The Horizon for Technologies in Future Proofing Food Systems
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The Horizon for Technologies in Future Proofing Food Systems

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Content

• What are Future Proofing Food Systems?
• Where are we?
• What do we need?
• And for food science and technology > radical innovations?
• Examples of potential solutions?
• A need for a food systems approach?
What are Future Proofing Food Systems?

• HLPE (2017) : “a food system that ensures food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition of future generations are not compromised”.

• The definition lacks references to:
  – circular (bio-)economy,
  – cultural aspects and
  – optimal usage of natural and input from human resources;

• The questions evokes key issues as inclusiveness, consumption behaviour, affordability in economic terms, policy measures, nutrition in either ‘sufficient calories’ or ‘balance diets’ and ICT and digitalisation.
Where are we?

- An enormous challenge
And yet in some alarming zones

https://www.stockholmresilience.org/research/planetary-boundaries.html
And other major challenges?

*Exponential curves*

We are currently **extending the expiry date** of our planet.

We are not heading towards a sustainable, circular bio-economy (spiral)

We are not able to take away the uncertainties about a well-balanced society

http://www.worldometers.info/
What do we need?

A viable planet!, in terms of:

• Healthy inhabitants
• A viable habitat / environment
• A pleasant & respectful socio-economic context
• An aesthetic image

Sinusoidal curves
A frame where we balance at the edge of order and chaos

Originating from physics, in particular from **thermodynamics: for systems, food matrices, ..**

Interactions between persons, constituents (in e.g. biomatter) /factors/..

![Graph showing the relationship between order/rigidity and chaos/supercritical, unstable]  
Chaos (supercritical, unstable)

Order / Rigidity (sub-critical, stable)

Number of different constituents / factors / persons/..

*Ref: Kauffman, Prigogine, Holland*

Evolutions characterized by sinusoidal patterns

‘melting zone’: self-organized dynamics > favorable domain
What does it mean for food?

> we need to redefine the limits

Vitality / ‘richness

Non-vital planet earth: chaos

Scenario 1

Non-vital planet earth: rigid, dead

Scenario 2

Net effect?

Time

2015

2050

Luxurious products/services

Primary needs

Green-house effect
Bio- & Food- diversity loss
Population growth

Poverty
Food insecurity
Insufficient arable land
No drinking water
Hazards (microbial, chemical)
Radical innovations needed in Food / ruptures (I)

1. *Avoiding unnecessary exploitation of resources:*

- from products towards services & *de-materialization*,
- low density – high *satiety* food,
- alternative protein sources
- utilization the richness of nature’s structures (*biomimetics*),
- *waterless* systems,
- *synthetic biology* pathways,
- *energy only from the sun* (avoid the use of biomass),
- new breeding strategies for *entire* plant usage,
- ..
Radical innovations needed in Food technology / ruptures (II)

2. Efficiently transforming and using agro-resources:

- autocatalytic systems,
- targeted processes (not over-dimensioned)
- process intensification,
- local bio-refineries at the farm (no transport of water & air),
- new ICT driven processes (virtual design, domotics, 3D printing, ...),
- eco-efficient dynamic storage (products in coma),
- high precision water-droplet systems,
- energy efficient desalting of sea water,
- novel biomaterials & packaging concepts, etc.
3. Valorizing new co-products and waste streams and re-valorize all biomass:

- eco-pyramid valorization,
- aquaponics systems,
- new salt tolerant species,
- diverse agro-ecological-based products
- industrial ecology business concepts,
- circular economy concepts
- ,...

*Food Science becomes more and more transdisciplinary (management, economics, genetics,...)*

Sources: Poyry and Sanders
Ex. waterless system: dry fractionation

Abecassis, de Vries, Rouau, 2013...

WHY RUPTURE? .... Integral use of biomass, no water added during processing (thus no drying), local applicability, avoiding water transport, local employment
Ex. entire plant usage; Grap’Sud

GrapSud, a union of 7 wine cooperatives located in the South of France, with 210 employees on 6 production sites

Waste valorised:
125 000 tonnes of grape marcs
270 000 hl of wine lees
600 000 hl of wine most

→ A diversity of new value-added products issued from by-products

→ New biorefinery and processing schemes.

M. Donner, Naxos conference, 2017
Also, EU NOAW project
Ex. alternative proteins sources & products

meat alternatives on basis of new plant, algae and insect protein sources

WHY RUPTURE? .... Substantial reduction of environmental pressure due to protein-conversion factors and greenhouse gas emissions (CH4, etc.), challenges with nutritional profiles, ...

Inra, WUR, ..
Example: BBI Green Protein Project;
Ex. process intensification: HPHT

Why rupture? Adiabatic heating >> time for processing enormously reduced & No re-packing > treatment in the package itself

**EU IP FP6 NovelQ: To develop and successfully demonstrate** - eco-friendly - novel processing technologies (HPP, PEF, Plasma, microwave, radio frequency, ohmic heating and new packaging materials) for improved quality food and new products (fresh-like character, extended shelf-life)
Ex. targeted processing > EME

- PEF: highly efficient
- Plasma >> most targeted technology (at the edge of thermodynamics and electromagnetism)

WHY RUPTURE? .... Energy for cooking 80% reduced & inactivation of spores at room temperature ...
Ex. Eco-efficient dynamic storage

Why Rupture? .... Energy for climatisation during transport 70% reduced & stand alone & reduction of product loss

Partners: EET, Carrier Transicold, P&O Nedlloyd, The Greenery, Shell Solar, Ecofys, ERBS, WUR
Ex. biodegradable packaging materials

WHY RUPTURE? .... Valorization of largely unused co-products (approx 50% of all biomass) and waste (plus replacing synthetic materials, potential benefits due to biodegradability, ...)

EC-FP7 project, Gontard et al
Ex. Industrial ecology concept

WHY RUPTURE? ....
Closed circles/spirals locally > zero waste (potentially), new cooperation forms
Ex. circular economy concept: MELISSA project

Micro-ecological life support alternative *in space*

- **CREW**
  - **Higher Plants (IV)**
  - **Photosynthetic (IV)**
  - **Nitrifying (III)**
  - **Photoheterotrophic (II)**

- **Fungi**

- **Low mol. Weight organic fatty acids**

- **CO₂**
- **O₂**
- **NO₃⁻**

- **biodass**
- **waste**
World food systems would benefit from an *Intelligently Navigated Complex Adaptive Systems (INCAS)* approach.

*Summary IFSET Special Issue 5, France, 2018*
We need inspiration & creativity

Thanks to MC Escher

Diversity interconnected

Thinking in spirals, not in circles

Changing the landscapes & melting zones

Creating ruptures
We need different views; we need you!
Many thanks for your attention

Bioeconomy conference, Paris, 29 – 30 October 2019
EFFoST Conference on sustainability & food, Rotterdam, The Netherlands, 12 – 14 November 2019

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