



FORTY-FOUR EMERGING FOOD INNOVATIONS BY 2050



The FAO Food Safety Foresight Programme conducted a multi-phase foresight exercise to explore the broad landscape of emerging innovations in the field of new food sources and production systems (NFPS) deemed to likely impact future food safety. The exercise resulted in **44 key innovations** in the NFPS space.

Three time horizons were considered



Emerging innovations – new food sources and production systems

44 innovations in 9 clusters



Cluster 1
Valorization of agrifood by-products and waste/circular economy



Cluster 2
New production technologies



Cluster 3
New food sources and food ingredients



Cluster 4
Digitalization and data-based technologies



Cluster 5
Food safety/quality control



Cluster 6
Genetic engineering, gene editing and synthetic biology



Cluster 7
Personalized nutrition/nutraceuticals/food as medicine



Cluster 8
Food packaging



Cluster 9
Further emerging trends

Emerging food innovations by 2050

Cluster 1 Valorization of agrifood by-products and waste/circular economy

- 1 New sources (corn husks, brewers' spent grain, cassava leaves) of nutrients
- 2 New sources (oil cake/meal, rice bran) of bioactive compounds (antioxidants, peptides) and fibre
- 3 Novel growth media from consumer waste
- 4 Wastewater as source of fit-for-purpose water and nutrients for crops

Cluster 2 New production technologies

- 5 Fermentation techniques
- 6 Molecular farming
- 7 Food printing
- 8 Reverse food manufacturing and multiscale food structuring approach
- 9 Cellular agriculture
- 10 Liquid oil structuring (oleogels, emulsion gels, bigels, high internal phase emulsions)
- 11 Controlled environment agriculture

Cluster 3 New food sources and food ingredients

- 12 New sources of fats and oils (Brazil: macaúba, tucumã and babaçu)
- 13 Under-utilized/orphan crops
- 14 Cultured human milk
- 15 Edible bird's nest
- 16 Single-cell proteins
- 17 Nanotechnology
- 18 "Hybrid" food products
- 19 Edible insects
- 20 Protein-based sweeteners

Cluster 4 Digitalization and data-based technologies

- 21 Artificial intelligence in food production and food safety
- 22 Big data and the internet of things
- 23 Digital food twins
- 24 Distributed ledger technologies (such as blockchain)

Cluster 5 Food safety/quality control

- 25 Cold plasma
- 26 Irradiation
- 27 Biopesticides
- 28 Bacteriophages for pathogen control
- 29 Novel methods for food tracking

Cluster 6 Genetic engineering, gene editing and synthetic biology

- 30 Bioengineered microalgae
- 31 Gene-edited plants, including minor crops
- 32 New foods enabled by synthetic biology
- 33 DNA-based barcodes for food authentication

Cluster 7 Personalized nutrition/nutraceuticals/food as medicine

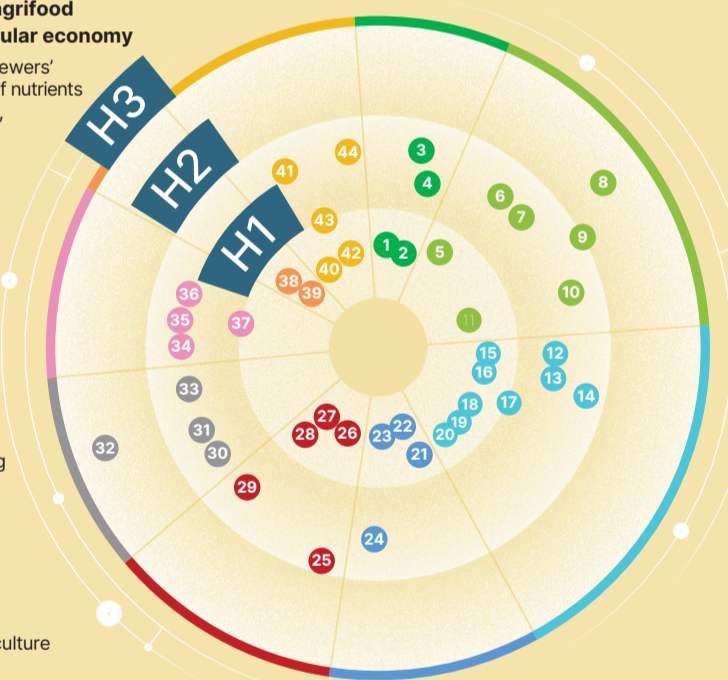
- 34 Nootropic foods
- 35 Microbiome-focused foods
- 36 Edible vaccines
- 37 Nutrigenomics and nutrigenetics

Cluster 8 Food packaging

- 38 Nanotechnology in food packaging
- 39 Recycling and reuse of food packaging/utilization of valorized materials in food packaging

Cluster 9 Further emerging trends

- 40 Reduced added salt and sugar food products/push for sugar alternatives
- 41 Sustainable food products/renewable energy solutions to new production technologies
- 42 E-commerce
- 43 Multi-sensory integration to enhance food-related experiences
- 44 Evolving human-food-computer interaction



Actions that need to be taken



Improve communication on new food sources and production systems and related issues.



Foster technical and scientific advancement.



Develop and optimize safety assessments.



Encourage collaboration and provide incentives.



Harmonize regulatory requirements.

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