Initiative for Convergent-manufacturing of Agriculture and Food for Equity (I-CAFE)

I-CAFE, a foundry for enabling nutrition and calorie equitable foods at the crossroads of traditional and future farms

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(The opinions expressed in the presentation are solely of the speaker and are not intended to represent any official positions of Purdue University.)
Why?: Convergence of Tech-socio-economic-political drivers

- Population
- Supply chain
- Bio-diversity
- Life expectancy
- Climate
- Inequity & Deserts
- Taste-diversity
- Pandemics
- Traceability
- Energy & Decarbonization
- Trade War
- Age of Mobility
Where?: Current Farms and Foods Trend

**By 2050**, 89% of the U.S. population and 68% of the world population is projected to live in urban areas. More than 300 urban areas in the U.S. have populations above 100,000; New York City, with 8.3 million inhabitants, is the largest. ... Between 2000 and 2010, urban land area in the U.S. increased by 15%.

https://css.umich.edu/factsheets/

**U.S. Cities Factsheet | Center for Sust:**

**TIME**

*BY ARYN BAKER*

**JANUARY 20, 2020 1:50 PM EST**

China's Ministry of Agriculture and Rural Affairs has set the lab-grown meat industry abuzz with the release of its official five-year agricultural plan (pdf in Chinese) on Jan. 26. For the first time, China included cultured meats and other "future foods" like plant-based eggs as part of its blueprint for food security going forward.

Grown from animal stem cells in a bioreactor and enriched on a nutrient broth, cultivated meats are a relatively new technology that promises to upend traditional animal agriculture by replacing slaughterhouses with laboratories. But while alternative meat companies have made immense strides in replicating the *taste* and texture of conventionally raised pork, beef, and chicken,
Agriculture and Food Self-Reliance and Assets for National Security

Agriculture and Food Manufacturing

Farmers

Harvestable Land

Grains

Farms

Agriculture and Food Supply Chain

Nutrition-dense and Calories-Rich Equity
Agriculture and food revolutions for human health, equity, and competitiveness

Demands, 4As: Along with **Acceptability** and **Availability**, **Accessibility** (gap) and **Affordability** (gap) to nutritious food

Acceptability

History of agriculture

8,000 BC  3,000 BC

1830

nowadays

Availability
How?: Approach, convergent-manufacturing for 4 “A”s

- Meet **acceptability** demand with nutrition, safety, taste and social participation.
- Meet **availability** demand with diverse materials sources, e.g. cellular ag, plant-based ag (e.g. soybean), insect-based protein, and more.
- Meet **accessibility and affordability** demands with digital, hybrid and distributed manufacturing by, for and with community participation.
Exploring new value space at the convergence of agriculture and technology to enable tasty and nutritious and calorie rich food accessible and affordable for all by mass-scale customization.
A cross-college thought leadership: Convergence of Cell Ag, Plant Ag, and Future Farms
Farm and Food Foundry for Convergent Manufacturing
Anthropology, Economics, Education, Nutrition, Policy, Sociology, Sustainability

Highlights (continuously updates):
Few example of organizations in Indiana: Eli Lilly, Beck’s Hybrids, Corteva Agriscience, AgriNovus Indiana, Indiana Soybean Alliance; Indiana Corn Alliance, Indiana Pork Farmers, Indiana University, Ivy Tech, Notre Dame University.

Few example heterogeneous materials: Proteins, cells and tissues, plants, and seeds.

Few example combinatorial processes: Bio-reactors, additive-transformative processes, integrated hybrid batch-continuous operations, intensified systems for rapid drying of particulates, digital agriculture, cultures and alternative protein; horizontal and vertical farming.

Example key platform issues (horizontals): Energy, sustainability, digital smartness and Industry 4.0, robotics, IoT, drones and sensor network, microelectronics and sensor and actuator chips and systems, cybersecurity, logistics and supply chain, equity and equality, technology policy and diplomacy.
Overarching Theme: Nexus of Farm-Food-Human-Climate for the Future of Humanity

TRADITIONAL RANCHES
Ranchers & Breeders
Processors & Packers

CONTROLLED ENVIRONMENT FARMS
Vertical Farms
Urban/Rooftop Farms
Indoor Farms

FUTURE FOODS & FARMS

TRADITIONAL FARMS
Family Farmers
Agribusiness
Legacy Infrastructure

CULTIVATED FOOD
Cellular Agriculture
Plant-Based & Alt-Proteins
3D Printing
Themes & Teams: Future Food and Farms

- Genetics, cells and tissues
  - Deng, Meng; Kim, Brad; Kuang, Shihuan; Rainey, Katherine Martin; Sealy, Michael P.

- Manufacturing, Nutrition and Safety
  - Bapat, Salil; Butzke, Christian E; Campbell, Wayne W; Deng, Meng; Kim, Brad; Kuang, Shihuan; Mattes, Richard D; Mishra, Dharmendra K; Liceaga, Andrea; Mosier, Nathan S; Nemali, Krishna; Sealy, Michael P; Simsek, Senay; Sotelo, Luz

- Testing, Data Analytics and I 4.0
  - Ardekani, Arzoo; Buckmaster, Dennis; Sutherland, John W; Tuinstra, Mitchell R; Yih, Yuehwern

- Commerce, Supply Chain, Jobs
  - Butzke, Christian E; Iyer, Ananth V; Groll, Eckhard A; Joyce, Brad; Lusk, Jayson L; Sutherland, John W; Thomas, Arthur William; Yih, Yuehwern; Zehring, Craig Allen; Ziviani, Davide

- Equity, Communities, Education
  - Connaughton, Stacey L; Giri, Nandhini; Katar, Bhagyashree; Pfeiffer, Linda J; Prokopy, Linda S; Yih, Yuehwern; Sotelo, Luz

- Ecosystem and Sustainability
  - Ciez, Rebecca Elaine; Flachs, Andrew T; Krishna, Ashima; Singh, Shweta; Sutherland, John W; Yih, Yuehwern

Group picture of faculty attendees from the Future Foods and Farms meeting (Monday, 12/13/2021)

Purdue Leaderships and Admin Support
- Bogan, Bill; Bond, Sally J; Chen, Wayne; Engle, Bernie; Farmus, Cristina D; Huetteman, Carl A; Shade, Steven A

Purdue University
Investing in food equity for Human and Humanity: A Call to Action

Impact: Food-integrated Equity
Every nutritious food and manufacturing farm matters, when at least one human goes hungry!
Drivers for Selection of this Theme

Differentiation

Subject Matter Expertise

Indiana, mid-west and US centric for advancing value and value chain for economy

More than $1T in real impact
The theme is aligned with national and the White House Priorities

- **Climate** justice
- **Equity** for all
- **Jobs** in communities
- **Manufacturing** in US
Thank you

3D printing of food

Micro Farms

Education

Cell Ag

Smart and Sustainable Manufacturing Systems

Cellular Agriculture: An Outlook on Smart and Resilient Food Agriculture Manufacturing

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