Technological Food Innovations for Healthy and Sustainable Diets:

New Sources, New Production Systems, New Future

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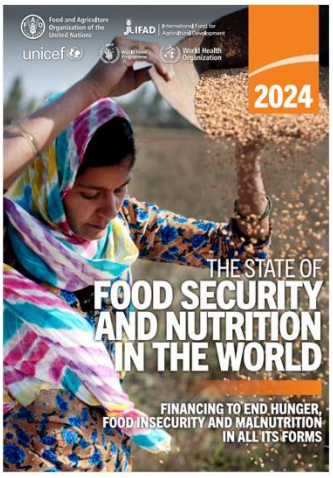
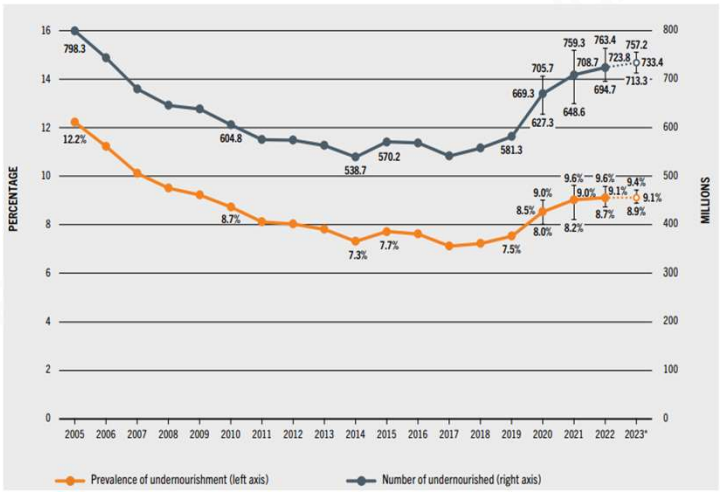
Introduction





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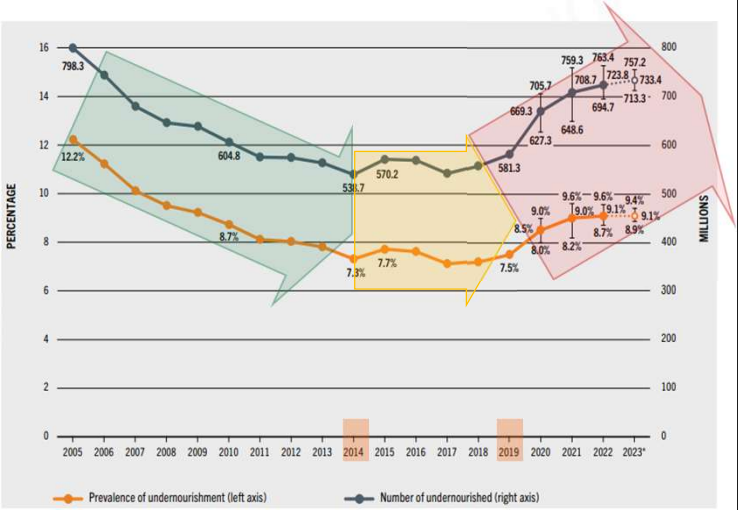
Introduction

Phenomenon of the U-turn of Hunger.

- **2005-2014:** Global hunger (PoU) declined from 12.2% to 7.3%.
- **2014-2019:** Stagnation in hunger reduction.
- **2019-2023:** Sharp rise and persistence of elevated PoU levels of around 9.1%, or about 733.4 million people



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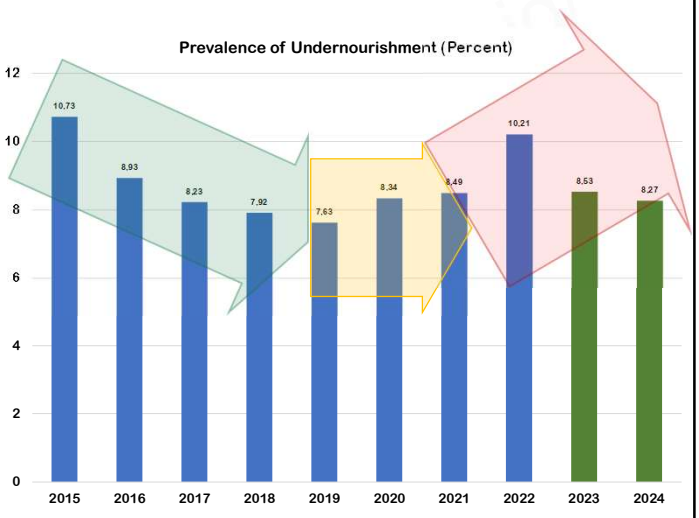
Introduction

Phenomenon of the U-turn of Hunger.

- **Initial Decline:** PoU decreased steadily from 10.73% (2015) to 7.63% (2019).
- **The Reversal (U-turn):**
  - PoU increased to 8.34% in 2020.
  - It peaked at 10.21% in 2022.
- **Current State:**
  - Decreased to 8.27% in 2024.
    - Still significantly higher than the 2019 level of 7.63%
    - Challenging → indicating a reversal of progress.



https://www.bps.go.id/en/statistics-table/2/MTQ3MyMy/prevalence-of-undernourishment--percent-.html

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Introduction

Food security & vulnerability

https://drive.google.com/file/d/1tWwYUXmE2fKEkCr5ogzPzXTINJs4hFsj/view?usp=drive_link

Rasio Konsumsi Terhadap Produksi

- >= 1,50 Defisit Tinggi
- 1,25 - <1,50 Defisit Sedang
- 1,00 - <1,25 Defisit Rendah
- 0,75 - <1,00 Surplus Rendah
- 0,50 - <0,75 Surplus Sedang
- <0,50 Surplus Tinggi

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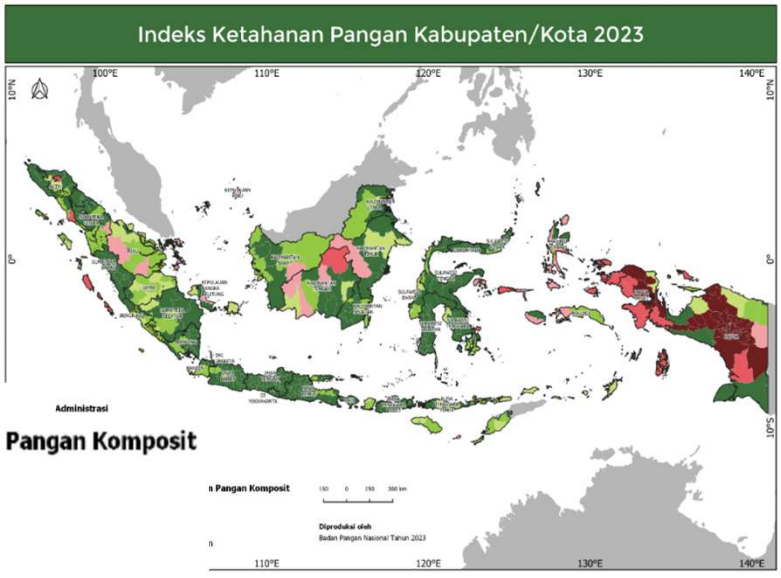
Introduction

Food security

https://drive.google.com/file/d/1P5KIdhdmZkVLWIpC82TaCH_3rCxQaLG6/view?usp=drive_link

Kerentanan Berdasarkan Indeks Ketahanan Pangan Komposit

- Sangat rentan
- Rentan
- Agak rentan
- Agak tahan
- Tahan
- Sangat tahan



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Introduction

Phenomenon of the U-turn of Hunger.

- 2025- 2030? →NOT on track to achieve SDG 2
  - Zero Hunger?
  - Malnutrition?.

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Malnutrition

"The Rise of Overweight and Obesity"

(https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight#:~:text=Worldwide%20adult%20obesity%20has%20more,16%25%20were%20living%20with%20obesity)

GLOBAL

	1990	2022
Prevalence of Overweight		
• Adults (> 18 yo)	25%	43% (Global) 31% (WHO SEAR)
• Children (5 -19 yo)	8%	20% (19% girls, 21% boys)
Prevalence of Obesity		
• Children (5-19 yo)	2 % (31 Mio)	8% (160 Mio)

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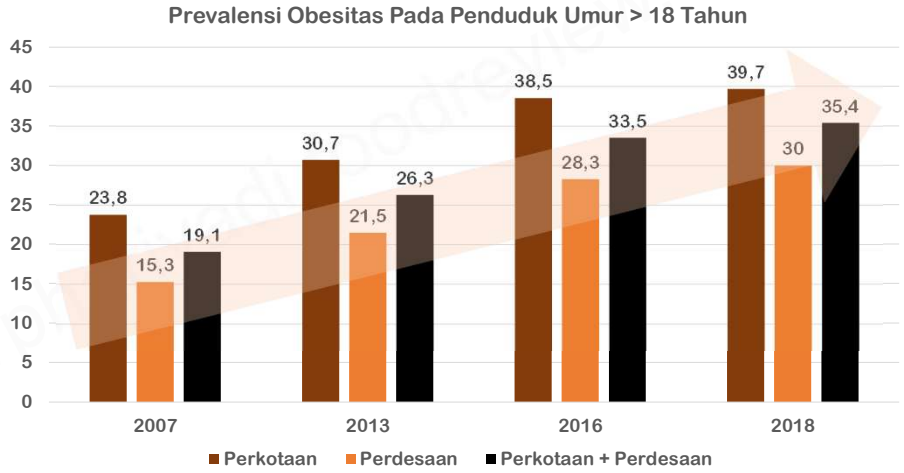
Malnutrition

"The Rise of Obesity in Adults > 18 yo"

(https://www.bps.go.id/id/statistics-table/2/MTQ4MSMy/prevalensi-obesitas-pada-penduduk-umur---18-tahun.html)

INDONESIA



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Malnutrition

INDONESIA

Nutritional Status Trends in Children Under 5

SUMBER

BUKU SAKU
Hasil Survei Status Gizi Indonesia (SSGI) 2022

	Hasil Riskesdas		Hasil SSGI		
	2013	2018	2019	2021	2022
Stunting	37,6	30,8	27,7	24,4	↓ 2,8 21,6
Wasting	12,1	10,2	7,4	7,1	↑ 0,6 7,7
Underweight	19,6	17,7	16,3	17,0	↑ 0,1 17,1
Overweight	11,8	8,0	4,5	3,8	↓ 0,3 3,5

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Need healthier diets → dietary improvement.

Recognize the diverse range of food sources consumed;

- Homemade meals,
- Street foods/restaurant/fast-food
- Processed foods (pre-packed & labelled)
  - Complex & important role of processing in the food system

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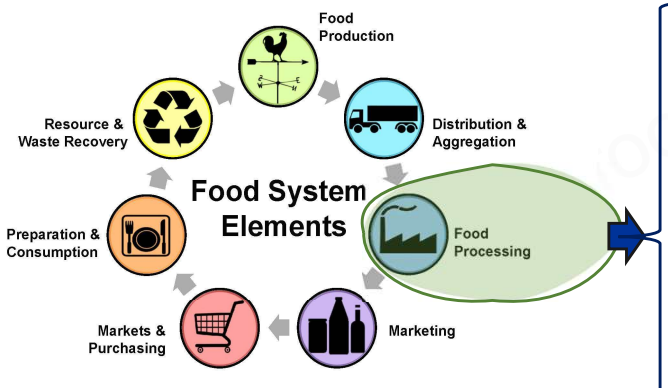
Role of Food Processing in the Food System



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From: Wilkins, J. and Eames-Sheavly, M. Discovering the Food System; An experiential learning program for young and inquiring minds. Cornell University, Departments of Nutritional Science and Horticulture. http://www.discoverfoodsys.cornell.edu/

Essential part of the food system:

→ food processing as a critical link between the production side and the consumption side of the food system

→ converting raw agricultural materials into safe, nutritious, functional, affordable, socially and culturally acceptable "processed food"

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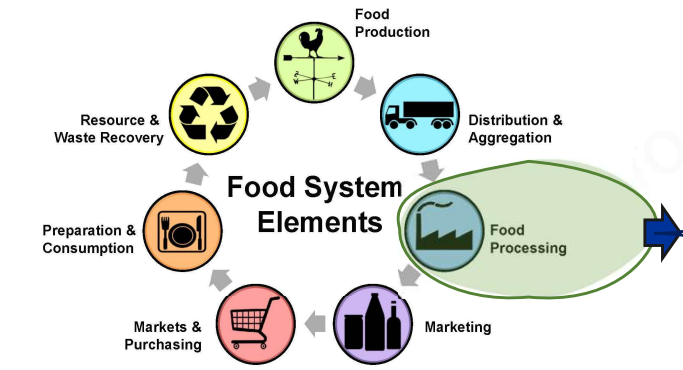

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Essential part of the food system:

- ensuring food safety
- enhancing nutrition - fortification
- Preservation/extending shelf life
- increasing accessibility (conveniency, affordability, and availability).
- improve economic value
- promoting diversification
- improving sustainability (food loss & waste, process efficiency)

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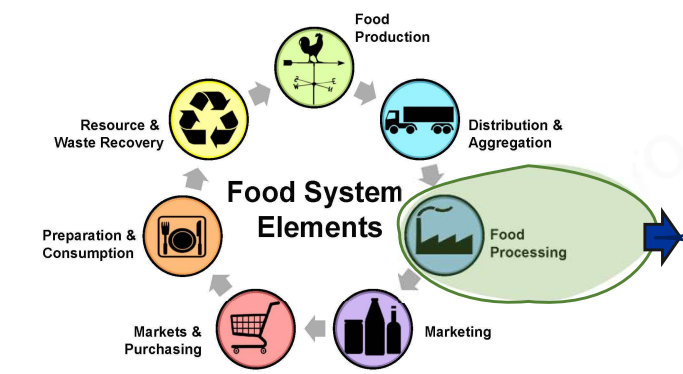
Role of Food Processing in the Food System



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Focus on Two Key Global Themes:

- Exploration in New Food Sources.
- Innovations in New Food Production Systems (e.g., cell-cultured meat).

Additional Focus:
Examining common misperceptions about food processing.

Goal

Highlight transformative potential and critical policy implications, especially for Indonesia.

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Exploration in the New (Sources of) Food

Definition: New (sources of) food are defined as those that have not been widely consumed globally, either due to their historical consumption being limited to specific regions or their recent emergence in the global market as a result of technological advancements.

1. **Edible Insects** [~ sustainable protein sources?; crickets, grasshoppers, mealworms, etc].
2. **Jellyfish** [~ low-fat protein alternatives with potential health benefits].
3. **Plant-Based Alternatives** [~ mimicking meat /dairy using ingredients like soy, peas, nuts].
4. **Seaweeds/Macroalgae** [~ rich in iodine, vitamins, and minerals, requiring no arable land or freshwater].
5. **Microalgae** [~ nutrient-dense options like spirulina and chlorella, offering high protein and essential fatty acids].

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Exploration in the New (Sources of) Food

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1. **Edible Insects**
2. **Jellyfish**
3. **Plant-Based Alternatives**
4. **Seaweeds/Macroalgae**
5. **Microalgae**

- Gaining attention for their sustainability and nutritional benefits
- Challenges:
  - Related to cultural acceptance
  - Production scalability, and
  - Food safety,
  - Food Processing (**Ensuring Food Safety, Improving Nutritional Profiles, Creating Palatable Products, Scaling Production, Customizing for Consumer Needs, Ensuring Sustainability**)

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Innovation in the New Food Production System

Definition: New production systems refer to innovative or enhanced technologies in food production that facilitate the creation of emerging food sources.

1. **Cell-Based Food Production** [~ culturing animal cells in controlled environments to produce meat, poultry, seafood, dairy, and eggs without traditional farming].
2. **Precision Fermentation** [~ using GM microorganisms (e.g., yeast, bacteria, fungi) to produce specific food ingredients like proteins, fats, and flavors through fermentation].
3. **3D Food Printing** [~ advanced manufacturing tech, customizes food items in terms of shape, texture, and nutrition using food-grade materials like purees, doughs, and proteins].
4. **Controlled Environment Agric.** [~ vertical farming and other systems that optimize growing conditions for plants, reducing resource use and environmental impact].

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Innovation in the New Food Production System

Definition: New production systems refer to innovative or enhanced technologies in food production that facilitate the creation of emerging food sources.

1. **Cell-Based Food Production**
2. **Precision Fermentation**
3. **3D Food Printing**
4. **Controlled Environment Agric.**

- Aim to address food security, sustainability, and consumer demands
- Challenges:
  - scalability,
  - cost, and
  - regulatory compliance
  - … etc

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Realizing NFPS (New Food Sources & Production System) ?

Requires food processing technology:

- Ensuring food safety
- Optimizing production methods, and
- Scaling up operations to meet growing consumer demand.

1. **R & D & Advanced Processing Technologies** [~ precision fermentation, 3D food printing, and controlled environment agriculture].
2. **Safety Assessments** [~ Rigorous evaluation of microbiological, chemical, and physical hazards associated with NFPS, including allergenicity, contamination risks, and toxicological impacts].
3. **Scaleability & Sustainability** [~ integration of environmentally friendly practices and production system → reducing resource use, minimizing waste, utilizing renewable energy sources.
4. **Regulatory Compliance** [~ development and adherence to comprehensive regulatory frameworks that address the unique challenges of NFPS, ensuring food safety and consumer protection.
5. **Consumer Acceptance** [~ cultural biases and educating consumers about the benefits and safety of NFPS-derived products, such as cell-based meat or plant-based alternatives]

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Realizing NFPS (New Food Sources & Production System) ?

Requires food processing technology:

- Ensuring food safety
- Optimizing production methods, and
- Scaling up operations to meet growing consumer demand.

Output

Processed Food
(Or, even classify as UPF)

Using and popularizing the term "UPFs" while condemning such foods as inherently bad may be:

(i) Contradictory or counterproductive for innovation

(ii) Especially when NFPS are deemed sustainable and offer solutions to food security and environmental challenges

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UPFs and Case of "Cell-Cultured Meat"

- Meat produced from animal cells in controlled bioreactors
  →**Represents a systemic shift** from traditional agriculture to an industrial, biotech-driven system with extreme precision

  - **The NOVA Paradox & Anti-Innovation?**
    - Cell-cultured meat, despite sustainability and health advantages, is classified as "UPF" by NOVA (~ due to its production method).
      → **This** risks undermining innovative solutions for a healthier, more sustainable food future.

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UPFs and Case of "Cell-Cultured Meat"

- **Urgent to re-evaluate and refine existing classification systems.**

  - These systems should accurately reflect the nutritional value, environmental impact, and technological sophistication of novel foods & promote innovation for healthier & sustainable food system

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Policy for a Healthier & Sustainable Food Future in Indonesia? Conclusion:

- **Collaboration is Key.** Robust dialogue among scientists, government regulators, industry, and society is essential to establish scientifically robust, innovative, food system.
  - Food technology innovation, through new sources and production systems like cell-cultured meat, is vital for our future. It's critical to understand that processing is an enabling component, and that misclassifications can hinder progress of innovation.
  - By investing in R&D, developing agile policies, and establishing robust regulatory frameworks, Indonesia can secure a healthy, resilient, and sustainable food future.
- **Again,** collaboration across sectors is needed, embracing the vital role of food processing in feeding our nation.

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