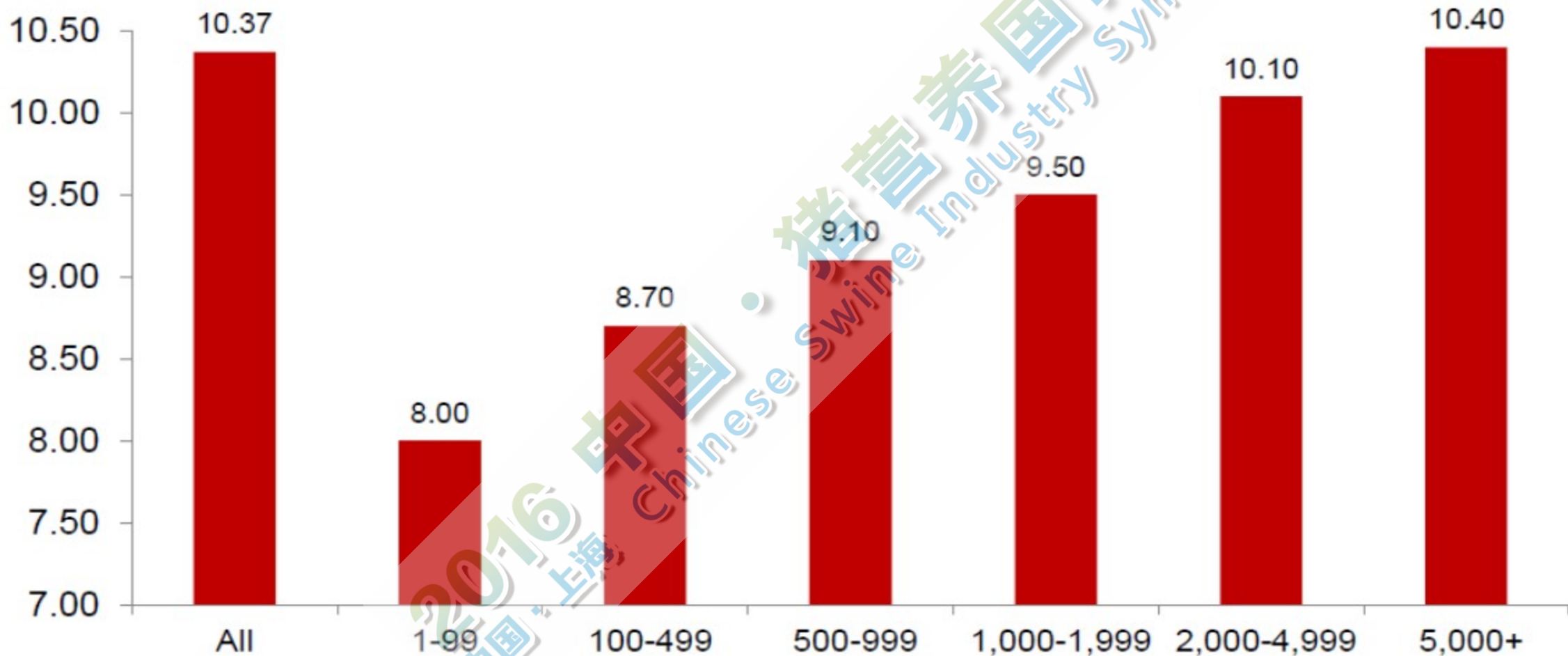
存栏肉猪

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

窝带仔数

Number head



# 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



camco

## 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 22<sup>nd</sup>, 2012

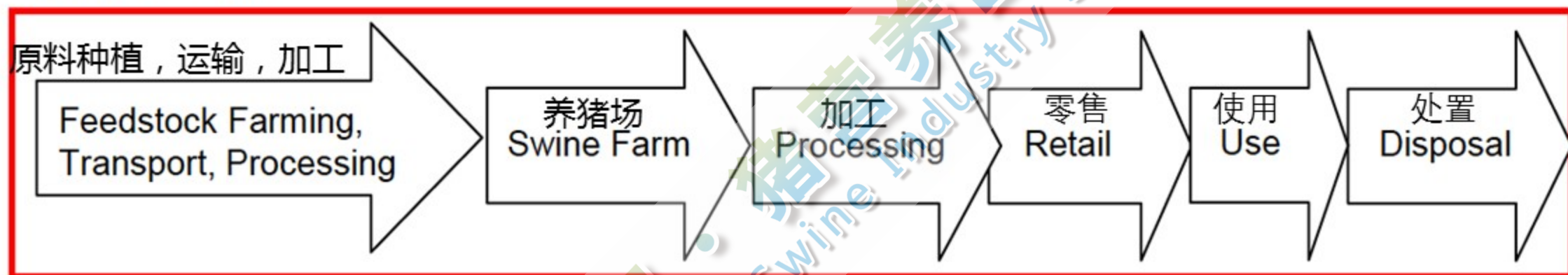
Lead Authors: Garth Boyd, Ph.D., PAS, Sr. Vice President Agricultural Services, Camco  
Roger Cady, Ph.D, Sr. Technical Advisor & Sustainability Lead, Elanco



# 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

# 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



# 1959 – 2009年的生命周期分析 (LCA)

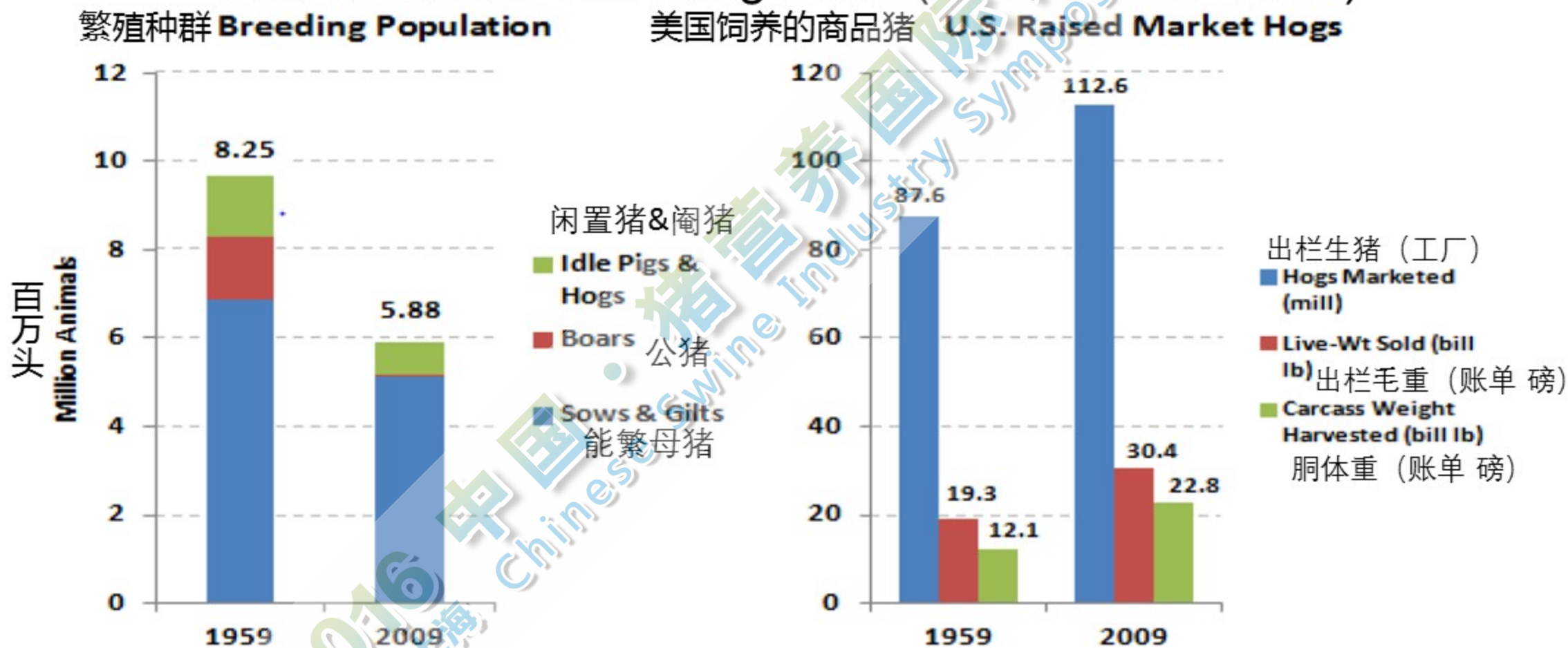
## Life Cycle Analysis (LCA) from 1959 -- 2009

### 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<sub>2</sub> , CH<sub>4</sub> , N<sub>2</sub>O测量  
Global warming potential: measured by CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O

# 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

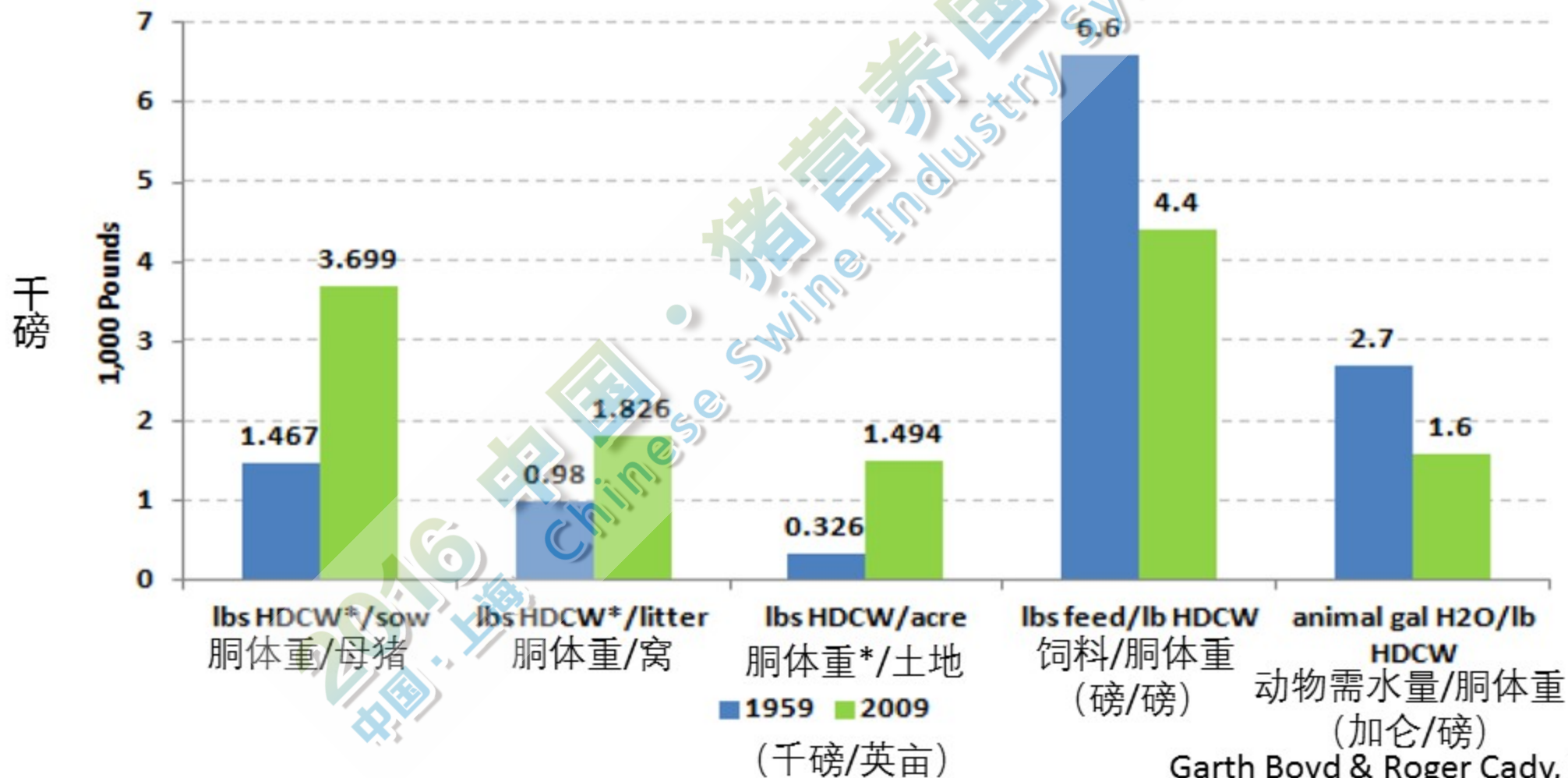
Garth Boyd & Roger Cady, CAMCO, 2012

# 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



2009年，只需要**5**头猪就能生产1,000磅胴体重量，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.

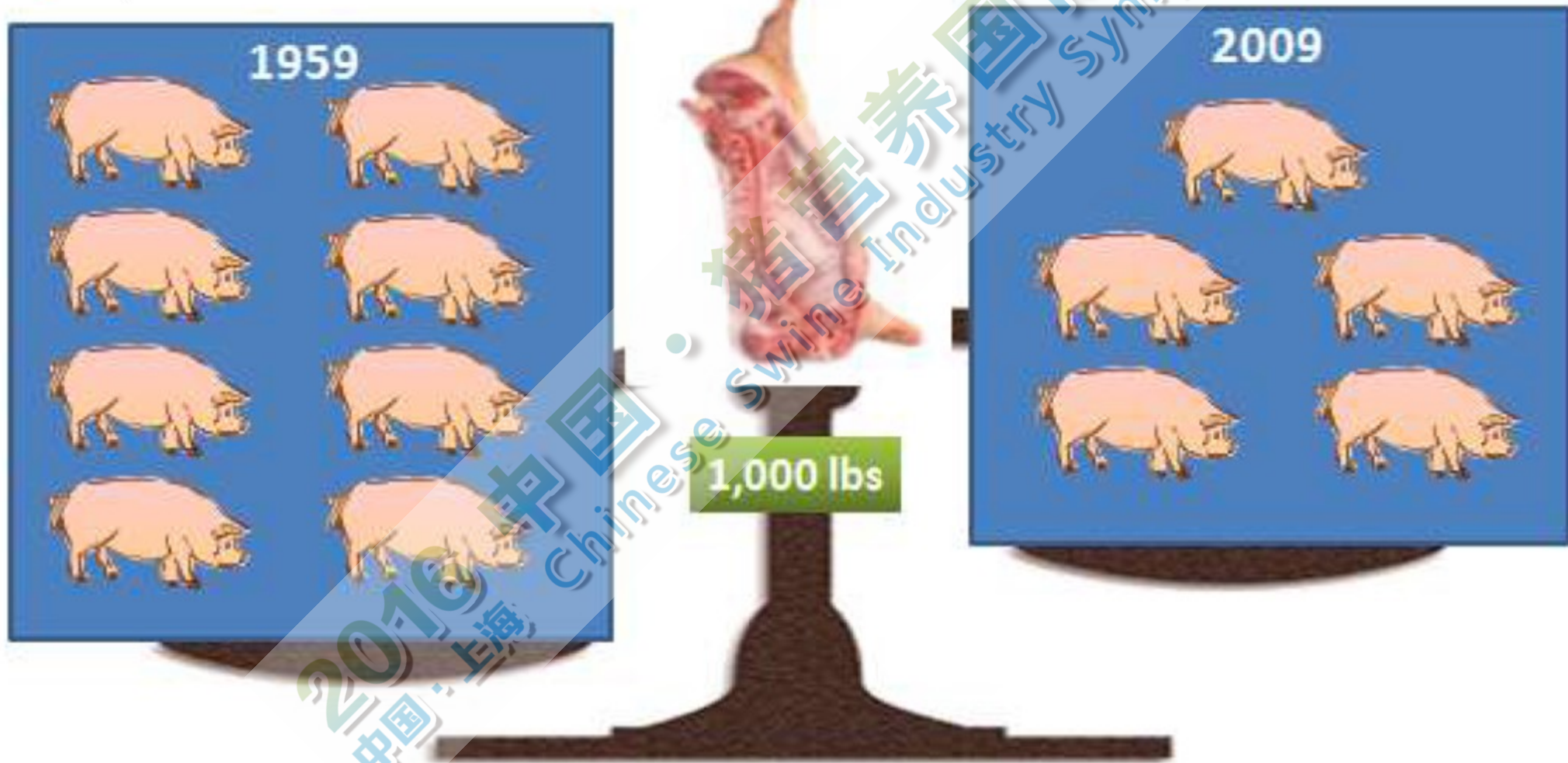
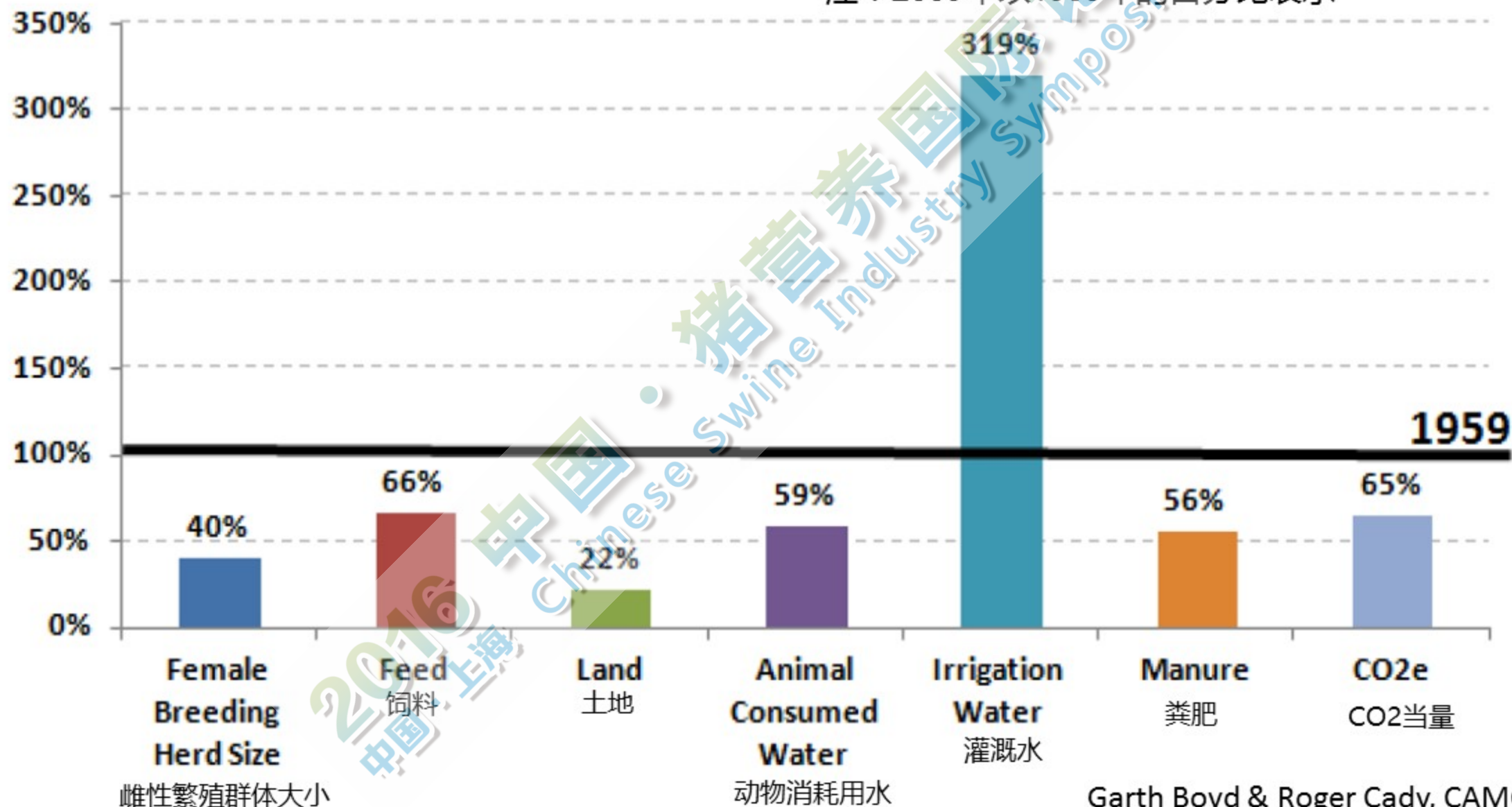


Figure 1: Comparison of Key U.S. Swine Industry Environmental and Resource Use Measures (per 1,000 lbs. of hot dressed carcass weight produced)

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)

NOTE: 2009 expressed as a percent of 1959.

注：2009年以1959年的百分比表示



# 公众接受度？ Socially Acceptable?



**Go meatless on Mondays.**  
**Take 274 million cars off the road.**

If, by 2050, everyone skipped meat just one day a week, it would be the equivalent of cutting a year's worth of GHG emissions from 274 million passenger cars.

Meatless Monday #LessMeatLessHeat

Michael E. Sommer, L. van Haren, D. R. van Eem, M. G. Edrington, S. S. Hasan, P. 2016. Climate benefits of changing diet. Climate Change 16(1): 41-52. United States Environmental Protection Agency. United States Environmental Calculator.



**You Can't Be a MEAT-EATING Environmentalist**

**Meat production contributes to:**

- Leveling of 80% of Amazonian rain forest
- Wasting of 15 trillion gallons of water per year
- Producing 130 times as much waste as that of the entire U.S. population
- Killing of 59 billion animals every year



**PROCESSED MEAT CAUSES CANCER**

**MEAT = GLOBAL WARMING**

**a well-fed world** [www.AFWF.org](http://www.AFWF.org)



# 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
  - $\beta$ -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

**APPLEGATE**  
CHANGING THE MEAT WE EAT™

**NATURAL**  
UNCURED BEEF & PORK HOT DOG

NOT PRESERVED • KEEP REFRIGERATED BELOW 40°F AT ALL TIMES

NO NITRATES OR NITRITES ADDED EXCEPT FOR THOSE NATURALLY OCCURRING IN SEA SALT & CELERY POWDER

**NO ANTIBIOTICS USED™ • HUMANELY RAISED™™**

VEGETARIAN GRAIN-FED DIET • GLUTEN & CASEIN FREE • NO FILLERS

**Nutrition Facts**

Amount Per Serving	1 Hot Dog
% Daily Value*	
Total Fat	15g
Total Protein	12g
Total Sodium	10g
Total Sugar	1g
Total Fat	15g
Total Protein	12g
Total Sodium	10g
Total Sugar	1g

NET WT. 12 OZ. (340g)

**global animal PARTNERSHIP**

**Step 1**

**NO CAGES, NO CRATES, NO CROWDING**

Certified to Global Animal Partnership Standards by Earth Claims LLC

[www.globalanimalpartnership.org](http://www.globalanimalpartnership.org)

THE FINEST TASTING MEAT IN THE WORLD

**NIMAN RANCH**  
RAISED WITH CARE

**APPLEWOOD SMOKED UNCURED PETITE HAM**

NOT PRESERVED • KEEP REFRIGERATED BELOW 40°F AT ALL TIMES

No Nitrates or Nitrites Added  
Except for Naturally Occurring Nitrates in Celery Powder.

Pork Raised with:  
**No Antibiotics - Ever**  
**No Added Hormones - Ever\***  
**All Vegetarian Feeds**

FULLY COOKED

\*Federal regulations prohibit the use of hormones in pork.

**WE'RE PROUD TO CARRY AN EXCLUSIVE SELECTION OF PORK RAISED ON NON-GMO PROJECT VERIFIED FEED FROM AMERICAN HOMESTEAD NATURAL PORK.**

**NON-GMO PROJECT VERIFIED**

**EXCLUSIVE**

**2**

[nongmoproject.org](http://nongmoproject.org)



**WHAT IS FOOD WITH INTEGRITY?**

**FOOD WITH INTEGRITY IS OUR COMMITMENT TO FINDING THE VERY BEST INGREDIENTS RAISED WITH RESPECT FOR THE ANIMALS, THE ENVIRONMENT AND THE FARMERS.**

**GREAT TASTE WITHOUT THE WORRY™**

MADE WITH **100% All-Natural\* Pork** RAISED WITH:

- ✓ NO ANTIBIOTICS-EVER
- ✓ NO ADDED HORMONES-EVER\*\*
- ✓ NO ANIMAL BY-PRODUCTS
- ✓ GLUTEN-FREE

**PRAIRIE GROVE farms**

**Pulled Pork with Barbecue Sauce**

FULLY COOKED • KEEP REFRIGERATED • NET WT 14 OZ

**Sugar Mountain Farm**

**Wholesome Food for your family farm family's table**

**Crate Free Grass & Dairy Fed Heritage Breed Pigs Humanely Raised Free-Ranging Outdoors**



It means serving the very best sustainably raised food possible with an eye to great taste, great nutrition and great value.

It means that we support and sustain family farmers who respect the land and the animals in their care.

It means that whenever possible we use meat from animals raised without the use of antibiotics or added hormones.

And it means that we source organic and local produce when practical. And that we use dairy from cows raised without the use of synthetic hormones.

Food With Integrity is a journey that started more than a decade ago and one that will never end.

**CHIPOTLE**

PROUDLY RAISED IN THE USA

**ALL NATURAL**

**Smithfield FRESH PORK**

- ✓ USDA Process Verified†
- ✓ No Added Steroids or Hormones†
- ✓ No Artificial Ingredients\*

PRODUCT OF USA

# 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

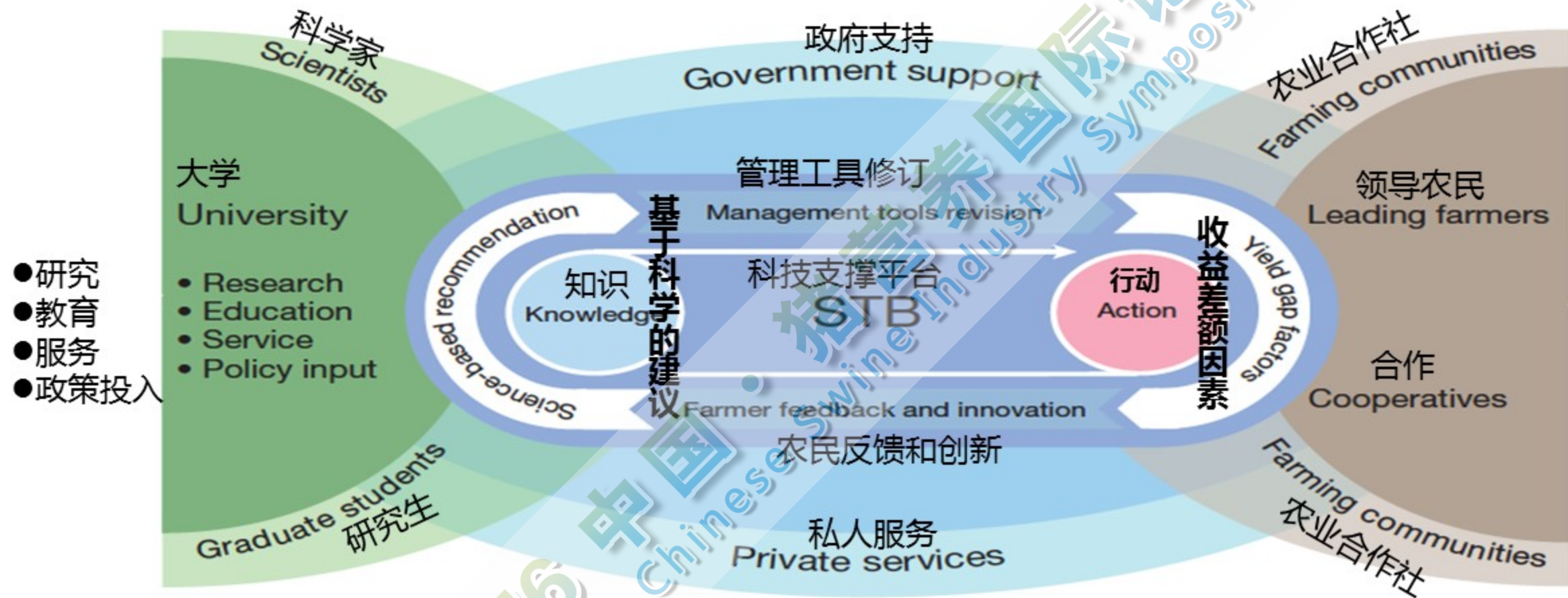
Encourage more Extension Educators to transfer technology to producers

- 招募和培养学生从事农业工作

Recruit and train students for careers in agriculture

# 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\*



**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

# 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

# 影响产量差距的主要因素

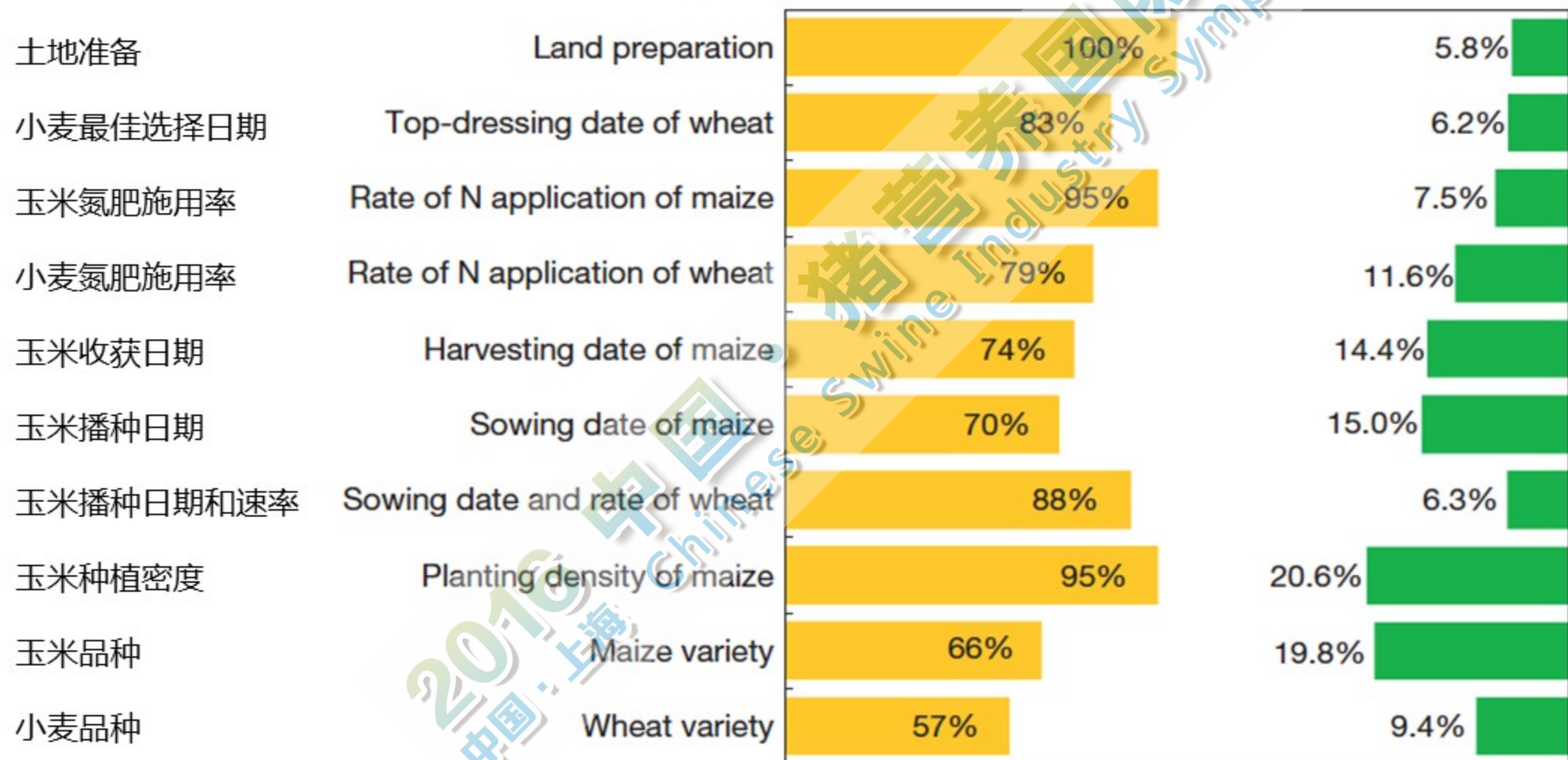
## Major Factors Contributing to Yield Gaps

不采用推荐做法的农民百分比

Percentage of farmers not using recommend practice

收益差额

Yield gap



# 科学技术支撑平台

## Science and Technology Backyard (STB)

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

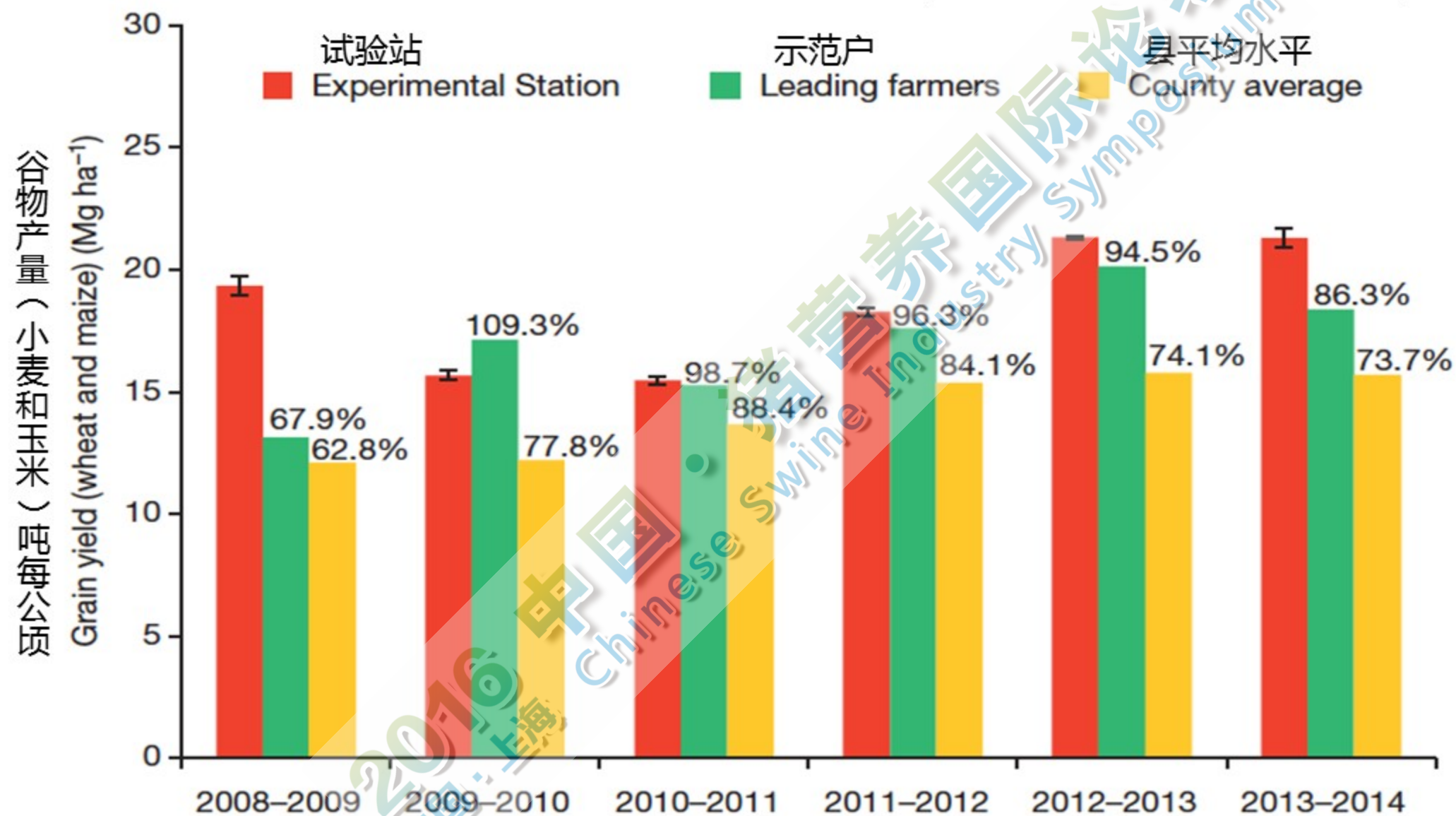
- 制定了克服产量限制的10项建议  
Developed 10 recommendations to overcome limited yields
- 签约示范户 ( n=45, 2009年 )  
Engaged leading farmers\* (n=45 in 2009)
- 教育推广计划:Extension education programs:
  - 现场演示, 农业学校, 产量竞争  
Field demonstrations, farming schools, yield contests
  - 海报, 定制挂历  
Posters, customized calendars
  - 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

# 小麦和玉米产量 ( 2008-2009年开始SBT )

## Combined Wheat & Maize Yields (SBT started 2008-2009)





# 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

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	农民人均收入	总农业产值
						Rural per capita agriculture income (\$) 农村人均农业收入 (\$)	Total agricultural output value (Million \$) 总农业产值 (百万美元)
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户者相比：

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%)



# 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

# 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NWAUFU学习中国文化（5-6月）  
Nebraska students attend NWAUFU to learn Chinese culture (May-June)
- **NWAUFU本科生交流研究 NWAUFU Research Exchange for Undergraduate Students**
  - 20名NWAUFU学生/年在内布拉斯加进行研究  
20 students/year NWAUFU students conduct research at Nebraska
- **3 + 1食品科学计划 3+1 Food Science Program**
  - 双学位项目（NWAUFU + UNL）每年50名NWAUFU学生：3年在NWAUFU + 1年在Nebraska  
Dual degree program (NWAUFU + UNL) 50 NWAUFU students/year: 3 years at NWAUFU + 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?

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