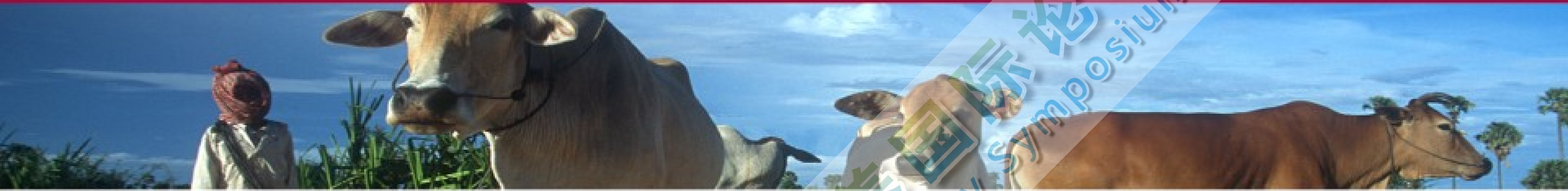

用于可持续猪饲料和猪肉生产的新型蛋白和能量原料

New protein and energy feedstuffs for sustainable swine feed and pork production

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主要内容 Outline of presentation

1. 研究背景 The context

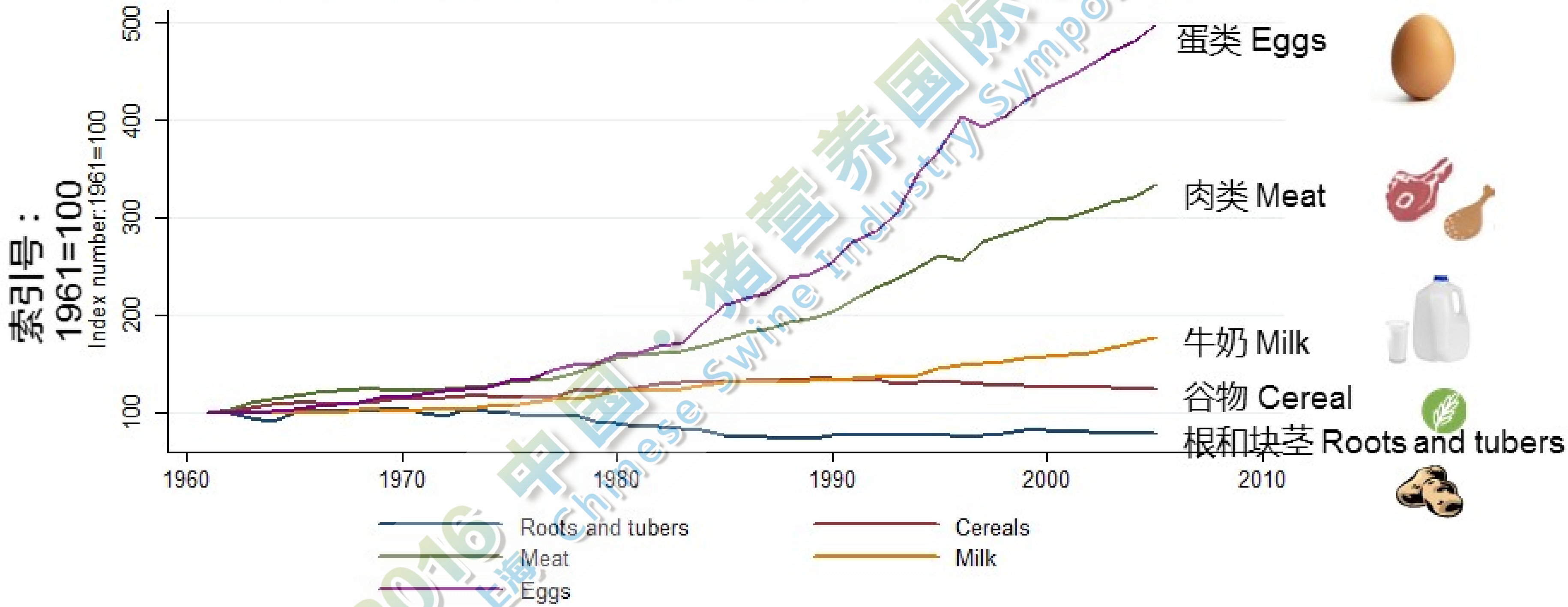
2. 新型饲料 Novel feeds

- 源于生物乙醇生产的副产品 Co-products from bioethanol production
- 源于常规原料生产生物柴油的副产品 Co-products from biodiesel production from conventional resources
- 源于有毒油籽植物生产生物柴油的副产品 Co-products from biodiesel production from toxic oilseed plants
- 昆虫粉 Insect meals
- 海藻类 Seaweeds
- 分离蛋白、树叶粉和单细胞蛋白 Protein isolate, leaf meals and single cell proteins
- 食物残渣作为饲料 Food waste as feed
- 通过酶和处理的第二代生物燃料的未来饲料Feeds through enzymes and treatments for second generation biofuel

3. 结论 Conclusions

发展中国家消费快速增长

Consumption growing rapidly in developing countries



发展中国家主要食品的人均消费—Kg/人/年（索引号：1961=100）

Per caput consumption of major food items in developing countries – kg per caput per year (index numbers 1961=100)

全球动物生产 Global animal production: 2005-2050

+121%

+65%

+92%

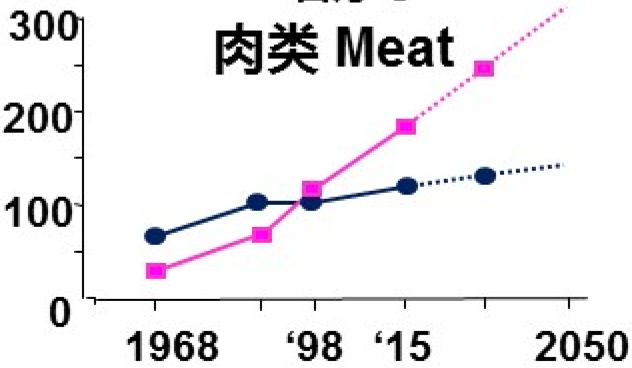
+62%

+66%

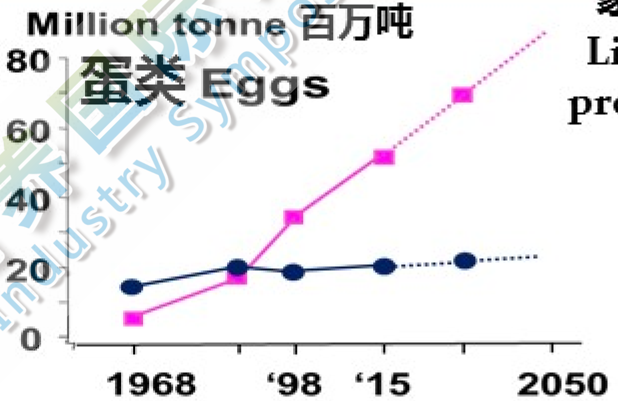
+43%

Source: Alexandratos & Bruinsma, 2012

研究背景—单胃动物产业 The context – monogasric industry



家畜生产 Livestock production



目前，工业化畜禽生产：

全球55%的猪肉和71%的禽肉生产

在工业集约化程度高的地区，78%的饲料谷物饲喂给猪和家禽。

Currently, industrial swine & poultry production:

55% and 71% of global pork & poultry production

78% of feed grains use for pigs and poultry in the regions where industrial intensive system dominate

对动物饲料的巨大需求 Huge demand for animal feed

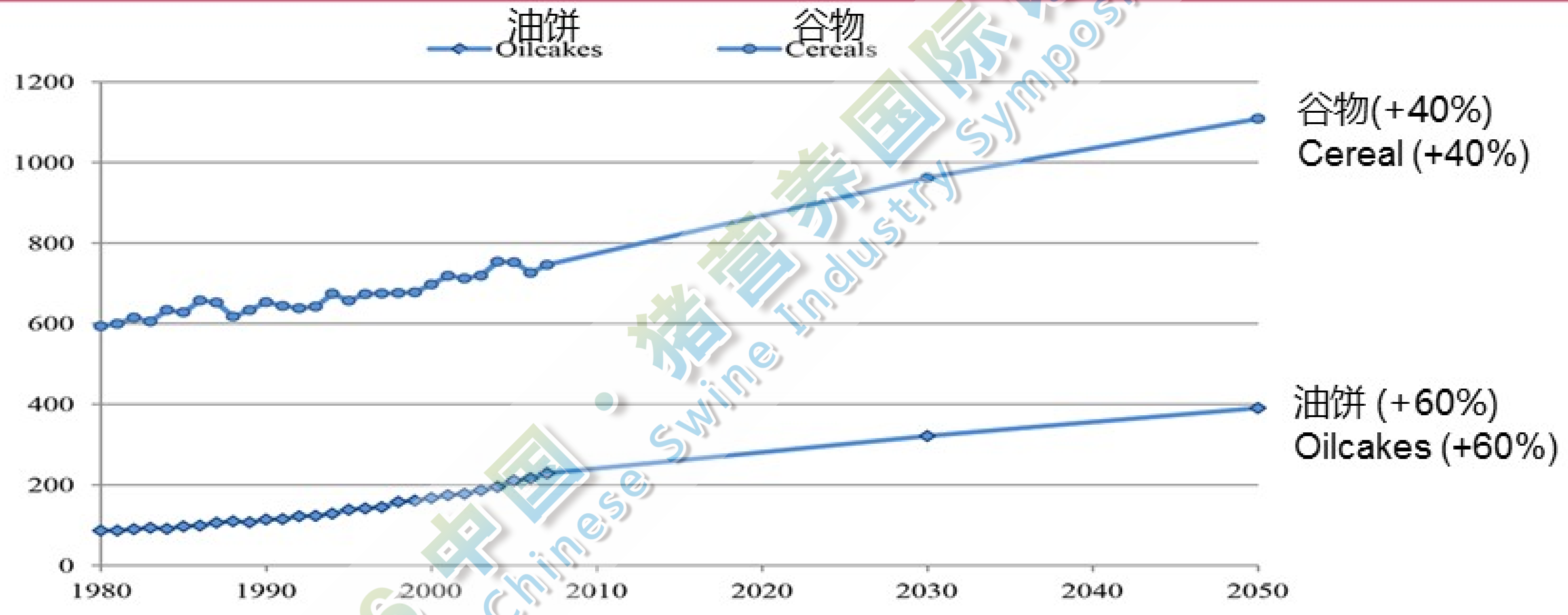
2050年

额外生产的4.43亿吨玉米
An additional 443 million tonnes of maize production

60%用于动物饲料（23%用于生物燃料）
60% for animal feeds (23% for biofuels)

大豆生产将需增至约3.9亿吨（目前水平的80%）
Soybean production would need to increase by nearly to 390million tonnes (80% of the present level)

油饼和谷物用作饲料 Oilcakes and cereal use as feed



Historical data 1980-2007 from FAOSTAT; Projections: World feed use of Cereals: sum of the country feed projections; World projections of oilcakes feed use: world oilcakes production derived as joint products from the summation of the country production projection of oilcrops.

来自FAOSTAT的1980-2007年的历年数据：全球饲用谷物预测：全国饲料总和预测；全球饲用油饼预测：全球油饼产量来自于各种全国油料作物油饼产品产量预测的总和。

食品-饲料竞争 Food-feed competition

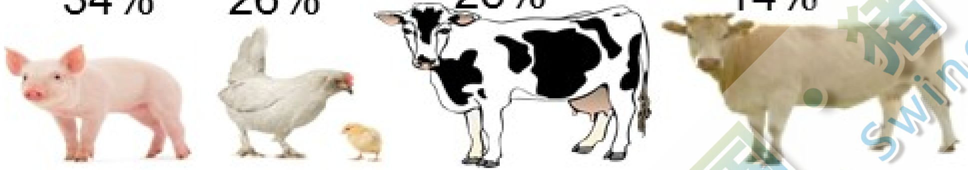
2012-2013:7.95亿吨谷物（ 1/3谷物总量 ）-动物饲料

2012–2013: 795 million tonnes cereals (1/3 total cereal) - animal feed

占用于畜牧业中谷物的总量

Of the total cereal use in livestock sector

34%　26%　26%　14%



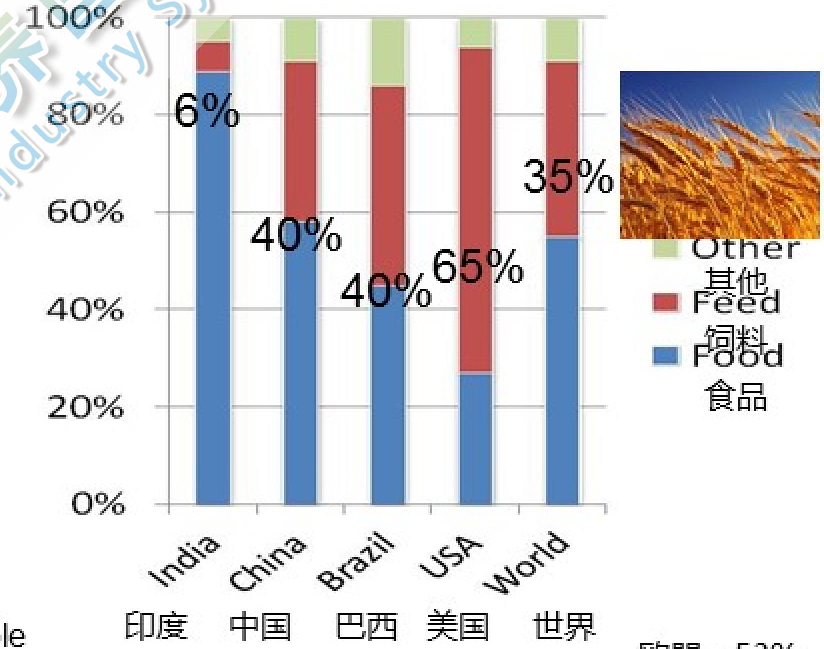
谷物能量用于肉品生产Cereal energy used for meat production,

如果直接喂养 if fed directly

满足　meet

35亿人每年需要的卡路里 Annual calorie need of 3.5 billion people

Nellemann et al. (2009), UNEP



欧盟：53%

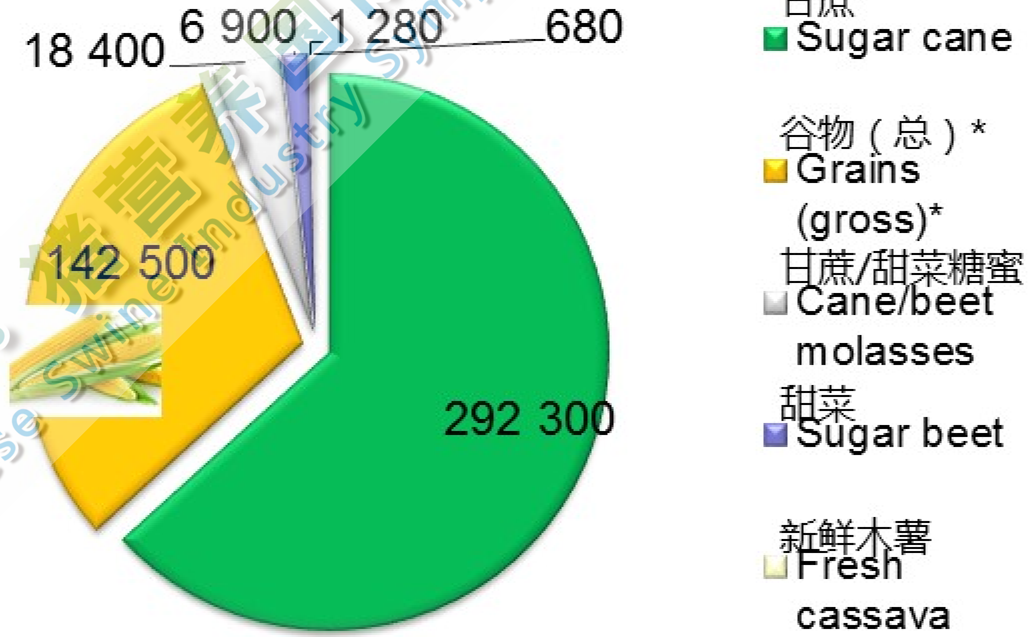
EU: 53%

燃料-饲料竞争 Fuel-feed competition

至2050生物燃料持续快速扩张
A continued rapid expansion of biofuel up to 2050

营养不良的学龄前儿童
Undernourished pre-school children

非洲和南非比其他地方高300和170万
Africa and South Asia being 3 and 1.7 million higher than otherwise *FAO (2009)*



X 1000 tonnes *FAO (2013)*

中国是饲料的需求、贸易和价格的主要驱动力
China the main driver of feed demand, trade and price

动物产品概览 Animal product outlook

- 全球猪肉的50%（最大生产国和消费国）50% of the world's pork (largest producer and consumer)
- 全球禽肉的20%（第二大生产国）20% of the world's poultry (second largest producer)
- 全球牛肉的10% 10% of the world's beef
- 全球第四大牛奶生产国 Fourth largest milk producer of the world

饲料概览 Feed outlook

- 世界最大的大豆进口国（约6千万吨/年） World's largest soybean importer (*ca* 60 million tonne/annum)
- 巨大的酒糟蛋白（约5百万吨/年），大麦、小麦和高粱的进口国 Huge importer of DDGS (5 million tonne/annum), barley, wheat & sorghum
- 2011年：玉米总产量的70%用于饲料 In 2011: used *ca* 70% of its total corn production for feed.
- 全球玉米贸易总量比中国全部饲用玉米需求量少得多 Total global trade in corn is much less than China's entire corn feed demand

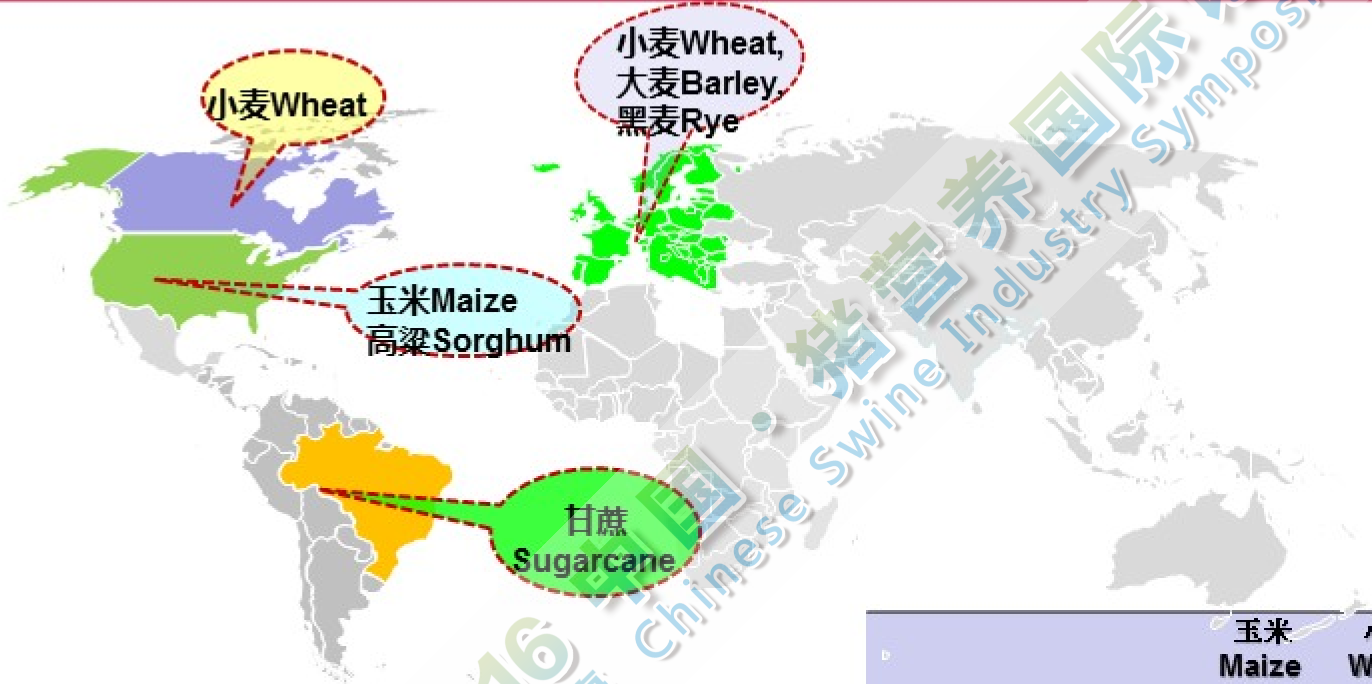
食品不再是饲料资源
Food-not Feed Resources

生物乙醇产量：5倍增长

Bioethanol production: 5-fold increase

生物燃料
Biofuel

生物乙醇由何而来 From what bioethanol is being produced?



作物数量
Number of plants

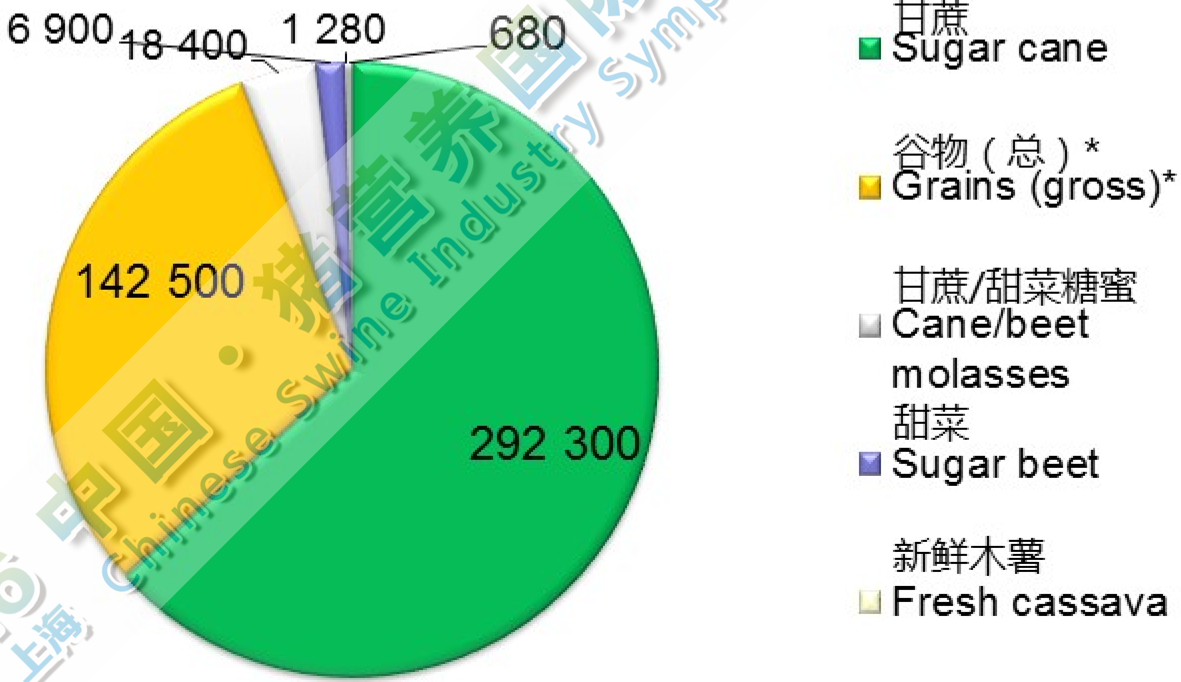
	玉米 Maize	小麦 Wheat	其他谷物 Other Grain	合计 Total
美国USA	186	0	9	195
欧盟EU	9	9	8	26
加拿大CANADA	8	5	3	16

2010世界乙醇副产品作为饲料的使用量（千吨）

2010 world feedstock usage for fuel ethanol (thousand tonne)

大约1/3谷物用于生产富含蛋白质的乙醇副产品

Approximately 1/3 of grain used for fuel ethanol is protein-rich co-products

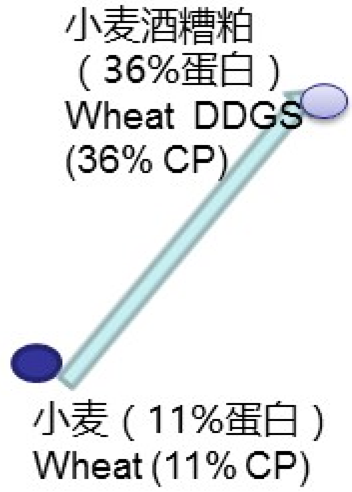


Source: F.O. Licht, 2011

玉米乙醇副产品的特性 Properties of corn ethanol co-products

动物饲料/其他副产品 Animal feed/other co-products	粗蛋白副产品 Crude protein (%)	脂肪 Fat (%)
玉米 Corn	8.3	3.9
豆粕 Soy bean meal	45-50	1.4
玉米酒糟粕 DDGS	30.8	11.2
脱脂酒糟粕 d-DGS[1]	34.0	2.7
高蛋白干酒糟 HP-DDG[2]	48.6	3.4
玉米蛋白饲料 Corn gluten feed	23.8	3.5
玉米胚芽 Corn germ	17.2	19.1

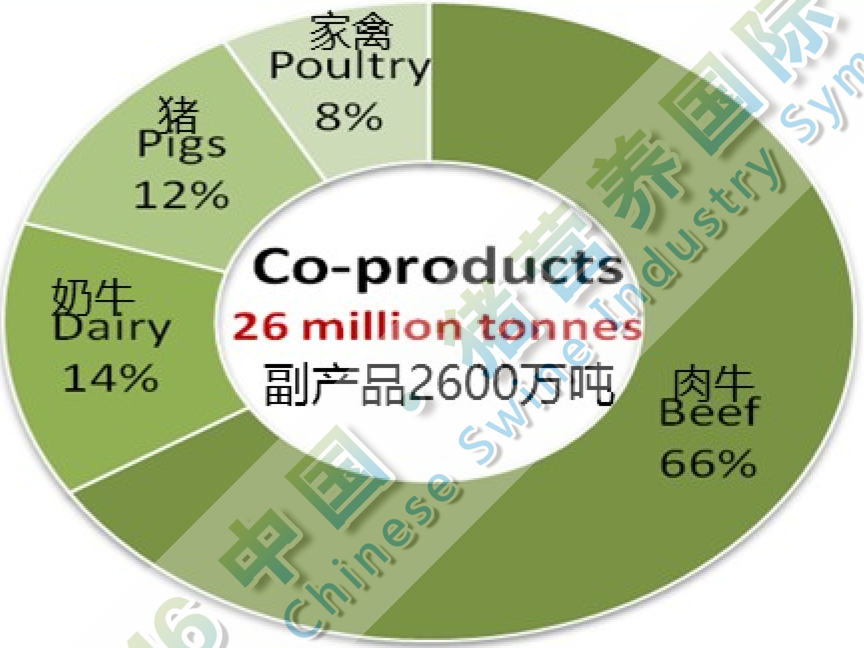
1脱脂酒糟粕 De-oiled DGS
2高蛋白干酒糟 High-protein dry distillers' grains



动物日粮中玉米酒糟粕正常添加水平：玉米酒糟粕中的限制性必需氨基酸是赖氨酸和色氨酸，小麦酒糟粕中的限制性必需氨基酸是赖氨酸和苏氨酸。

For normal inclusion levels of DDGS in animal diets, the limiting EAAs are *lysine and tryptophan for maize* DDGS, and *lysine and threonine for wheat* DDGS.

美国谷物酒糟的应用　Distillers grain use in the US



美国年产量
USA annual production

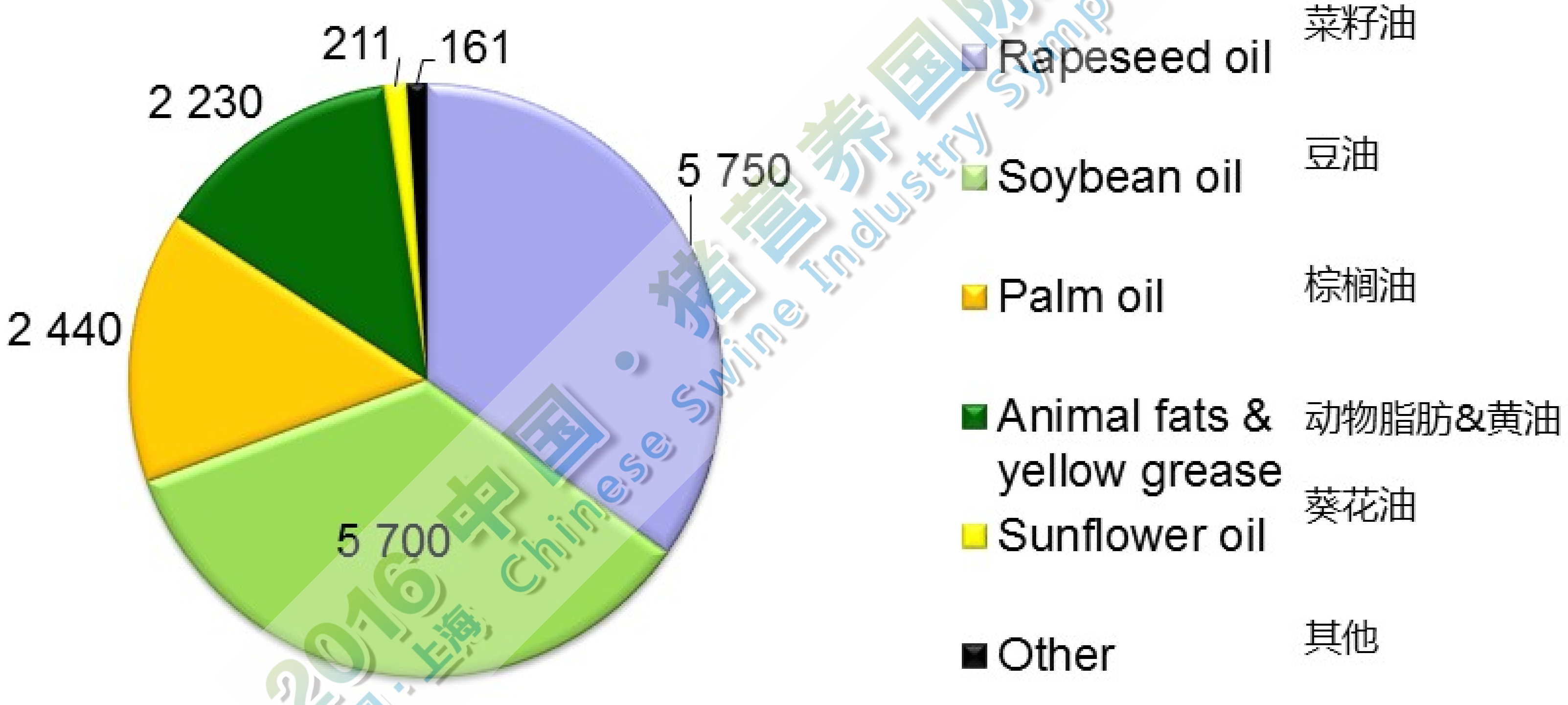
2000年前后几十年里典型生长猪日粮组成变化（%以饲料为基础）（美国）

Ingredient composition changes (% as-fed basis) in typical growing swine diets in the decades before and after 2000 (US)

配料 Ingredient	2000年前 Before 2000	目前玉米、豆粕和玉米酒糟粕的价格 At current maize, soybean meal and DDGS prices	
玉米 Maize	70	53	↓
豆粕 Soybean meal	25	11	
油籽粕 Canola meal	0	0	
玉米酒糟粕 DDGS	0	30	↑
精选白脂膏 Choice white grease	2	3	
其他配料、维生素、矿物质、氨基酸Other ingredients, vitamins, minerals, amino acids	3	3	
合计 Total	100	100	

Shurson et al. 2012

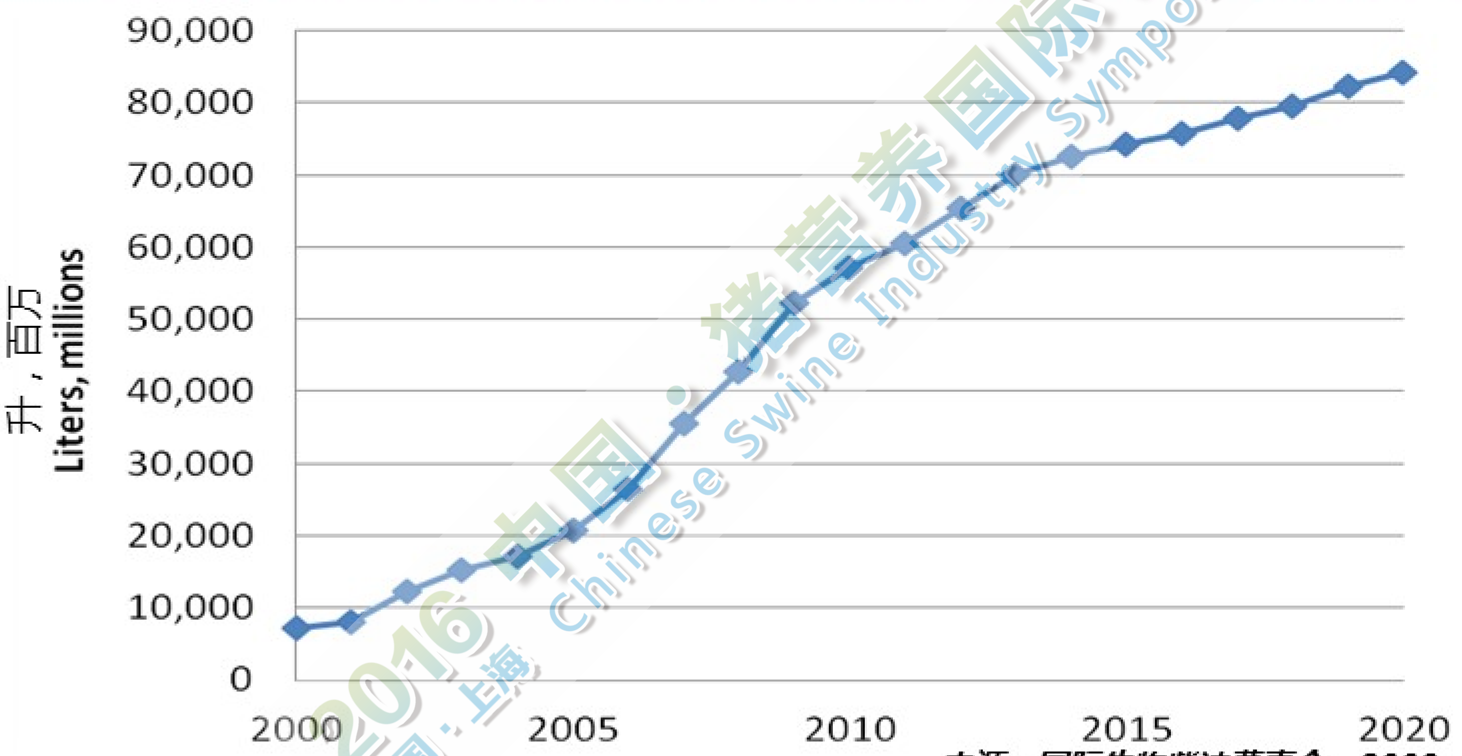
2010世界生物燃料副产品作为饲料的使用量（千吨）
2010 world feedstock usage for biodiesel (thousand tonne)



Source: F.O. Licht, 2011

生物柴油产量的增长和预期的全球膨胀

Growth and anticipated world expansion of biodiesel production

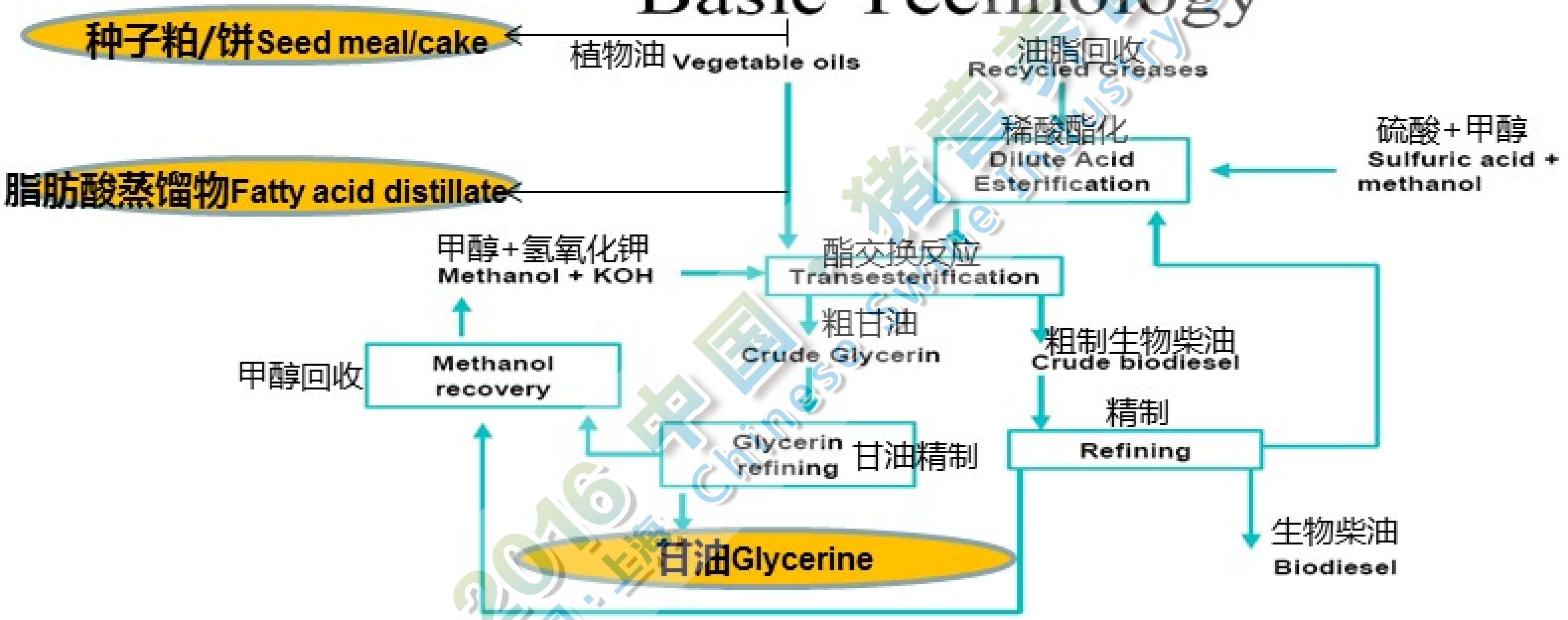


来源：国际生物柴油董事会，2008

SOURCE: National Biodiesel Board, 2008

生物柴油的一般生产工艺
General biodiesel production process

基础技术
Basic Technology



生物柴油副产品——甘油用于猪和鱼日粮中
Biodiesel co-products – Glycerol in pig & fish diets

对猪来说，粗甘油含有与玉米相似的能量
Crude glycerine contains similar energy to that of corn for pigs

- 母猪日粮 = 9% Sow diets = 9%
- 断奶仔猪 = 6% Weaners = 6%
- 育肥猪 = 15% Finishers =15%

脂肪酸蒸馏物 Fatty acids distillate

- 利用饱和及不饱和脂肪
  Utilize saturated as well as unsaturated fats
- 不饱和脂肪/油可导致体脂中沉积更多的不饱和脂肪酸
  Unsaturated fats/oils results in more unsaturated fatty acids in their body fat
- 使胴体脂肪更软，这会降低胴体品质
  Makes carcass fat softer and this reduces carcass quality

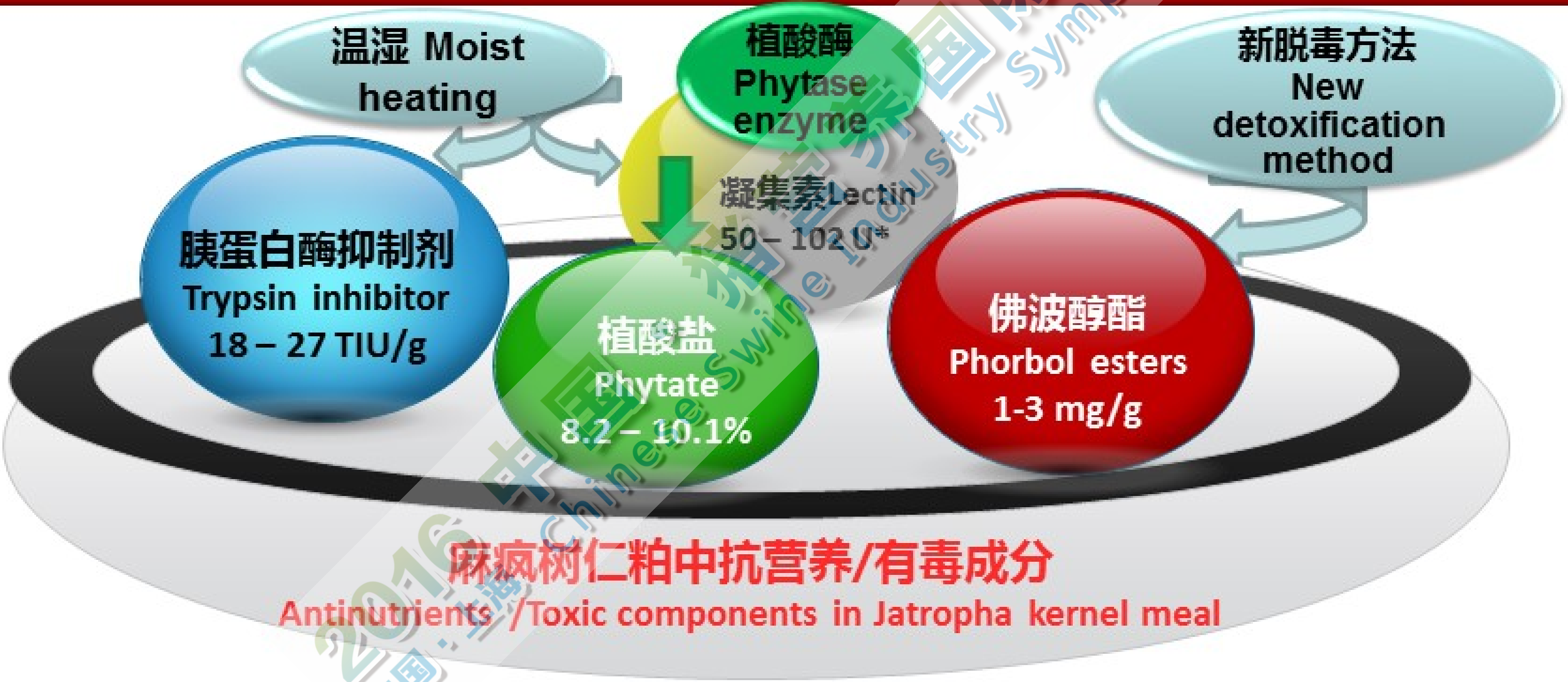
麻疯树仁粕 *Jatropha curcas* kernel meal

核仁粕 Kernel meal

核仁粕（58%蛋白，90%蛋白消化率和优质氨基酸组成）
Kernel meal (58 % protein of 90% digestibility & excellent amino acid composition)

麻疯树仁粕中抗营养和有毒因子

Antinutritional and toxic factors in Jatropha meal



U*: 1 mg of meal that produced haemagglutination per ml assay medium. (Source: Makkar and Becker, 2009)

组织病理学研究 Histopathological studies

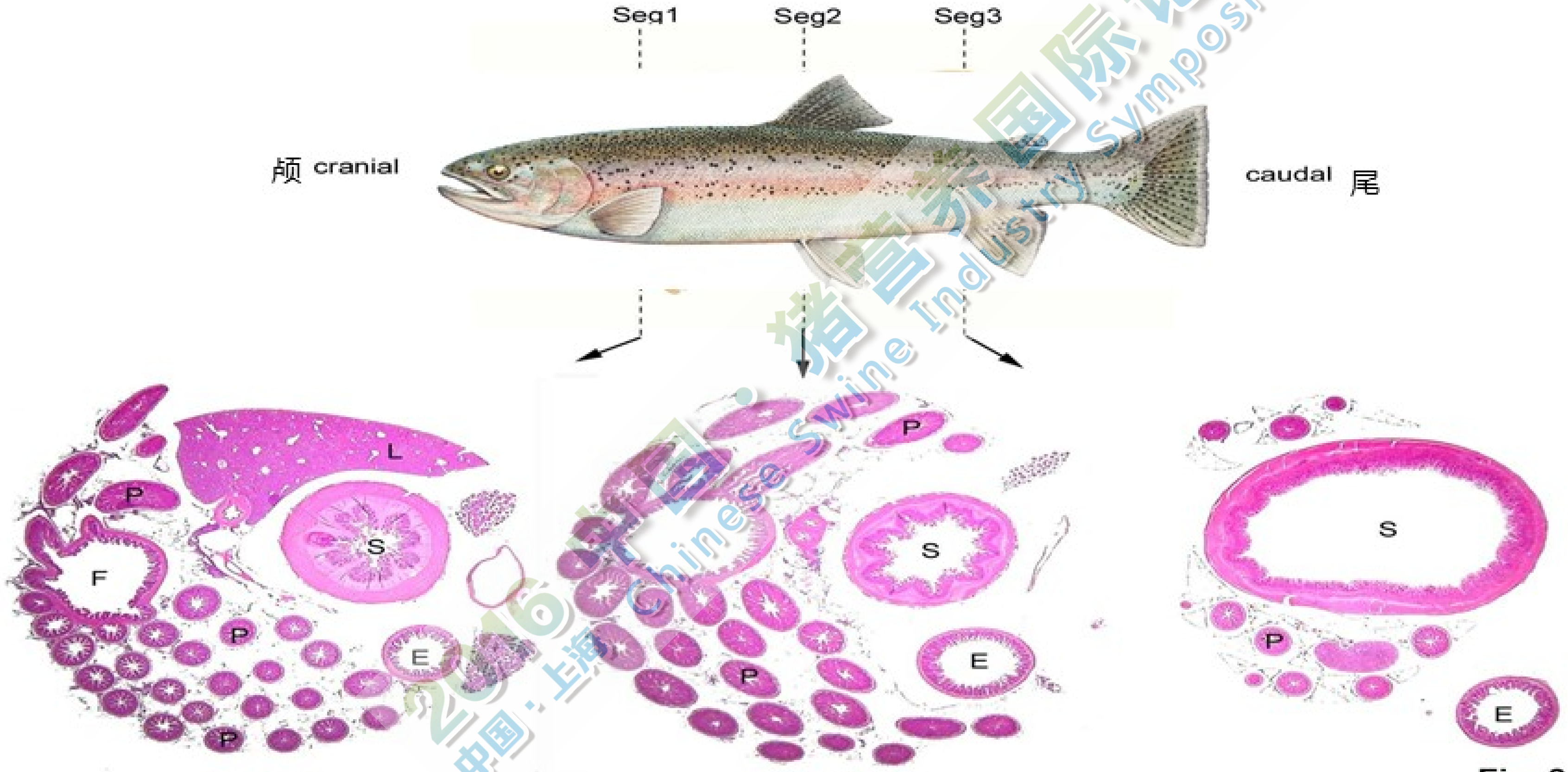
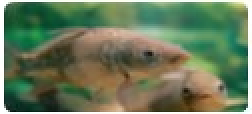


Fig. 3

鱼、猪和火鸡日粮中的麻疯树仁粕
Jatropha kernel meal in fish, pig and turkey diets



鲤鱼日粮 Common carp (*Cyprinus carpio* L.) diet:

粗蛋白 – 38%和脂质 – 10% Crude protein – 38% and lipid – 10%

虹鳟鱼 Rainbow trout (*Oncorhynchus mykiss*) diet:

粗蛋白 – 45%和脂质 – 24% Crude protein – 45% and lipid – 24%

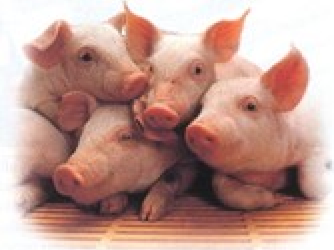
罗非鱼 Nile tilapia (*Oreochromis niloticus*):

粗蛋白 – 36%和脂质 – 8% Crude protein – 36% and lipid – 8%

白对虾 White leg shrimp (*Pennaeus vannamei*):

粗蛋白 – 35%和脂质 – 9% Crude protein – 35% and lipid – 9%

以蛋白为基础可替代50%鱼粉
50% replacement of fishmeal on protein basis



&

以蛋白为基础可替代50%豆粕
50% replacement of soymeal on protein basis

无毒麻疯树 Non-toxic Jatropha

麻疯树白桦（无毒）
Jatropha platyphylla (non-toxic)

麻疯树（无毒）
Jatropha curcas (non-toxic)

基于非食用油的生物柴油产业副产品（粕/饼）

Co-products (meal/cake) of non-edible oil-based biodiesel industry

	粗蛋白 % Crude protein	有毒物质 Toxic compounds
蓖麻 *Ricinus communis*	27.1- 40	蓖麻毒素,蓖麻碱（生物碱）,CB-1A（稳定的过敏原） Ricin , ricinine (alkaloid), CB-1A (stable allergen)
橡胶树 *Hevea brasiliensis*	21.9	生氰糖苷（亚麻苦苷和百脉根苷），植物凝血素（抗生育因子）Cyanogenic glycosides (linamarin and lotaustralin), phytohaemagglutinin (antifertility factor)
海甘蓝 *Crambe abyssinica*	46 – 58	外延前致甲状腺肿素（硫代葡萄糖苷） Epi-progoitrin (thioglucoside)
黄花夹竹桃 *Thevetia peruviana*	42.8 – 47.5	强心苷（黄夹苷A,黄花夹竹桃二糖苷和乙酰单苷） Cardiac glycosides (thevetin A, thevebioside, gluco-peruvoside and acetylated monoside)
印楝 *Azadirachta indica*	45.0 – 49.4	印楝素（萜类拒食素），类异戊二烯和含硫化合物 zadirachtin (tetra-nortriterpenoid antifeedant), isoprenoids and nimbidin (sulphurous compound)
水黄皮 *Pongamia pinnata*	24.2	水黄皮次素（呋喃类黄酮），抗营养因子（植酸盐,单宁酸和蛋白酶抑制剂） Karanjinin (furano-flavonoid), antinutritional factors (phytates, tannins and protease inhibitors & glabrin)

抗营养和有毒因子
Antinutritional and Toxic Factors

亚麻荠粕和芥菜饼
Camelina sativa meal and *Brassica Juncea* cake

亚麻荠或亚麻,芸苔属植物(十字花科)
***Camelina sativa* or false flax - the *Brassica (Cruciferae)* family**

- **粗蛋白：36-40%**
  （富含必需氨基酸包括赖氨酸&蛋氨酸）
  Crude protein: 36-40%
  (rich in EAA including lys & meth)

- **添加40%时，蛋白和氨基酸消化率略低--与菜籽粕相比**
  At 40% incorporation CP and AA digestibilties slightly on the lower side -- compared with those of canola meal

即使在较高的采食量水平下，日粮中亚麻荠饼添加至18%无不良影响
***Brassica juncea* cake at up to 18% of the diet No ill effects, although at higher levels of intake**

昆虫作为饲料用于猪 Insect as feed for pigs

黑兵蝇蛹或黑水虻
Black Soldier Fly or *Hermetia illucens*

蛆虫：家蝇幼虫
Maggots: larvae of the housefly *Musca domestica*

- 蛋白质质量一般较高，类似于其他动物肉 Protein quality is generally high, similar to other animal meat source
- 蛋白质含量：约50% Protein content: ca 50%
- 脂肪含量是变化的,但通常是必需多不饱和脂肪酸的良好来源。Fat content is variable, but in general a good source of essential polyunsaturated fatty acids.
- 铁、锌和维生素A的重要来源
A significant source of iron, zinc and vitamin A.

挑战：工业化大规模生产时，安全问题和监管方面
Challenges: Mass production at an industrial scale, safety issue and regulatory aspects

来源 Source: Makkar et al (2014): AFST

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Animal Feed Science and Technology

Review

State-of-the-art on use of insects as animal feed

Harinder P.S. Makkar, Gilles Tran, Valérie Heuzé, Philippe Ankers

昆虫粉中的氨基酸 Amino acids in insect meals

与鱼粉相比 Compared with fish meal

- 昆虫往往含有较低的赖氨酸，桑蚕含有比较丰富的赖氨酸。
  Insects tend to contain lower lysine silkworms are relatively rich in lysine.
- 除了桑蚕外，含硫氨基酸往往较低。
  Sulfur amino acids tend to be lower, except for silkworms.
- 苏氨酸水平大致相当，但桑蚕中更多。
  Threonine levels are roughly comparable but are greater for silkworms.
- 通常色氨酸水平较低，除了桑蚕和家蝇蛆粉。
  Tryptophan levels are generally lower, except for silkworms and housefly maggot meal.

与豆粕相比 Compared with soybean meal

- 桑蚕和双翅目在全球范围内有更好的氨基酸组成，可能代替鱼粉比代替豆粕更好。
  Silkworms and Diptera have a globally better amino acid profile and could be better substitutes of fish meal than soybean meal.

藻类的化学组成 Chemical composition of micro-algae

	蛋白Protein	碳水化合物 Carbohydrate	脂肪 Lipids	核苷酸 Nucleic acid
柱胞鱼腥藻 *Anabaena cylindrical*	43–56	25–30	4–7	Na
水华束丝藻 *Aphanizomenon flos-aquae*	62	23	3	Na
斜生栅藻 *Scenedesmus obliqus*	50–56	10–17	12–14	3–6
四尾栅藻 *Scenedesmus quadricauda*	47	na	1.9	na
莱茵衣藻 *Chlamydomonas rheihardii*	48	17	21	na
小球藻 *Chlorella vulgaris*	51–58	12–17	14–22	4–5
蛋白核小球藻 *Chlorella pyrenoidosa*	57	26	2	na
水棉 *Spirogyra sp.*	6–20	33–64	11–21	na
益生杜氏藻 *Dunaliella salina*	57	32	6	na
眼虫藻 *Euglena gracilis*	39–61	14–18	14–20	na
三毛金藻 *Prymnesium parvum*	28–45	25–33	22–38	1–2
四爿斑藻 *Tetraselmis maculate*	52	15	3	na
紫球藻 *Porphyridium cruentum*	28–39	40–57	9–14	na
钝顶螺旋藻 *Spirulina platensis*	46–63	8–14	4–9	2–5
小眼虫 *Euglena gracilis*	39–61	14–18	14–20	na

一些藻类的氨基酸组成（g/100 g 蛋白）
Amino acid profile of a few algae (g/100 g protein)

来源	Source	Ile	Leu	Val	Lys	Phe	Tyr	Met	Cys	Trp	Thr	Ala	Arg	Asp	Glu	Gly	His
蛋类 Egg		6.6	8.8	7.2	5.3	5.8	4.2	[illegible]	2.3	1.7	5.0	Na	6.2	11.0	12.6	4.2	2.4
豆粕 Soybean		5.3	7.7	5.3	6.4	5.0	3.7	[illegible]	1.9	1.4	4.0	5.0	7.4	1.3	19	4.5	2.6
小球藻 *Chlorella vulgaris*		3.2	9.5	7.0	6.4	5.5	2.8	1.3	na	Na	5.3	9.4	6.9	9.3	13.7	6.3	2.0
杜氏藻 *Dunaliella bardawil*		4.2	11.0	5.8	7.0	5.8	3.7	2.3	1.2	0.7	5.4	7.3	7.3	10.4	12.7	5.5	1.8
钝顶螺旋藻 *Spirulina platensis*		6.7	9.8	7.1	4.8	[illegible]	[illegible]	2.5	0.9	0.3	6.2	9.5	7.3	11.8	10.3	5.7	2.2
水华束丝藻 *Aphanizomenon flos-aquae*		2.9	5.2	3.2	[illegible]	2.5	na	0.7	0.2	0.7	3.3	4.7	3.8	4.7	7.8	2.9	0.9

与豆粕的必需氨基酸相比相当不错
Compared with soymeal EAA reasonably good

最优”（小球藻和螺旋藻）1g/kg 体重
可替代日粮中50%的大豆蛋白 (占总日粮蛋白质的33%)
Optimum”(Chlorella and Spirulina): 1 g/kg body weight
50% of soybean protein in diet can be replaced (33% of the total diet protein)

海藻（大型藻类）和浮萍
Seaweeds (macro-algae) and duckweed

褐藻 Brown algae	高达14%蛋白 up to 14% CP
红藻 Red Algae	高达50%蛋白 up to 50% CP
绿藻 Green algae	高达30%蛋白 up to 30% CP

生物活性物质的良好来源
Good source of bioactive compounds

例如：源于昆布属植物品种的海带多糖和褐藻多糖硫酸酯可改善仔猪性能（肠道健康和生长性能改善）。 Examples: Laminarin & fucoidan from *Laminaria* species improved piglet performance (gut health & performance improvements)

- **每公顷高产的潜力**
Potential to give high yield per hectare

- **未来工作领域：易于开发，成本效益好和环保 ，大规模生产，收割&干燥方法&工具**
Future areas of work: Develop easy, cost effective & environmentally friendly large scale production, harvesting & drying methods & tools

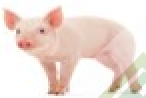
- **限制：重金属（砷），农药，过敏原，碘和其他矿物质** Constraint: heavy metals (arsenic), pesticides, allergens, iodine & other minerals

Makkar et al. (2016)

利用辣木属减少食品-饲料竞争？
Decreasing food-feed competition using Moringa?

密集耕作辣木
Intensive cultivation of *Moringa oleifera*

产量 Yield	产量（吨/公顷/年） Yield (tons/ha/yr)	浓度（%干物质） Concentration (% DM)
干物质产量 DM yield	126	
蛋白 Protein	21.4	17.0
糖 Sugar	12.6	10.0
淀粉 Starch	10.0	7.9



10%叶粉即12.6吨=25%蛋白
总蛋白产量/公顷=3.2吨
10% leaf meal i.e. 12.6 tons = 25% protein
Total protein yield/ha = 3.2 tons

豆粕=2 – 3.5吨/公顷 & 含35%蛋白
总蛋白产量/公顷=0.7 – 1.23 吨
Soybean = 2 – 3.5 tons/ha & has 35% protein
Total protein yield/ha = 0.7 – 1.23 tons

氨基酸Amino acids	辣木Moringa	豆粕Soymeal	鱼粉Fishmeal
赖氨酸 Lysine	6.0	6.18	7.50
蛋氨酸 Methionine	1.98	1.32	2.70
半胱氨酸 Cystine	1.35	1.38	0.80

2016 中国 · 猪营养国际论坛

Chinese Swine Industry Symposium

中国 · 上海

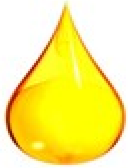
利用绿色化学方法生产的蛋白水解物
Protein hydrolysate using green chemistry

- 水黄皮种子 Pongamia seed
- 油菜籽 Rapeseed
- 葵花籽 Sunflower seed
- 亚麻荠籽 Camelina seed
- 麻疯树 Jatropha kernels

酶法辅助采油

Enzyme assisted oil extraction

油 Oil



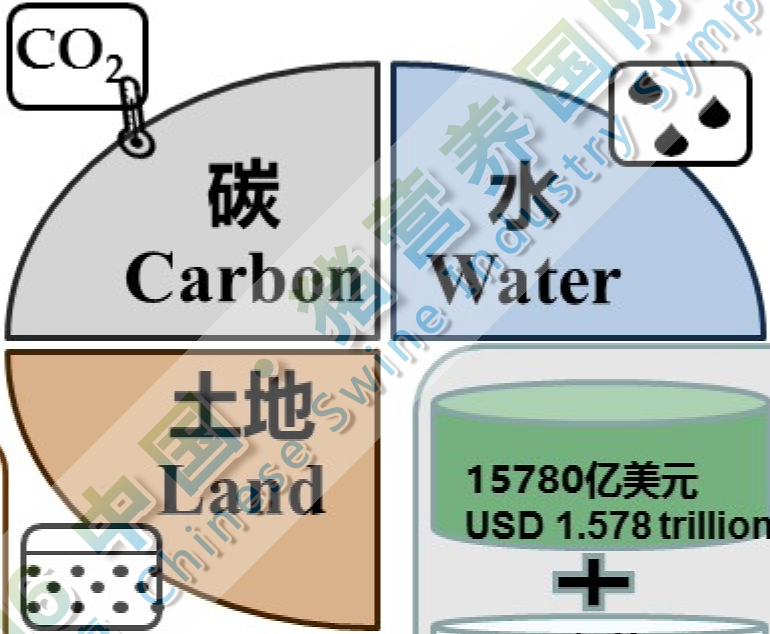
水解蛋白

Hydrolysed proteins

食物浪费的追踪（1.3 Gt/年）

Footprint of food wastage (1.3 Gt/year)

3.3 公吨CO_2平方/年
3.3 Gt CO_2eq/year
=
第三大排放国，
如果食物浪费是一个国家
3rd largest emitter,
if food wastage was a country



305 km³/年
305 km³/year
=
日内瓦湖的3倍
3 times lake Geneva

15亿用于种植被浪费的食物
1.5 billion ha used to grow food that is wasted
=
30%农业用地
30% of agricultural land

15780亿美元
USD 1.578 trillion

社会环境成本(低估)
Socio-environmental costs (under-estimate)

+

10550亿美元
USD 1055 billion

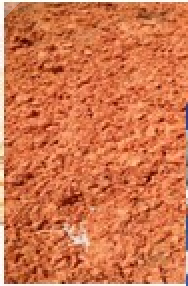
经济成本(2012)
Economic costs (2012)

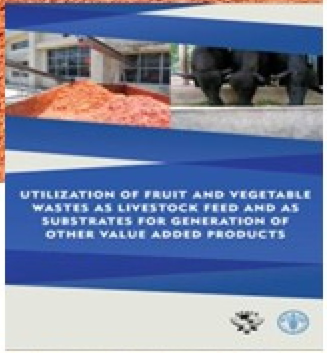
食物浪费的全部成本
Full cost of Food Wastage

Source: FAO, 2013. Food Wastage Footprint: Impacts on Natural Resources

果蔬废料用于猪饲料

Fruit and Vegetable Wastes to Pig Feed





每年1.3公吨废料（总量的30%）

1.3 Gt (30% of total) Wasted per year

食品加工行业（组织）：水果和蔬菜损失（百万吨）
Food processing sector(organized): Losses in Fruit &Vegetable (million tons)

印度	1.81	India	1.81
中国	32.0	China	32.0
美国	15	USA	15

昆虫饲养 Insect rearing

Makkar et al. (2014)

未来饲料是通过酶和各种处理方法生产的第二代生物燃料
Future feeds through enzymes and treatments for second generation biofuel

禾本草、稻草、生活垃圾
Grasses, straws, stovers, domestic waste residues

↓

各种处理和酶
Treatments and Enzymes

富含简单碳水化合物的饲料
Feeds rich in simple-carbohydrates

动物营养需要留意
Need for animal nutritionist to keep an eye

建议的添加水平　Suggested levels of incorporation

饲料资源 Feed resources	建议水平　Suggested levels
玉米酒糟蛋白 Dried distillers grains with solubles	生长猪(断奶后2–3周)：高达30%　Growing pigs (2–3weeks after weaning): up to 30% 育肥猪：高达30%　Finishing pigs: up 30% 怀孕母猪：高达50%　Gestating sows: up to 50%
甘油　Glycerine	高达15%　Up to 15%
亚麻荠压榨饼 Camelina sativa expeller cake	高达30%，根据硫配糖体水平 Up to 30%, depending on glucosinolates level
芥菜饼　Brassica juncea cake	高达18%　Up to 18%
脱毒麻疯树仁粉 Detoxified Jatropha curcas kernel meal	替代常规来源蛋白高达50% Up to 50% replacement of protein from the conventional sources
无毒麻疯树仁粉 Jatropha kernel meals from non-toxic genotype	替代常规来源蛋白高达50% Up to 50% replacement of protein from the conventional sources
昆虫粉　Insect meal	替代常规来源蛋白高达50% Up to 50% replacement of protein from the conventional sources
棕榈仁饼　Palm kernel cake	20–25% 的日粮　20–25% of the diet

可能的有毒有害物质
Possible discriminatory factors

饲料资源 Feed resources	可能的不良物质 Possible undesirable substances
酒糟 Distillers grains	毒菌毒素、农药、重金属、高磷、植酸盐、抗生素、非淀粉多糖 Mycotoxins, pesticides, heavy metals, high phosphorus, phytate, antibiotics, non-starch polysaccharides
麻疯树粉(有毒) Jatropha meal (toxic)	佛波酯、胰蛋白酶抑制剂、植酸盐、麻疯树毒蛋白 Phorbol esters, trypsin inhibitor, phytate, curcin
麻疯树粉(无毒) Jatropha meal (non-toxic)	胰蛋白酶抑制剂、植酸盐、麻疯树毒蛋白 Trypsin inhibitor, phytate, curcin
茶花和芸苔属植物粕/饼 Camelia & Brassica meal/cake	硫配糖体、胰蛋白酶抑制剂 Glucosinolates, trypsin inhibitors
昆虫粉 Insect meals	农药、重金属、生物危害(取决于饲养昆虫的材料) Pesticides, heavy metals, bio hazards (depending on the materials used for rearing insects)
海藻 Seaweed	褐藻多酚、重金属、矿物质、复合碳水化合物(如海藻酸盐、硫酸岩藻糖聚合物和海带多糖、琼脂、木聚糖、硫酸半乳糖体、卟啉和木聚糖) Phlorotannins, heavy metals, minerals, complex carbohydrates (such as alginates, sulphated fucose-containing polymers & laminarin, agars, xylans, sulphated galactans, porphyrans & xylans)
辣木叶粉 Moringa oleifera leaf meal	单宁酸和/或皂角苷(在某些品种中) Tannins and/or saponins (in some cultivars)
屠宰场废物 Slaughterhouse waste	生物危害 Bio hazards
食物残渣 Food waste	农药、杀虫剂残留、霉菌毒素、重金属、生物危害 Pesticides, pesticide residues, mycotoxins, heavy metals, bio hazards

可持续型动物日粮和新型饲料资源
Sustainable animal diets and place of novel feed resources

新型饲料资源 Novel feed resources

- 不与人类食物竞争
  Do not compete with human food
- 大多数新型饲料是：副产品或是通过使用农工业副产品– 使用—低碳和水足迹及低土地需求生产。 Most of the novel feeds are: co-products or are produced by using agro-industrial by-products – their use -- low carbon and water footprints and low land requirement.
- 绿色产业、就业机会
  Green industry, job opportunity

结论 Concluding remarks

"大量新型饲料资源是可利用的，这些都是蛋白和能量的良好来源，并能代替豆粕和谷物如猪日粮中的玉米以提高生猪生产系统的可持续性"

"An array of novel feed resource are available, which are good source of protein and energy and can replace soymeal and cereals such as maize in swine diets – enhancing sustainability of pig production systems"

谢 谢

Thanks for your attention