Opportunities and challenges for plant protein-based foods: Lessons from the soy industry

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## Disclosures

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Topics

Nutrition needs of global population across a spectrum of diet & health needs

The innovation landscape for meeting consumer needs with new protein ingredients and foods in which they are used

Stakeholders influence availability, affordability, sustainability and choice of consumption

Role of food industry in collaborative initiatives
Public health institutions and adjacent stakeholders must address needs across the spectrum.

Malnourished populations
- Recipients of food aid, therapeutic foods (RUTF, RUSF)

Nourished & Over-nourished populations
- Purchasers of food products formulated to meet needs & wants

Variety of proteins required to meet needs of growing global population and rising standards of living with concomitant patterns of food consumption.
Multiple protein sources are required

Global Protein Demand

• Global population is projected to grow from 7.2 billion to 9.6 billion by 2050. The majority of all growth is in the least developed countries.

• Demand for protein will strain the environment.

• Plant based alternatives are, and will be a necessary solution to providing enough protein to feed the world.

Source: Soyfoods Association of North America, 2014
The Current and Emerging Landscape for Alternative Protein Sources

Factors for consideration of commercialization of new protein sources
• Availability: Global and Local
• Affordability
• Quality, Safety, and Regulatory Status
• Supply Chain and Sustainability
• Implications for Food Formulation, Product Labelling and Positioning

2016 Global Food Security Index for Quality & Safety
Modeling US Feed to Food Conversion Efficiency - Implications of dietary changes to Food Security

Shepon, Eshel, Noor and Milo - A collaboration among Weizmann Inst., Harvard and ETH-Zürich

Sankey flow diagram - US Feed to Food Protein Flux

- Avg protein conversion efficiency for all livestock species - 7% to 8%
- Substantially different conversion efficiencies among livestock species - 31% to 3%
- Reallocation of resources from beef to poultry could meet the protein demands of 140 MM US consumers
- Reallocation to an optimal, nutritionally aware plant-based beef replacement could meet the dietary potential of 190 MM US consumers
Alternative Protein Sources: Cultivated Leguminous Crops

Cultivated Crops: Soya vs Pulses as candidates to address the protein gap
- Differences in geographic distribution
- Size of protein contribution to global protein production, and future needs
- Fundamental Differences in:
  ➢ Number of crop species that support the industry
  ➢ Utilization in human foods cf. animal feeds
  ➢ Macronutrient composition; Processing and purification technologies re: food ingredients
  ➢ Regulatory: Protein Quality, Labelling, Consumer Perception

2014 Soya Regional Production, tonnes

- South America
- Northern America
- Asia
- Europe
- Africa
- Central America
- Oceania

Ca. 105 MM tonnes of protein

2014 Pulses Regional Production, tonnes

- South America
- Northern America
- Asia
- Europe
- Africa
- Central America
- Oceania

Ca. 19 MM tonnes of protein

Alternative Protein Sources: Adaptability of Cultivated Leguminous Crops cf. Soybean

Figure 1. Where the eight priority legumes grow.
Source: CGIAR
Alternative Protein Discovery Platforms and Production Technologies

• Proteins by Fermentation / Culture
  - Food Grade Microbials
    ➢ Mycoprotein
    ➢ Microalgae
    ➢ Yeast
    ➢ Bacteria
  - Aquatic Plants
  - Insects
• Proteins from valorization of waste / co-product streams
  - FAO estimates of global quantitative food losses and waste:
    ➢ 40-50% for root crops, fruits and vegetables,
    ➢ 35% for fish,
    ➢ 30% for cereals,
    ➢ 20% for oilseeds, meat and dairy
  - Insects for Proteins and Lipids for Animal Feed
  - Marine Plants
Innovative Food Production and Supply Chain Technologies

• Food Production | Supply Chain Sustainability, Transparency & Optimization
  - Precision Agriculture & Precision Supply Chain & Sustainability
    ➢ E.g., Field to Market Consortium, Climate Corp, et al | Agrible
• Local vs. Global Production, Processing and Utilization
  - E.g., USDA - Agricultural Marketing Service investments in local and regional food systems

- Urban Agriculture | Vertical Farming


https://vertical-farming.net/
Highly Strategic Public | Private Partnerships Enabled the Growth of Soy Protein for Human Nutrition

Health Benefits of Soy Protein

**Emerging Health Areas of Differentiation**
- Gut health
- Kidney health
- Glucose management
- Liver health

**Established Evidence**
- Muscle
- Weight
- Body Composition
  - Cardiometabolic Health

**Strong Foundation for Research**
- Heart Health
- Protein Quality

Soy Protein for Healthy Aging

**Established Evidence**
- **Muscle Health**
- **Heart Health**
- **Cardiometabolic**

**Emerging Health Areas of Differentiation**

- **Glucose management**
  - Literature support role for soy protein, Acute study ongoing in India

- **Kidney health**
  - Invited review of literature on soy & kidney health published

- **Liver health**
  - High prevalence (11-46%) nonalcoholic fatty liver disease (NAFLD) globally. Increases with overweight (58%) & can be as high as 95% in obese people.

Soy protein, but not caseinate or dairy whey, prevent severe fatty liver in animal models
Opportunities and Issues for Plant-Protein Based Foods

All Value propositions are HIGHLY integrated, interdependent

• Sensory
  ➢ Taste, aroma, texture, appearance
  ➢ Context of the consumer cohort(s) and the “food form | formulation” must lead NPD

• Availability | Affordability
  ➢ Process technology runs from “gene to field to fork”, including supply chain and shelf life considerations
  ➢ Key driver for economic proposition, but also Quality and Acceptance
  ➢ Critical for perception of “Clean” ingredients | food

• Nutrition
  ➢ Human Protein Quality
    - Limiting EAA’s for legume protein PDCAAS: Met/Cys, Trp
    - Ingredient form is critical: Seed → Split → Flour → Conc → Isolate
    - Global Science | Regulatory landscape is very dynamic, but measured rate of change
    - Protein Quality has relevance far beyond “growth”; e.g., cardio-metabolic, muscle, liver, kidney.
    - “Human” Protein nutrition will need to address interdependence with microbiome, potentially including “personalization”
Olde Russian Proverb — Trust in God, but Take Care of Your Garden...

Hard lessons to be learned from Soybean Biotechnology

- Impressions, opinions and misconceptions of global consumers and regulators matter
- Transparency for all stakeholders is minimum “table stakes”
- National | Regional priorities will not always align
- Holistic view of science and technology is critical
- Novel supply chains and their supporting science & technology will be required
- Must anticipate that the landscape will change; pace of change is ever accelerating
Multiple stakeholders are involved in providing proteins for healthy foods for global consumers.
Key Takeaways

- There is an urgent need for protein innovation to meet the ongoing needs for a growing and more prosperous global population, and to do it sustainably by using comprehensive modelling techniques.
- Multiple approaches are being actively pursued to develop protein ingredient technologies to better meet these needs for sustainable and secure sources of protein containing or fortified foods.
- Additional technologies for the manufacture of the protein containing foods themselves are also being actively pursued.
- Many of these will be competitive to animal & soy-based technologies, others will be compatible with or complementary to soy & animal proteins.
- Adjacent technologies for superior ag production, processing, distribution and utilization will be essential components to nourish the population.
- **Multiple stakeholder groups must collaborate to effectively bring any new protein technology to market so that consumers’ and global population needs can be met.**
Who is AOCS?

- Spans the globe with more than 4,000 members
  - From 94 countries
  - Representing diverse companies, universities and government agencies

- Strives to provide trusted scientific, technical, and industry news and information to both members and nonmembers

- Not a business, but if we were—we’d be in the business of information
AOCS: Meeting the challenges of industry

Created in response to a need for members of the Cottonseed Crushers’ Association to ensure product quality across their industry.

Canola industry developed AOCS-supported methods starting in 1980.

AOCS

- Helped standardize procedures across the canola industry
- Evaluate analytical procedures
- Interlaboratory precision
- Facilitated Collaboration

AOCS 2017
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- AOCS can and will support the pulse industry
- Consistently evaluate the quality of pulses for processing and trading in the marketplace
- Online platform for collaboration & advancement:
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