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# The Horizon for Technologies in Future Proofing Food Systems

Hugo de Vries

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# The Horizon for Technologies in Future Proofing Food Systems

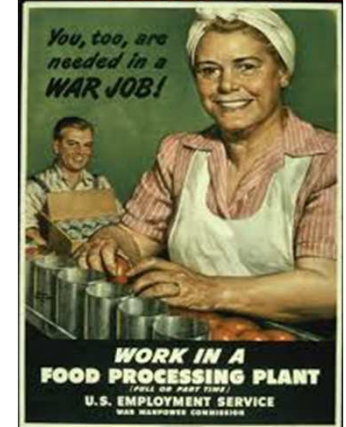
Hugo de Vries  
Research Director at Inra, France





# 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?**

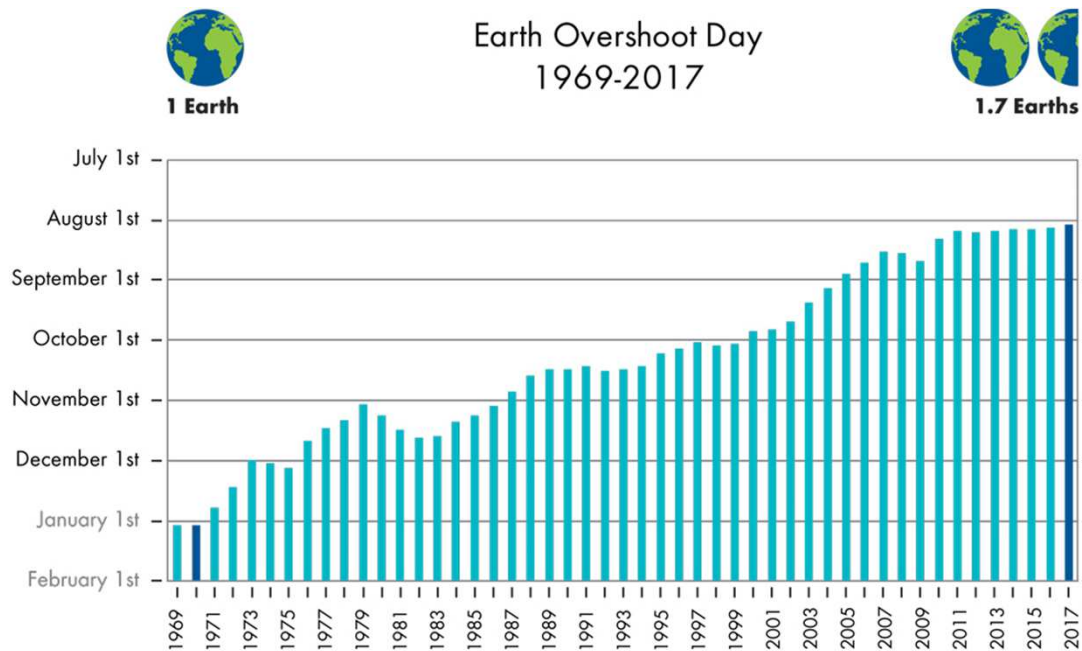


# What are Future Proofing Food Systems?

- 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



Source: Global Footprint Network National Footprint Accounts 2017

Combien de Chine faut-il pour subvenir aux besoins des Chinois?

CHINE 2.7

Qu'en est-il des autres pays?

FRANCE 1.4

U.S.A 1.9

INDE 2.0

ALLEMAGNE 2.1

GRECE 2.6

G.B. 3.0

EGYPTE 3.2

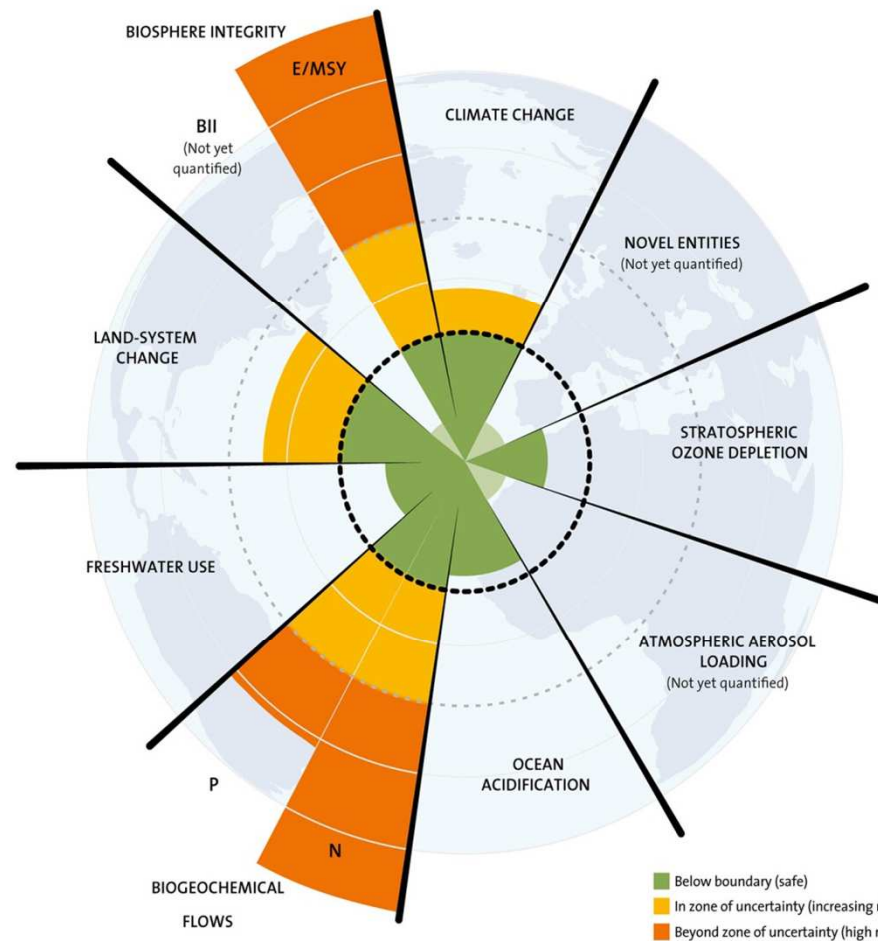
SUISSE 3.5

ITALIE 3.8

JAPON 5.5

MONDE 1.6

# And yet in some alarming zones



<https://www.stockholmresilience.org/research/planetary-boundaries.html>



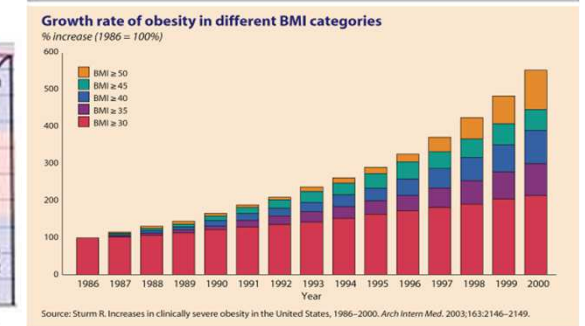
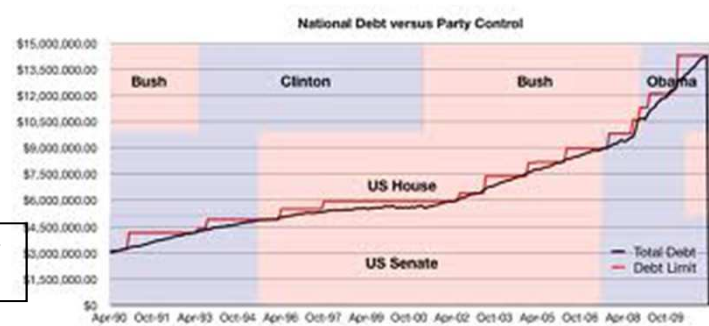
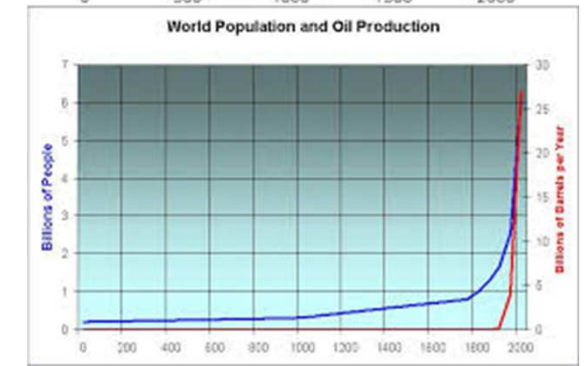
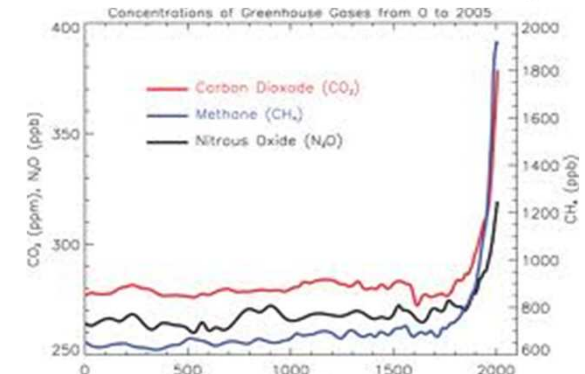
# And other major challenges?

## 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



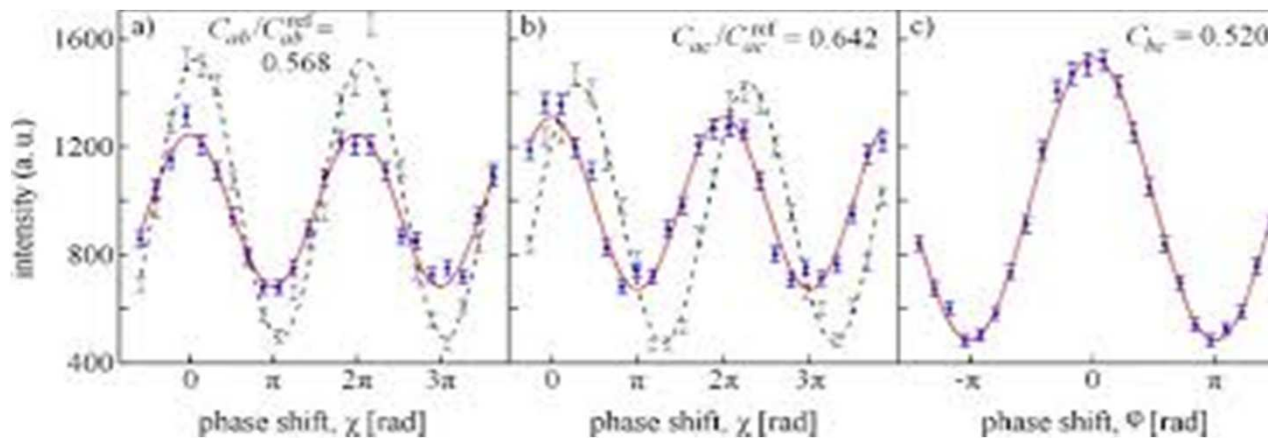
<http://www.worldometers.info/>

# 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*

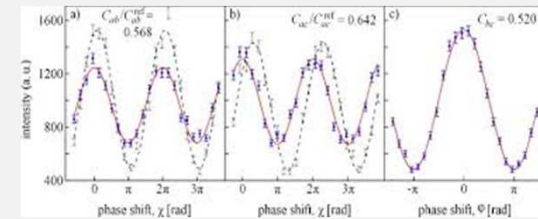
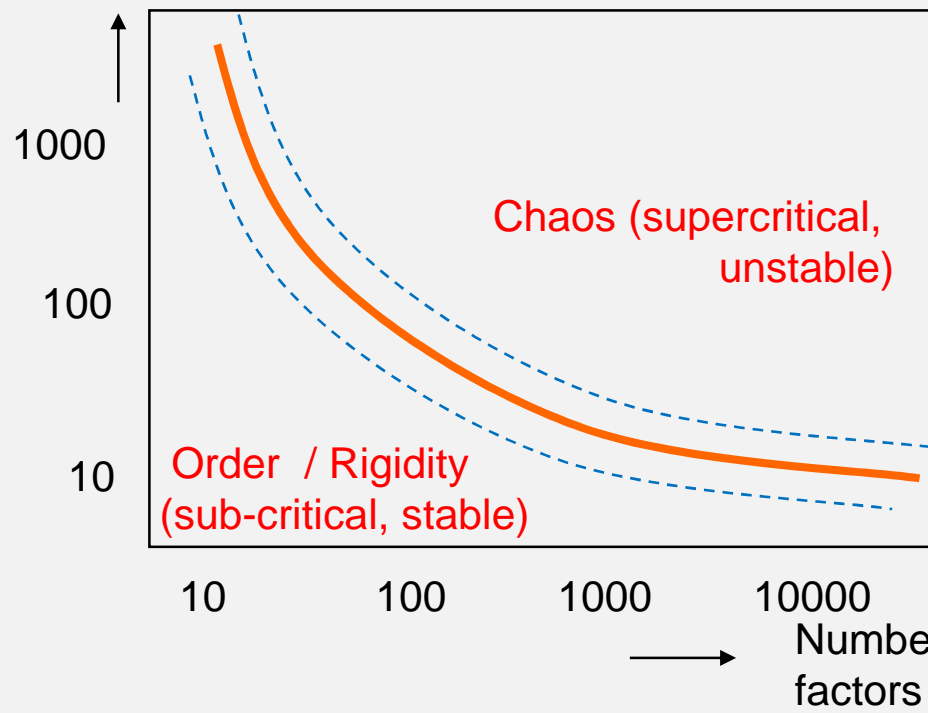




# A frame where we balance at the edge of order and chaos

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

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



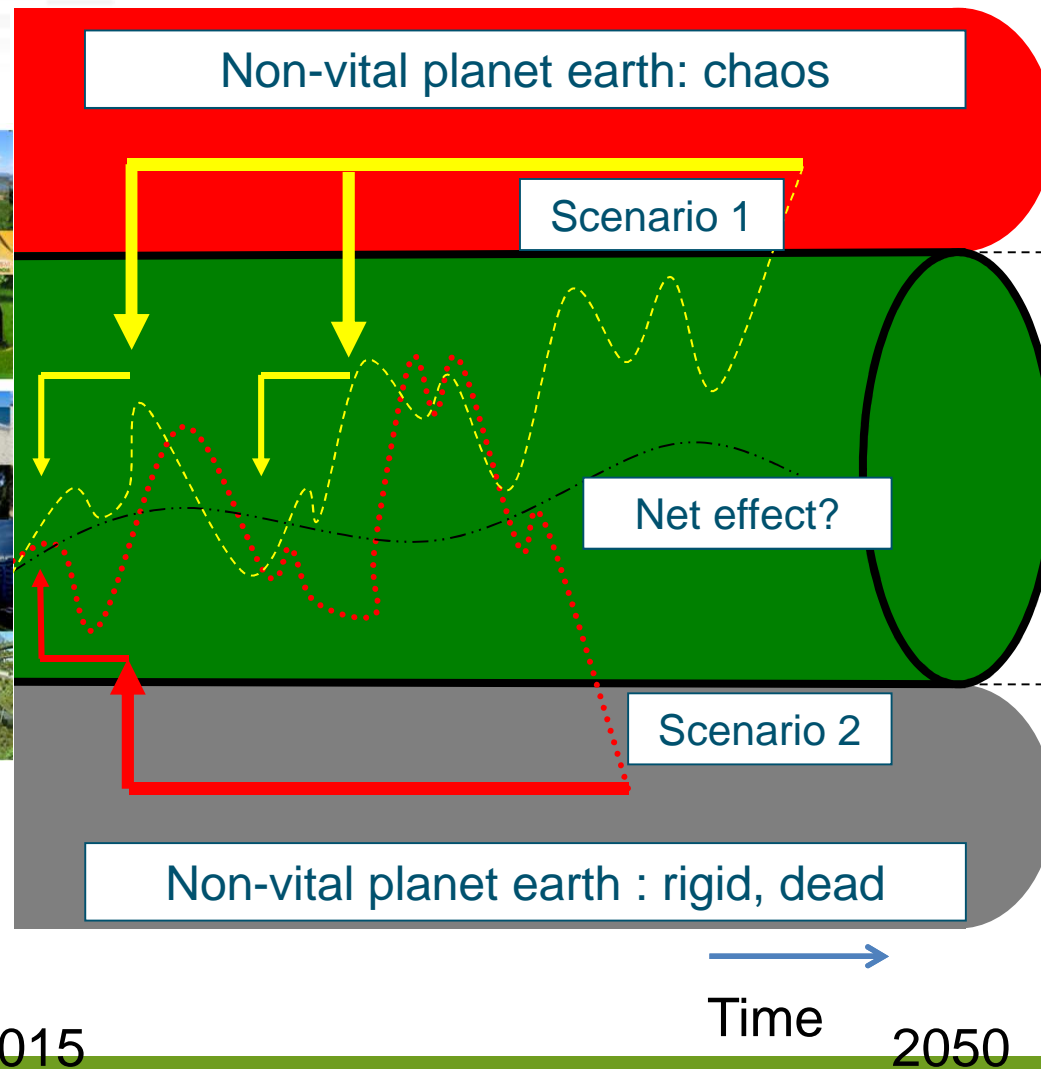
*Evolutions characterized by sinusoidal patterns*

'melting zone': self-organized dynamics > favorable domain

# What does it mean for food?

> *we need to redefine the limits*

Vitality /  
'richness



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

*Luxurious products/services*

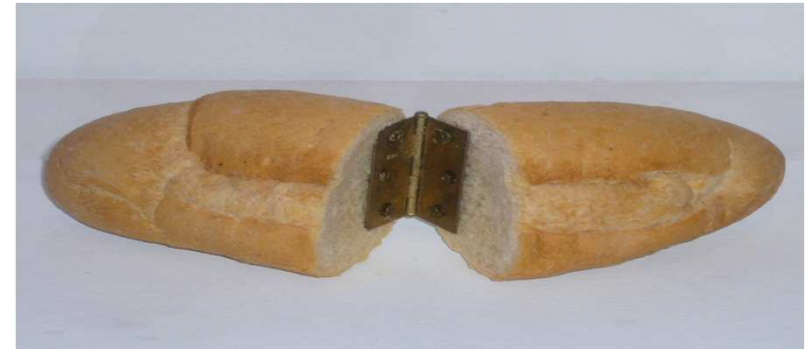
*Primary needs*

- 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,
- ..



Museum Booymans van  
Beuningen, Rotterdam

# 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.


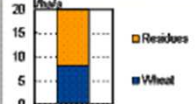



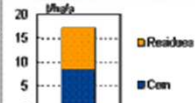

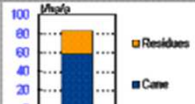

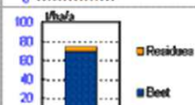


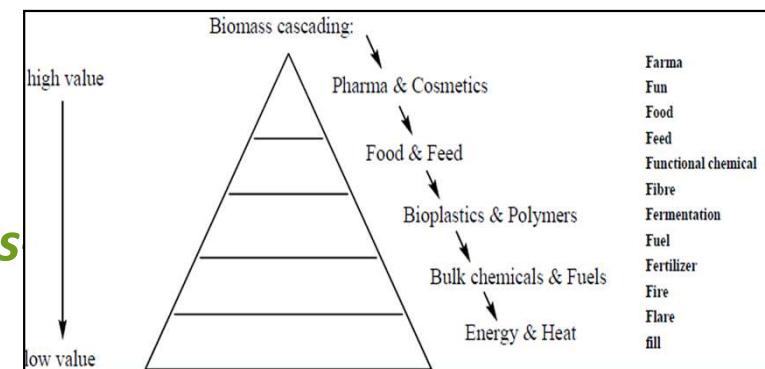
# Radical innovations needed in Food systems / ruptures (III)

## 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 trans disciplinary (management, economics, genetics,...)**

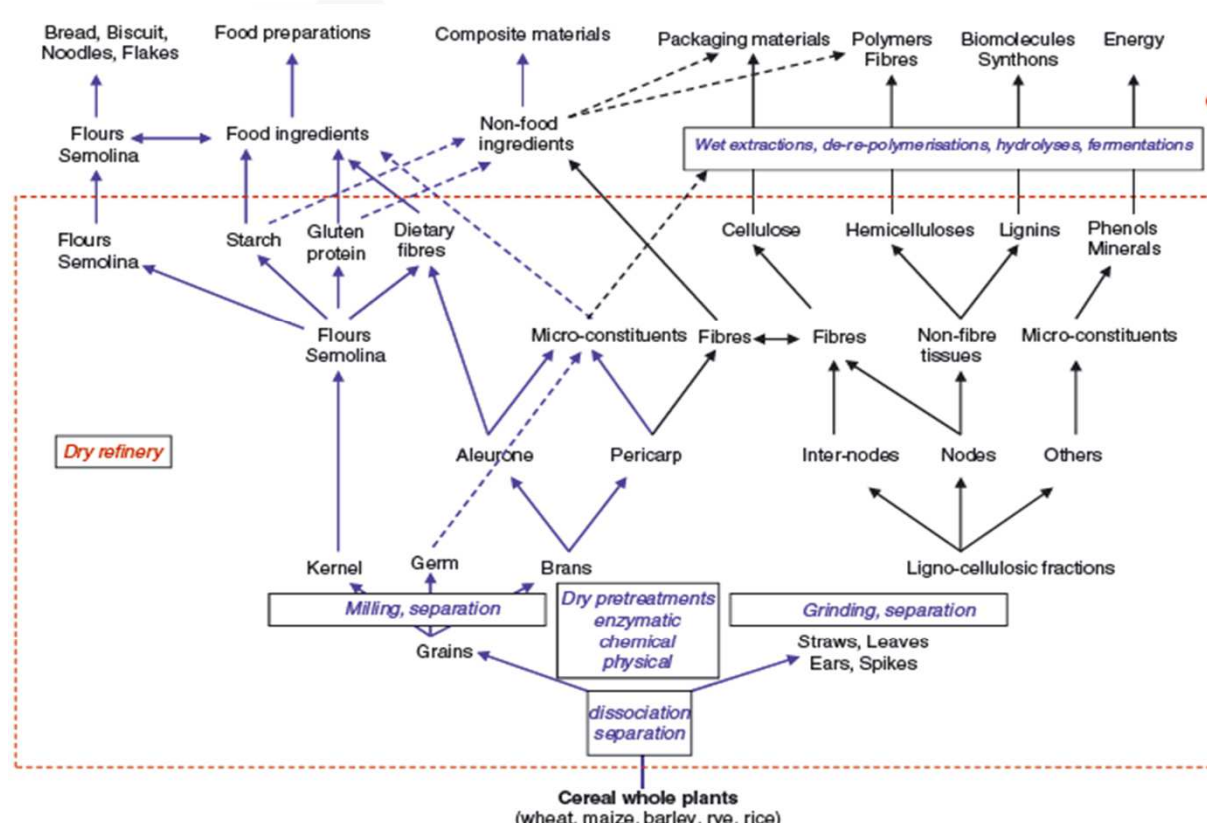
Feedstock	Crop yield kg/ha/a (fresh)	Residues kg/ha/a	Fractions																		
 Wheat	8000	11800																			
 Rye	3800	4400																			
 Corn	8180	<table border="1"> <tr><td colspan="3">8700</td></tr> <tr><td>Type</td><td>MC</td><td>Share d.w.</td></tr> <tr><td>Stalk</td><td>70-75</td><td>50</td></tr> <tr><td>Leaf</td><td>20-25</td><td>20</td></tr> <tr><td>Cob</td><td>50-55</td><td>20</td></tr> <tr><td>Husk</td><td>45-50</td><td>10</td></tr> </table>	8700			Type	MC	Share d.w.	Stalk	70-75	50	Leaf	20-25	20	Cob	50-55	20	Husk	45-50	10	
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 Sugar cane	58000-88000	24000-37000																			
 Sugar beet	69300	4700																			



Sources: Poyry and Sanders



# Ex. waterless system: dry fractionation



**Reverse engineering**  
Societal needs  
Consumer demand

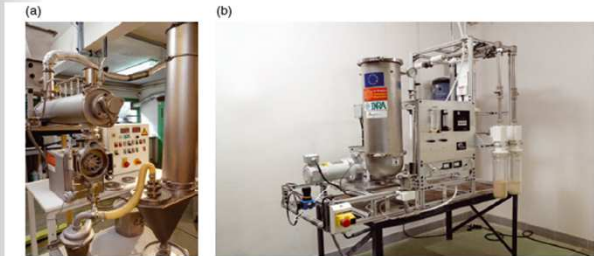


Figure 5. Pilot equipments for cryomilling (a) and electrostatic sorting (b) at INRA-IATE.

**Innovative processing technologies**

**Resources adaptation**

Genetics  
Agronomy  
Environment

Biodiversity

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

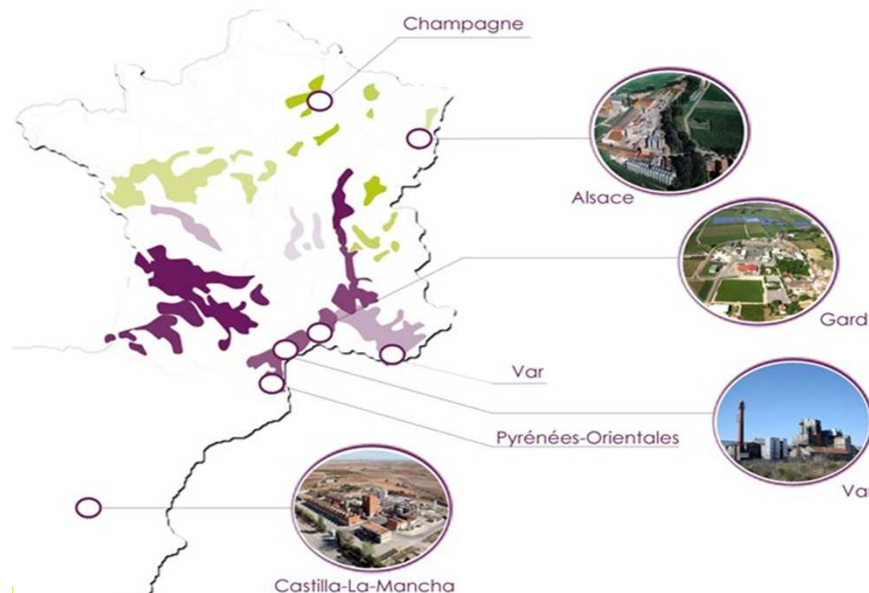
→ GrapSud, a union of 7 wine cooperatives located in the South of France, with 210 employees on 6 production sites

## 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.

# Ex. alternative proteins sources & products

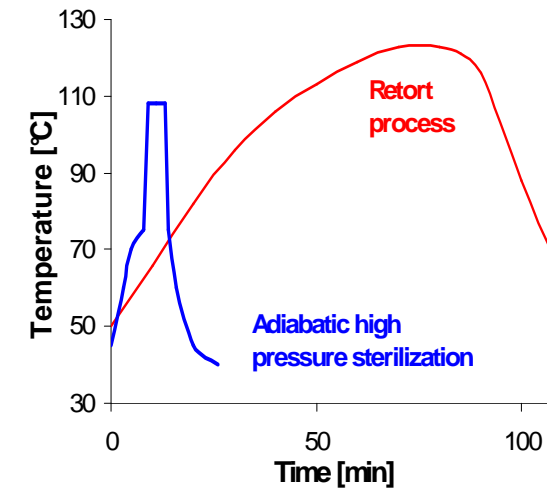
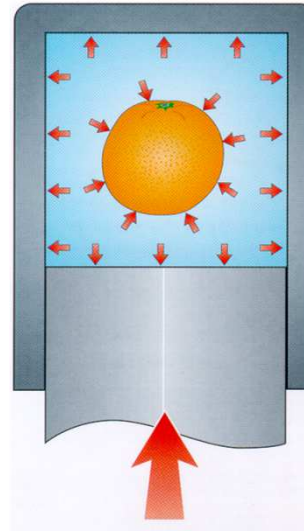


meat alternatives on basis of new plant, algae and insect protein sources

**WHY RUPTURE? .... Substantial reduction of environmental pressure due to protein-conversion factors and greenhouse gas emissions (CH<sub>4</sub>, etc.), challenges with nutritional profiles, ...**

15





Why rupture? Adiabatic heating  $\gg$  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)

**NovelQ**

*EC FP6 Integrated Project*

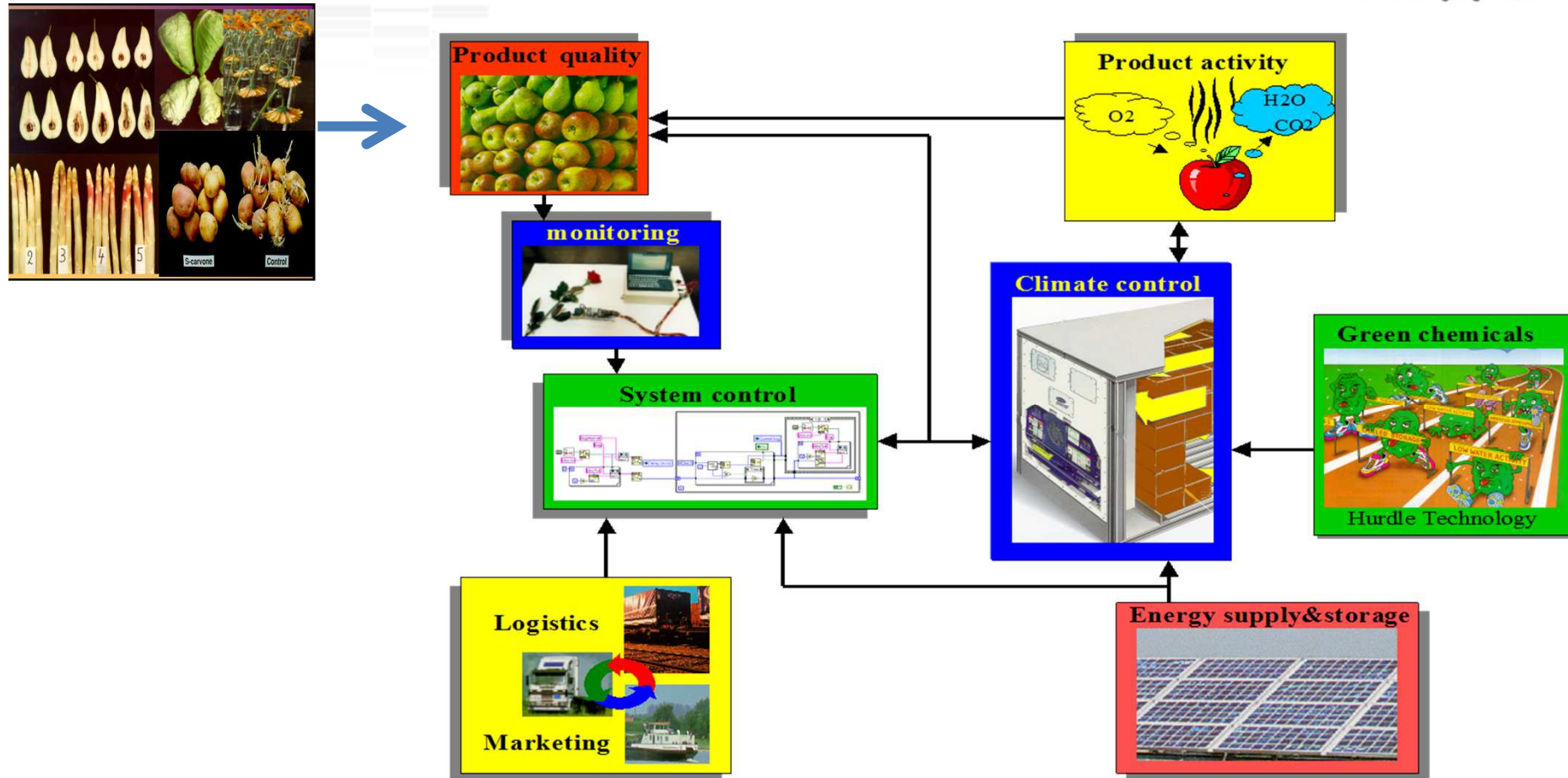


<http://www.innovation-xl.com/en/nutripulse.html>

**WHY RUPTURE? .... Energy for cooking 80% reduced & inactivation of spores at room temperature ...**

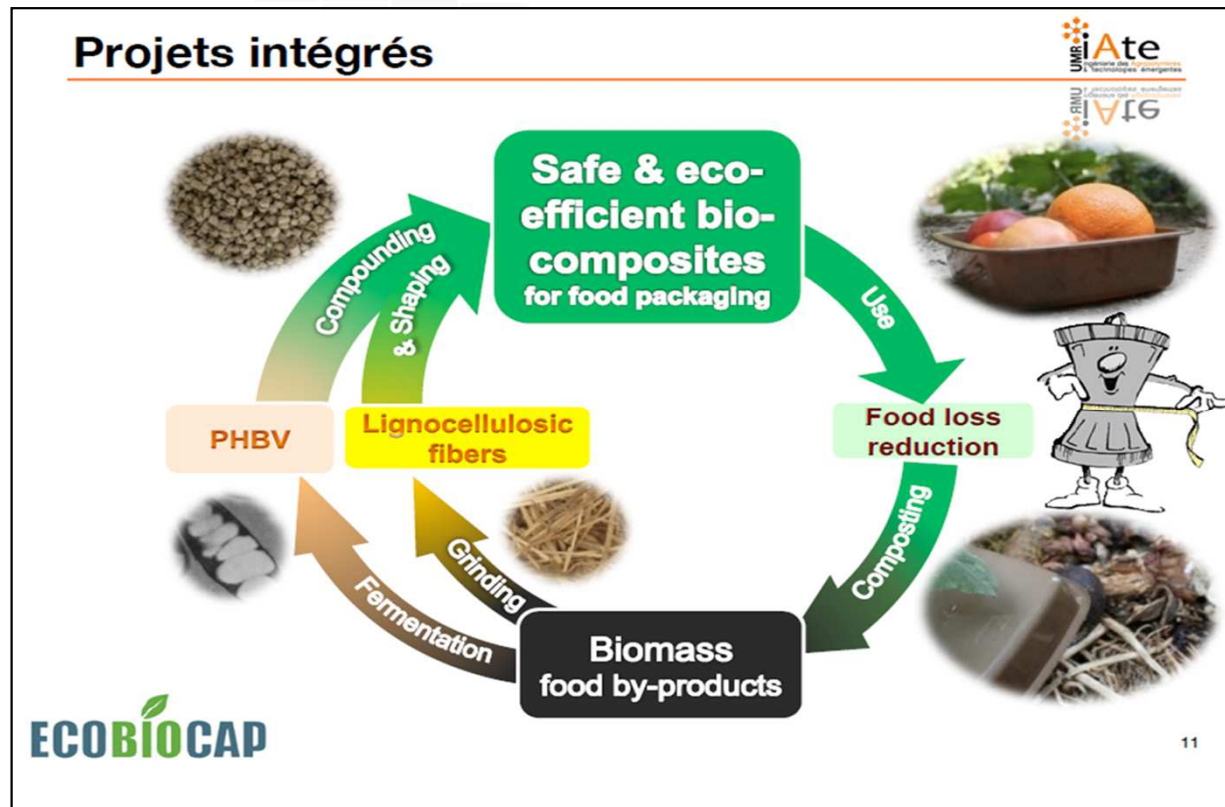


# Ex. Eco-efficient dynamic storage



**WHY RUPTURE? ... Energy for climatisation during transport 70% reduced & stand alone & reduction of product loss**

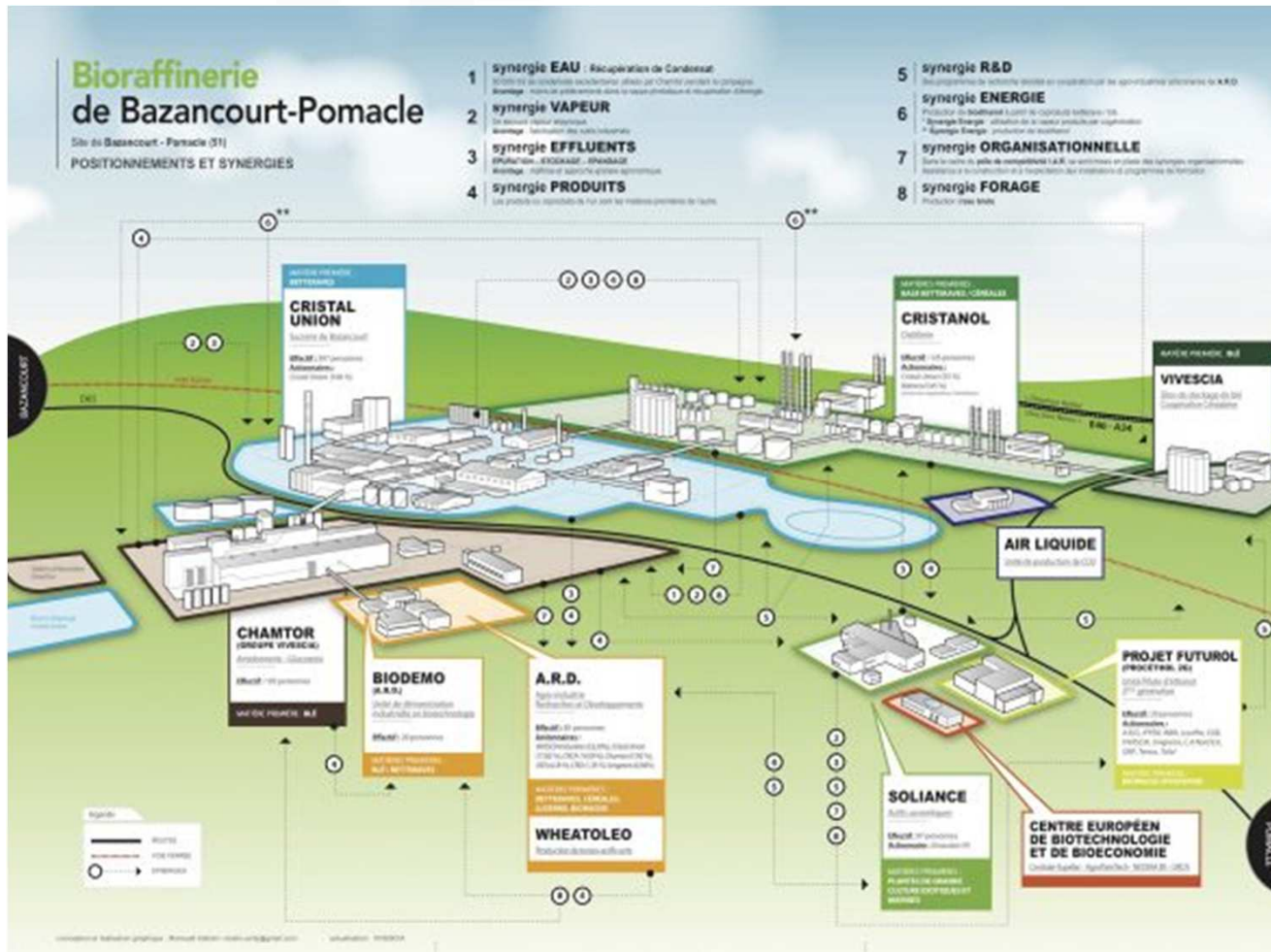
# Ex. biodegradable packaging materials



EC-FP7 project,  
Gontard et al

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

# Ex. Industrial ecology concept

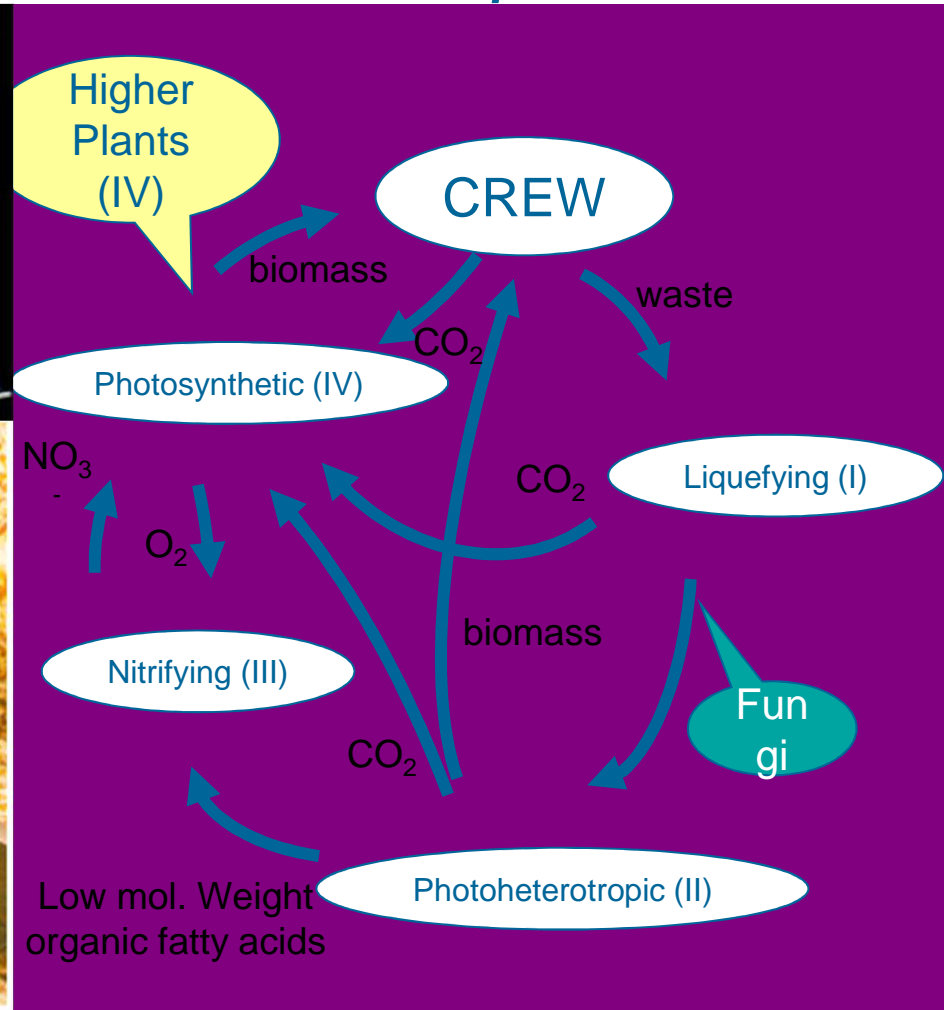


**WHY RUPTURE? ...**  
**Closed**  
**circles/spirals locally**  
**> zero waste**  
**(potentially), new**  
**cooperation forms**

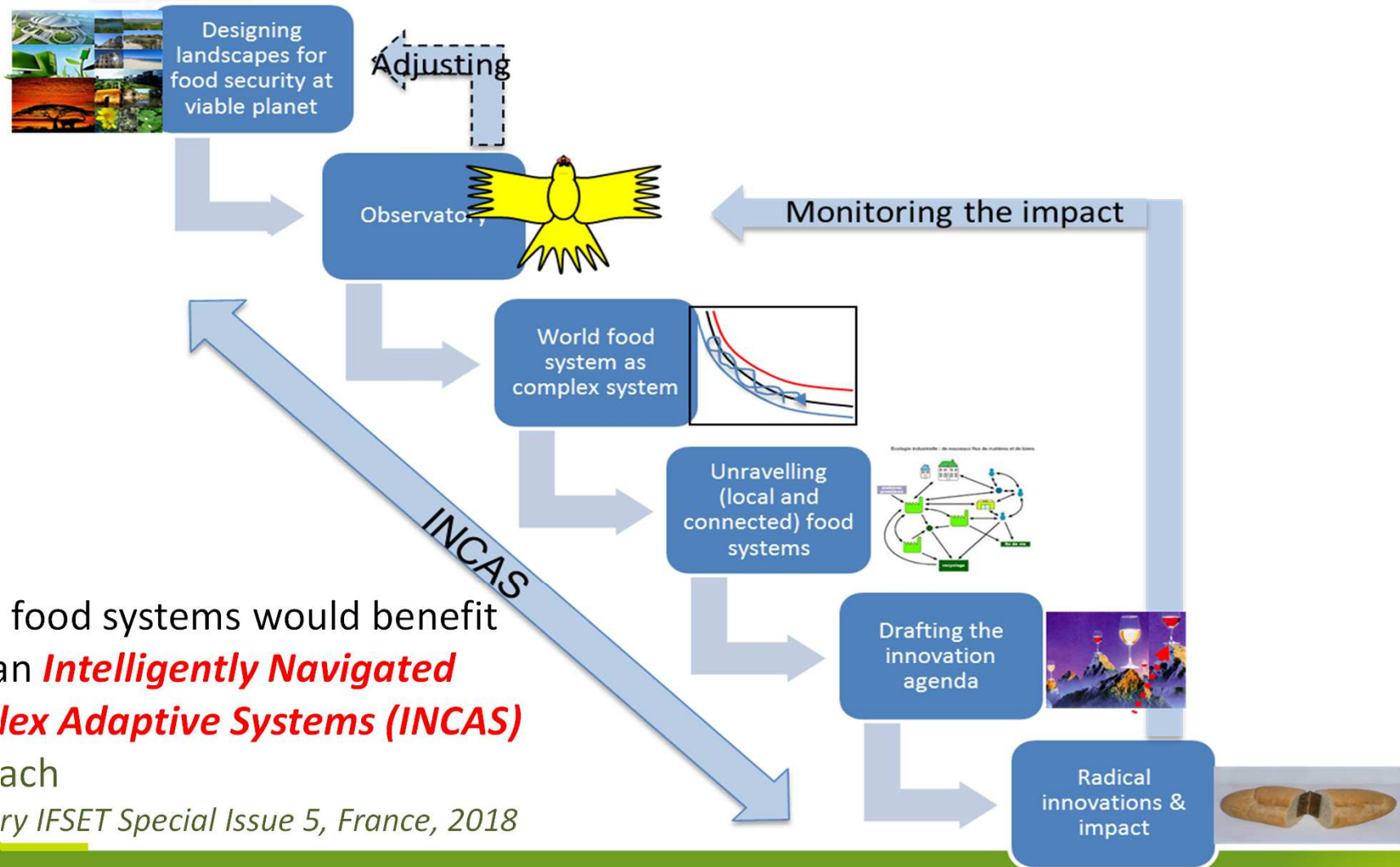


# Ex. circular economy concept: MELISSA project

## Micro-ecological life support alternative *in space*



# 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*



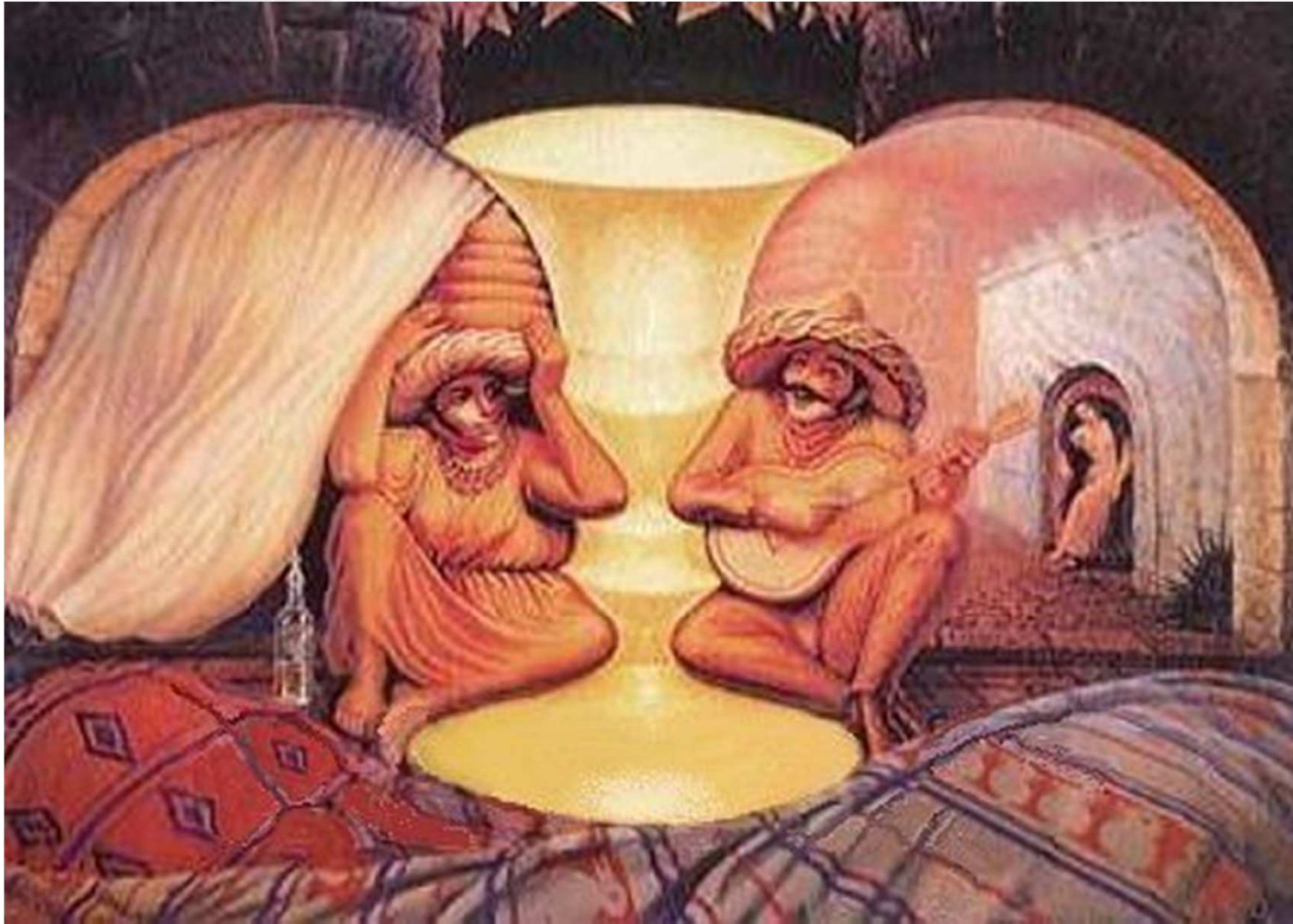
*Changing the landscapes & melting zones*



*Creating ruptures*



We need different views; we need you!





# Many thanks for your attention



(C) WWF Bioplastic Feedstock Alliance

*Bioeconomy conference, Paris, 29 – 30 October 2019*

*EFFoST Conference on sustainability & food, Rotterdam, The Netherlands,  
12 – 14 November 2019*

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