The Horizon for Technologies in Future Proofing Food Systems
Hugo de Vries

To cite this version:
Hugo de Vries. The Horizon for Technologies in Future Proofing Food Systems. Italian Society of Food Science and Technology Conference, Jun 2019, Bologna, Italy. pp.1-25. hal-02934216

HAL Id: hal-02934216
https://hal.inrae.fr/hal-02934216
Submitted on 9 Sep 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
The Horizon for Technologies in Future Proofing Food Systems

Hugo de Vries
Research Director at Inra, France
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/..

- **Order / Rigidity** (sub-critical, stable)
- **Chaos (supercritical, unstable)**

Evolutions characterized by sinusoidal patterns

‘melting zone’: self-organized dynamics > favorable domain

Number of different constituents / factors / persons/..

Ref: Kauffman, Prigogine, Holland
What does it mean for food?

> **we need to redefine the limits**

Vitality / ‘richness’

- Non-vital planet earth: chaos
- Non-vital planet earth: rigid, dead

Time 2015 2050

**Scenario 1**

**Scenario 2**

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)

- Scenario 1
- Net effect?
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.
Radical innovations needed in Food systems / ruptures (III)

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

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 marcns
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
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*

- Higher Plants (IV)
- Photosynthetic (IV)
- Nitrifying (III)
- Photoheterotrophic (II)
- Liquefying (I)

- Biomass
- Waste
- NO$_3$-
- CO$_2$
- O$_2$
- Low mol. Weight organic fatty acids
Need for food systems approach

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

hugo.de-vries@inra.fr