



## Technology meets ecology and economy; different cases on 'bio-economy systems' in Europe

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# Technology meets ecology and economy; different cases on 'bio-economy systems' in Europe.

Hugo de Vries, Mechthild Donner and Monique Axelos  
Inra, France





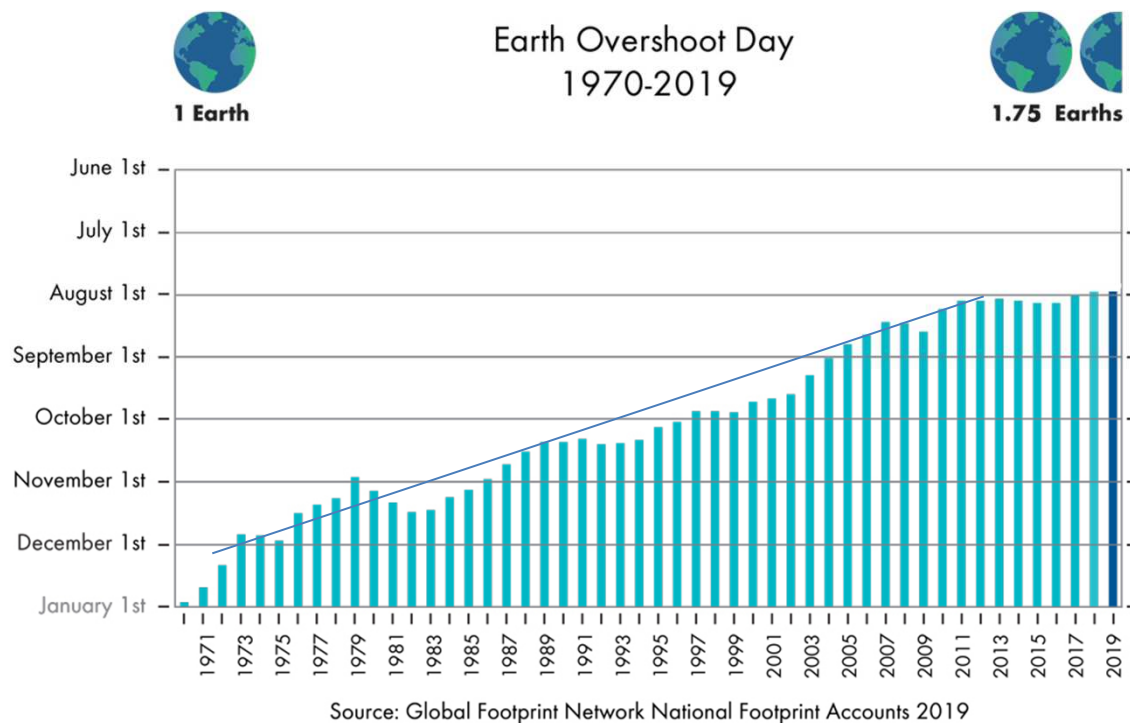
# Content

- Where are we?
- What do we need?
- And for **technology and new business models**  
> which radical innovations?
- Examples of potential options for both  
technology and new business?
- Need for a **bio-economy systems approach?**

# Where are we?

- An enormous challenge!

**Earth overshoot day 2019 is July 29 !**



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



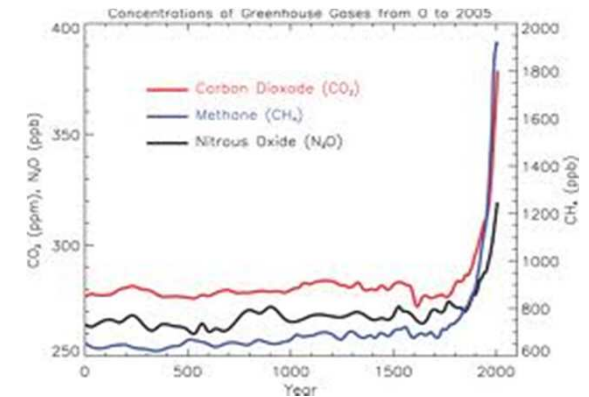
# Major challenges?

## Exponential curves

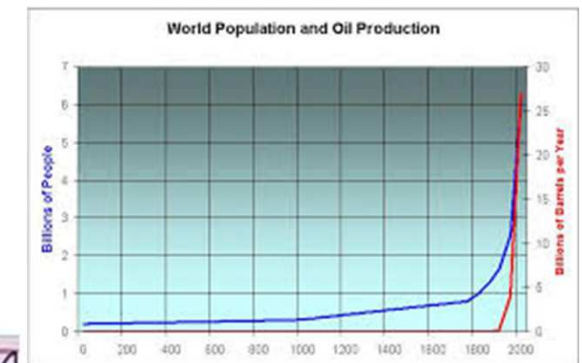
We are currently **extending the expiry date** of our planet.

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

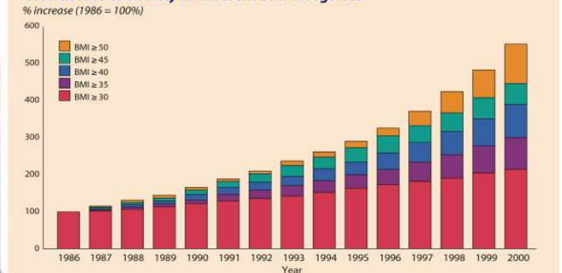
We are not able to take away the uncertainties about a well-balanced society



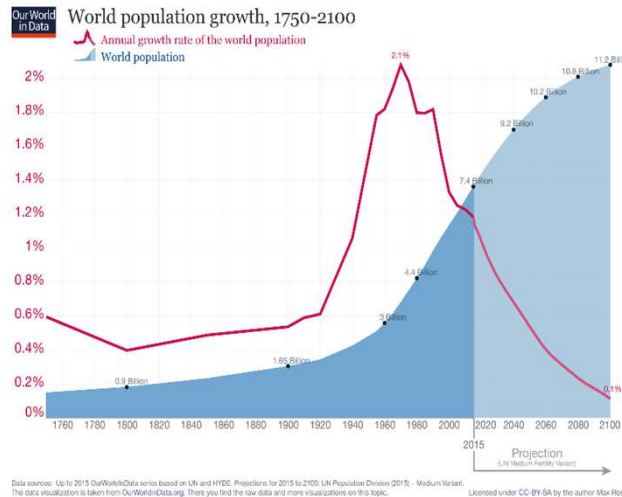
[www.worldometers.info/](http://www.worldometers.info/)



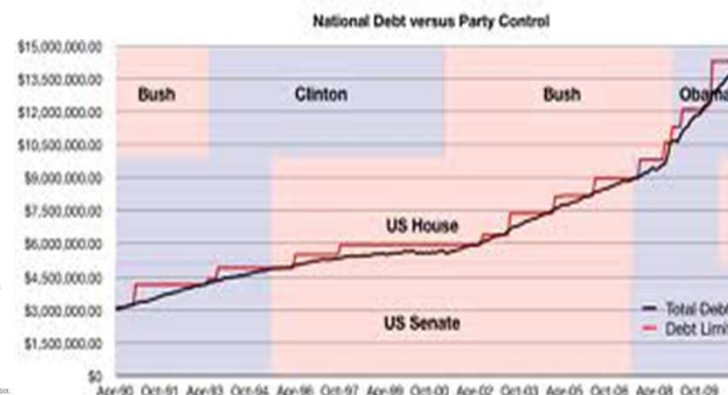
Growth rate of obesity in different BMI categories



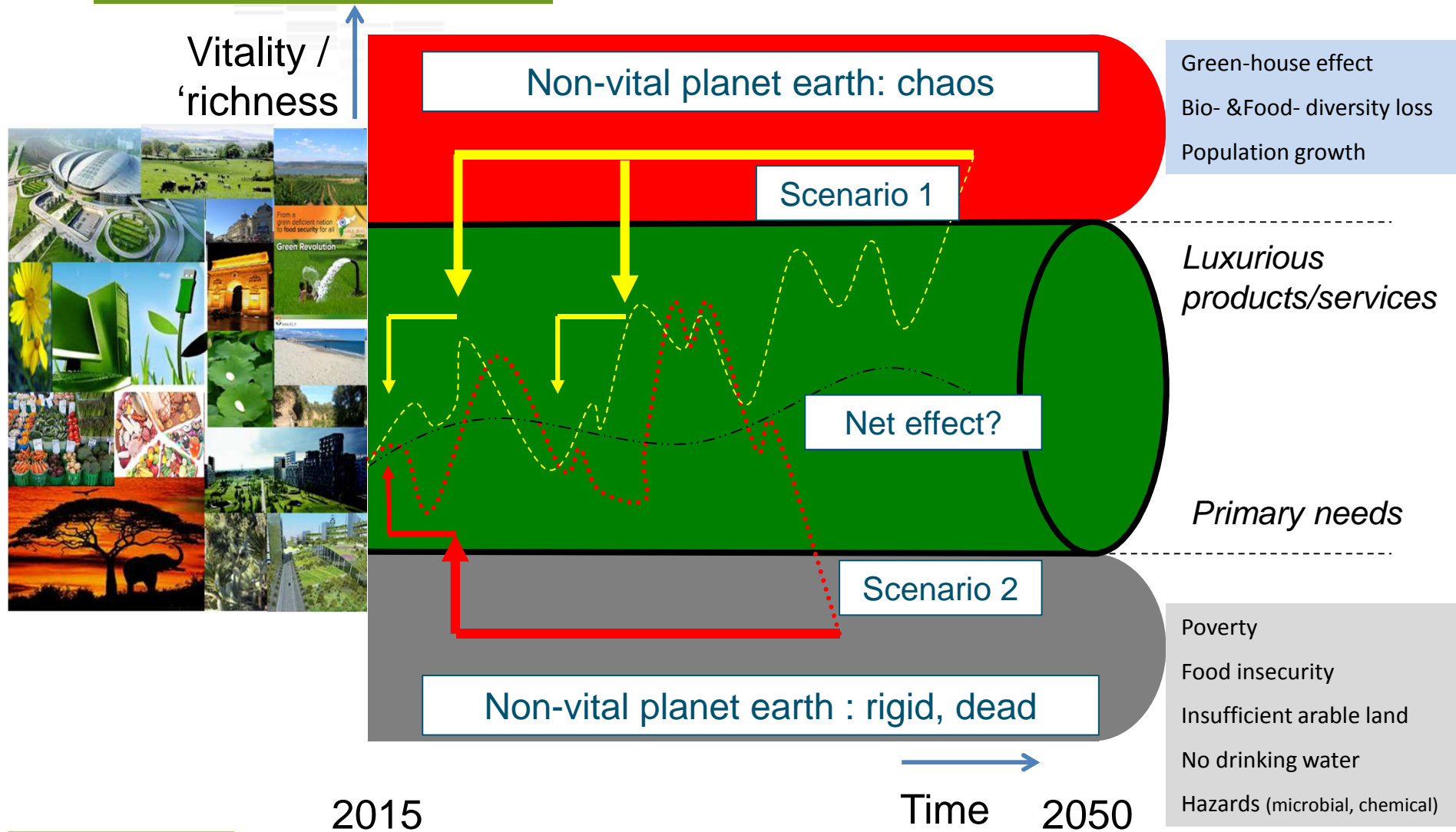
Source: Sturm R. Increases in clinically severe obesity in the United States, 1986–2000. *Arch Intern Med*. 2003;163:2146–2149.



Data sources: Up to 2015 OurWorldInData series based on UN and HYDE. Projections for 2015 to 2100: UN Population Division (2015) - Medium Variant. The data visualization is taken from OurWorldInData.org. There you find the raw data and more visualizations on this topic. Licensed under CC-BY-SA by the author Max Hoes.



# What do we need? > *we need to redefine the limits* > ecology as driver





# Options from the technology perspective

# Innovations in technology with consequences for business: avoiding unnecessary exploitation of resources (I)

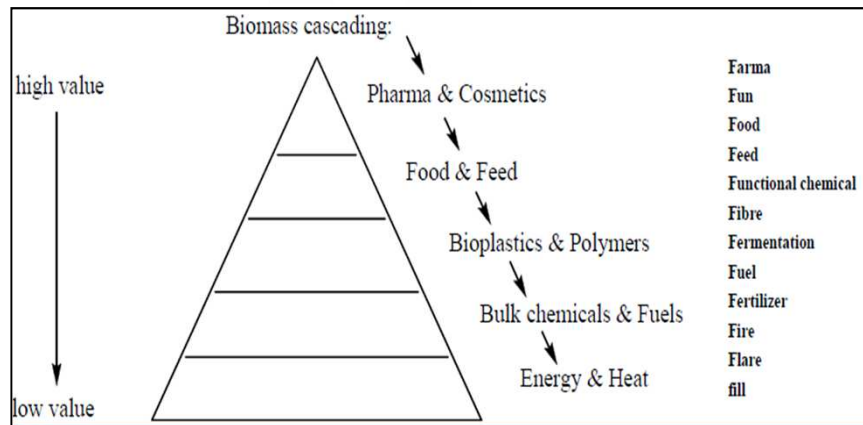
<u>New Technologies</u>	<u>Business proposition</u>	Business model
From products to services & de-materialization	Consultancy, support structure, cross-sector alliance	Individual / cluster of companies
Low density – high satiety food	New value proposition	Individual company
Alternative protein sources	New value proposition, cross-sector alliance	Individual/ cluster of company
Utilization the richness of nature's structures (biomimetic),	New value proposition, cross-sector alliance	Individual/ cluster of company
Waterless systems	New value proposition	Individual company
Synthetic biology pathways	New value proposition	Individual company


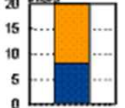

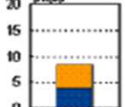

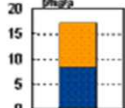
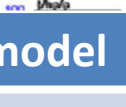


## Innovations in technology with consequences for business: efficiently transform and use agro-resources (II)

<u>New Technologies</u>	<u>Business proposition</u>	Business model
Autocatalytic systems	Autocatalytic firms?	Not yet known
Targeted processes (not over-dimensioned)	New value proposition	Individual company
Process intensification	Cluster of companies	Cluster of companies
Local bio-refineries at the farm	Bio-refinery plant	Cluster of companies
New ICT driven processes (virtual design, domotics, 3D printing, ...)	New value proposition	Individual company
Eco-efficient dynamic storage	Cross-sector Alliance	Cluster of companies
High precision water-droplet systems	New value proposition	Individual company
Energy efficient desalting of sea water	New value proposition	Individual company
Novel biomaterials & packaging concepts	New value proposition	Individual company

# Innovations in technology with consequences for business: (re-)valorising co-products and waste streams (III)



Feedstock	Crop yield kg/ha/a (fresh)	Residues kg/ha/a	Fractions
	8000	11800	
	3800	4400	
	8160	8700 Type MC Share d.w. Stalk 70-75 60 Leaf 20-25 20 Cob 50-55 20 Husk 45-50 10	
Sugar cane			

<u>New Technologies</u>	<u>Business proposition</u>	Business model
Eco-pyramid valorisation of resources	Agro-parks, Bio-refinery Plant, Cross-sector Alliance	Cluster
Aquaponics systems	New value proposition	Individual company
New salt tolerant species	New value proposition	Individual company
Diverse agro-ecological-processing methods	Cooperative, Bio-refinery plant, Agro-park, Industrial ecology	Cluster



# Options from the business perspective

# Innovations in business with consequences for technology with ecology/environment as driver

<u>New Business concepts</u>	<u>Business proposition</u>	Technology impact
New company activity in the <u>chain</u> (standard business model)	Product or technology innovation	New product or technology
Cluster of companies in the <u>chain</u> with multiple innovations	Product or technology innovations	A series of new products or technologies
Cluster of companies for valorizing products in a <u>cascading</u> manner	Cross-sector alliance, Multiple product or technology innovations	A series of new organizational clusters, products or technologies
<u>Circular</u> business models	New value proposition cross-sector alliance	New products should be recyclable, new techno?
New <u>cross-sector network</u> of companies	Radical innovations	Both product, technology and organizational

# Examples in new business & technology, going hand in hand



(C) WWF Bioplastic Feedstock Alliance



## Example 1

*New technology and business  
for valorising a co-product  
'innovation in the chain'*

# New technologies for extracting proteins from by-product streams



To be used as meat alternatives on basis of new plant, algae and insect protein sources or for bio-based products (coatings, paints, dermatology)

**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, ...**

14



# New business concept for protein valorisation: IMPROVE consortium or BBI Greenprotein team



**IMPROVE**  
Open Innovation Platform  
PROTEINS

Leading European centre  
for proteins valorisation

**TARGETED MARKETS:**  
Food, feed, cosmetics, biobased material  
& chemistry

**SCIENTIFIC ROAD MAP:**

- Extraction of native (soluble) proteins: properties assessment
- Aggregation, cross-linking, interaction with other proteins or polysaccharides
- Enzymatic hydrolysis and fractionation, for functional / nutritional / biological properties
- Determine mechanisms of biological properties (interaction with humans and animals)
- Bioactive peptides, allergenic response...
- Sustainable proteins modifications (chemical, enzymatic, thermo-mechanical treatments)
- Market, societal & Economical Studies

**FACILITIES:**  
170m² of laboratories and an 800m² pilot facilities covering a wide range of unit operations:

- Fractionation / separation
- Extraction / purification / concentration
- Enzymatic processing
- Drying / atomization
- Granulation / extrusion
- Physico-chemical and functional characterisation

**SERVICES PROVIDED:**

- Scientific and technical expertise (decision-making support)
- Confidential contractual research project (research services involving our laboratories and pilot facilities)
- Shorter-term services to resolve specific problems

**Examples of services:**

- Optimising a particular unit operation
- Designing a new process, from raw material to end product
- Producing samples for marketing to potential customers
- Characterising functionalities of a protein extract
- Improving product's digestibility
- Assessing new product's allergenic response

**IMPROVE**  
Multidisciplinary Institute for Proteins

Denis Chassaie  
+33 (0)3 22 44 26 55 - contact@improve-institut.com  
www.improve-institut.com

**IAR**  
International Association of Research in Food Technology



## Project data

- **Acronym:** GreenProtein
- **Project title:** Revalorisation of vegetable processing industry remnants into high-value functional proteins and other food ingredients.
- **Call:** Bio Based Industries Joint Undertaking . VC3. D5-2015 - Valorisation of agricultural residues and side streams from the agro-food industry -LINK-
- **Grant Agreement Number:** 720728
- **Consortium:** Nine partners from 5 different countries. Provalor B.V. (NL) – coordinator-, TNO (NL), Florette France GMS (FR), Ruitenberg Ingredients B.V. (NL), Bionet Engineering (ES), INRA (FR), Eurizon S.L. (ES), Pazmany Peter Catholic University (HU), Union Nikola Tesla - Faculty of Business and Industrial Management (RS)
- **Project leader:** Paulus Kusters, GreenProtein BV, Wageningen (NL)
- **Duration:** starting date 1<sup>st</sup> of September and it will last 4,5 years.
- **Budget:** 5.5 Million €

**WHY RUPTURE? .... New cooperation forms between companies, sharing of facilities, co-investments, ...**





## Example 2

*New technology and business  
with multiple innovations in  
the chain*

*‘cluster in a chain’*

# Examples: Innovation from the field to the plate:



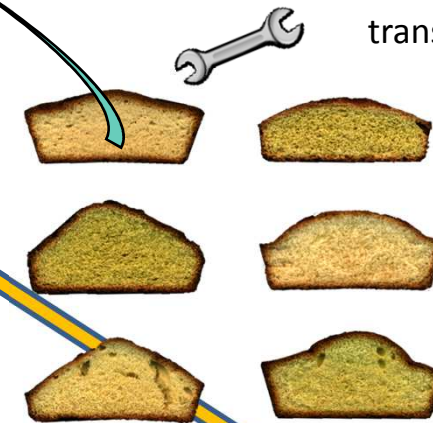
Rupture : New  
type of  
agriculture

**Reduction of  
fertilizers**

**% wheat/legumes >  
new mixed resources**



Novel dry  
fractionation &  
transformation steps

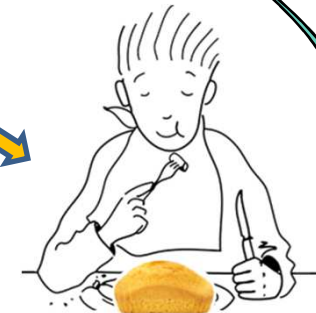


Ref: « Flexiprocess » project  
M.H. Jeuffroy & C Michon  
« Vegage » project V. Micard  
« Defi Blé Dur » project B. Cuq

French National strategy for protein  
transition

**New  
Nutritional  
advantages**

Approval ?



# New but temporary network of companies

## *BPI France Défi Blé Dur*

- 1 R&D centre, **INRA**
- 7 **industrial partners** (SME and multinationals) :
  - Pasta chain companies (95% of the total production) and couscous (100% of the total production ), **Alpina Savoie, Heimbürger, Panzani (coordinator), Pastacorp, Tipiak Epicerie**



- 2 support structures / companies:  
**ETIA, ENGIE Cofely**





## Example 3

*New technology and business  
for entire plant usage,  
'cascading usage'*

*Cross-sector alliance /  
cooperative*

# Ex. technologies for full plant resource usage dry fractionation

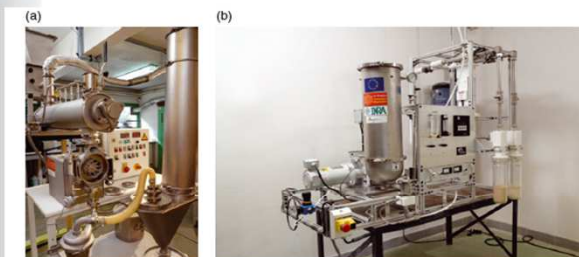
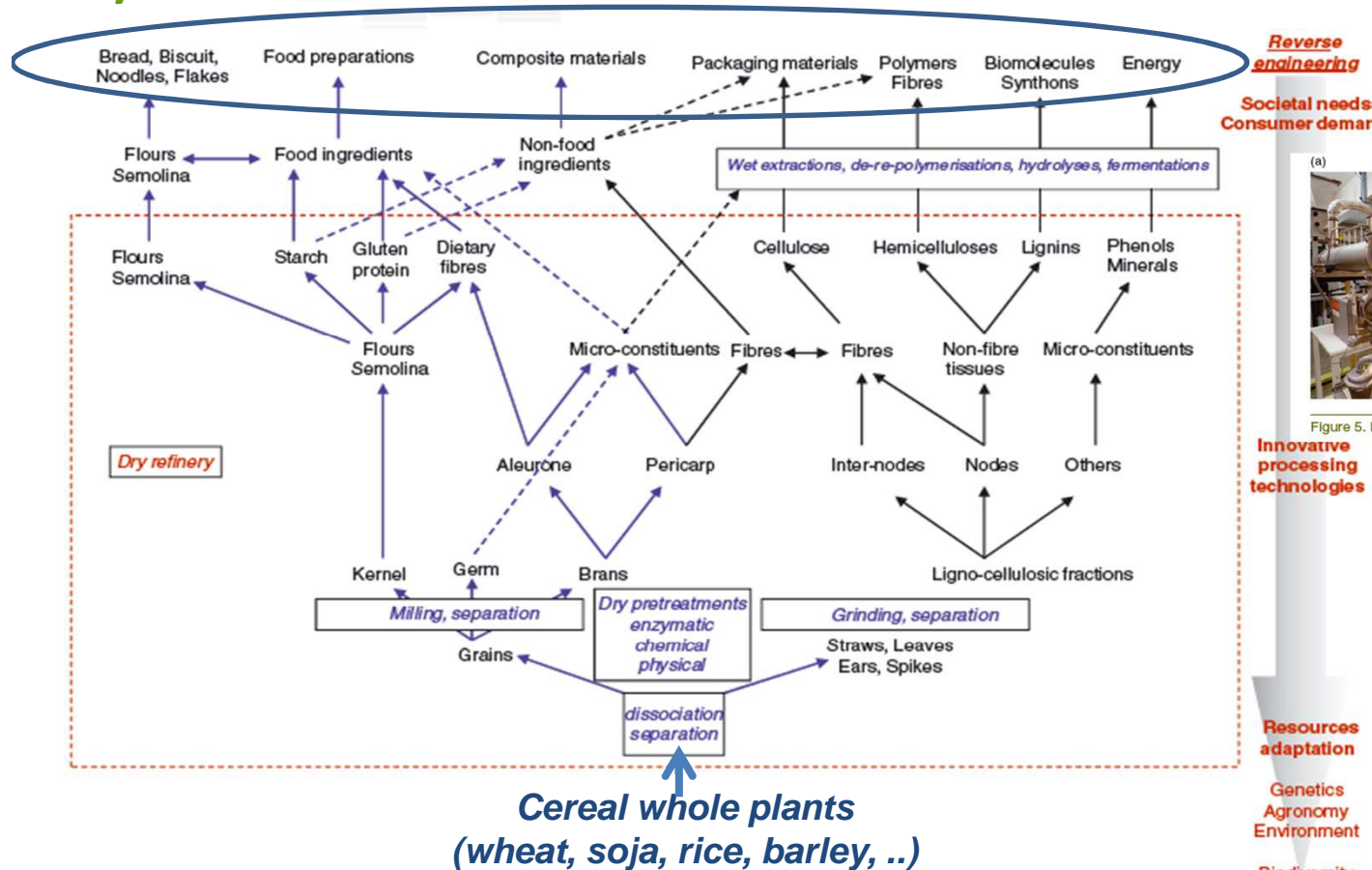


Figure 5. Pilot equipments for cryomilling (a) and electrostatic sorting (b) at INRA-IATE.

Abecassis et al., 2013, ..

**WHY RUPTURE? .... Integral use of biomass, no *water added* during processing (thus no drying), local applicability, avoiding water transport, local employment**



# Ex. New business model for entire plant usage; Grap'Sud

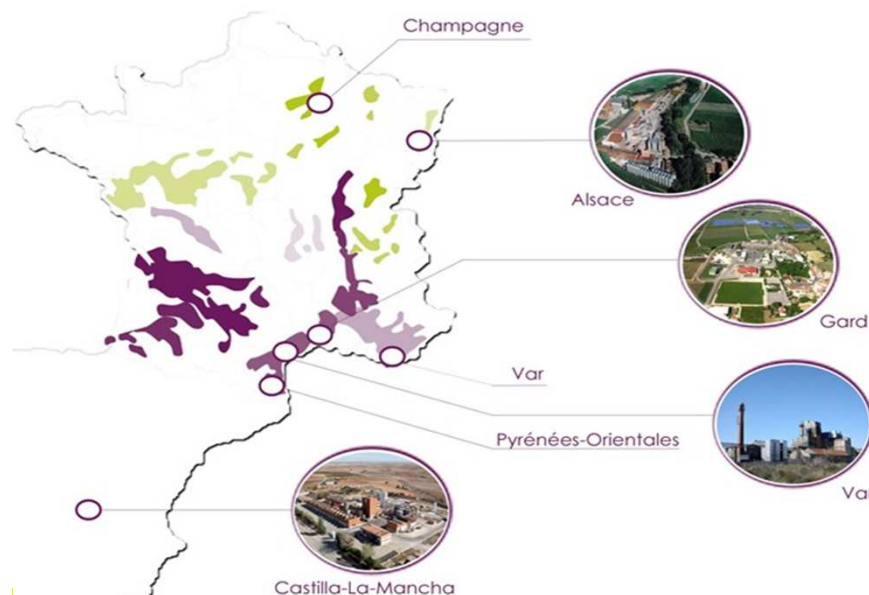
→ GrapSud, a union of 7 wine cooperatives located in the South of France, with 210 employees on 6 production sites

## Waste valorised:

125 000 tonnes of grape marc

270 000 hl of wine lees

600 000 hl of wine most



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

→ **Alternative cooperative structure** focused on multi-market business.

# Ex. New Association Bâtir-en-Balles



→ **New association** formed  
focused on non-food business

→ **Cross-sector valorization: rice husks in the Camargue for eco-construction**

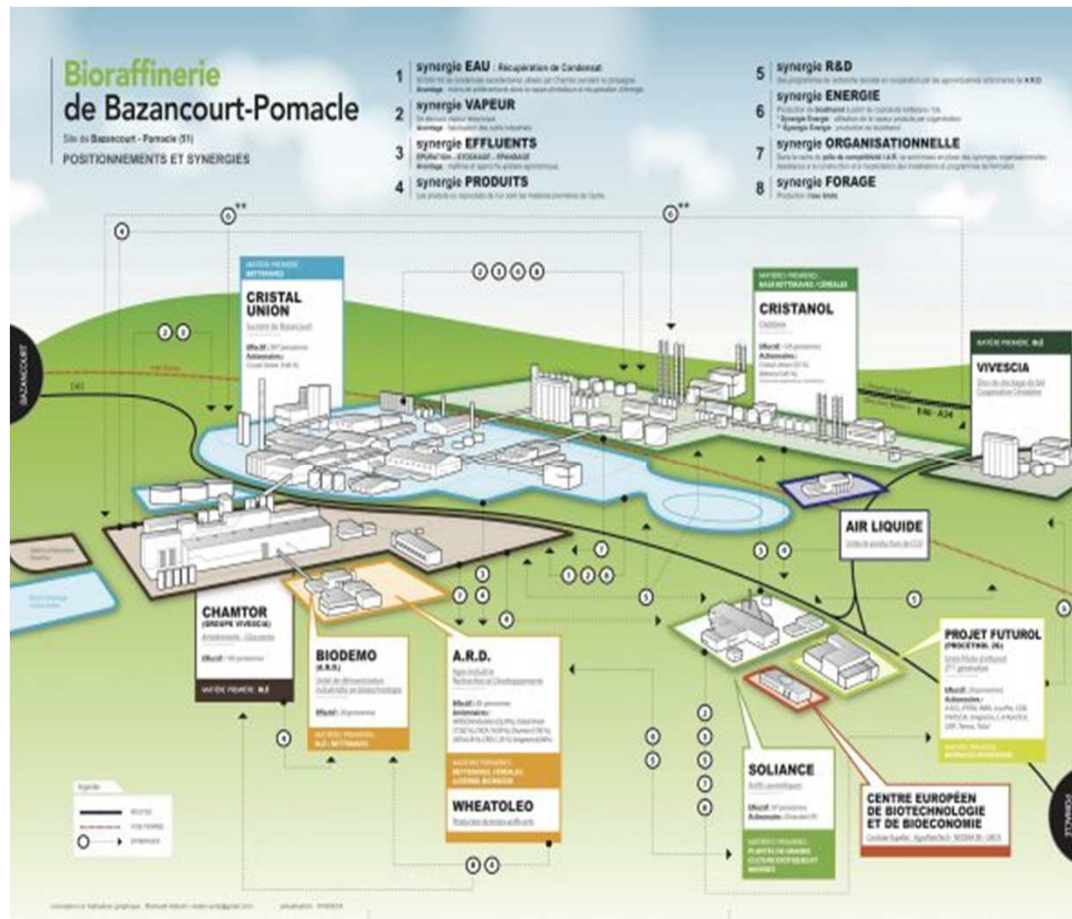




## Example 4

*New technology and business  
for industrial ecology  
'circular business model'*





Industrial ecology parks / symbiosis for regional development:

- Large scale: Pomacle

- Small scale: Biovallée



## Example 5

*New technology and business  
as cross-sector innovation  
'network approach'*

# Ex. Efficient dynamic storage for maritime transport

P&O Nedlloyd

Carrier  
TRANSICOLD

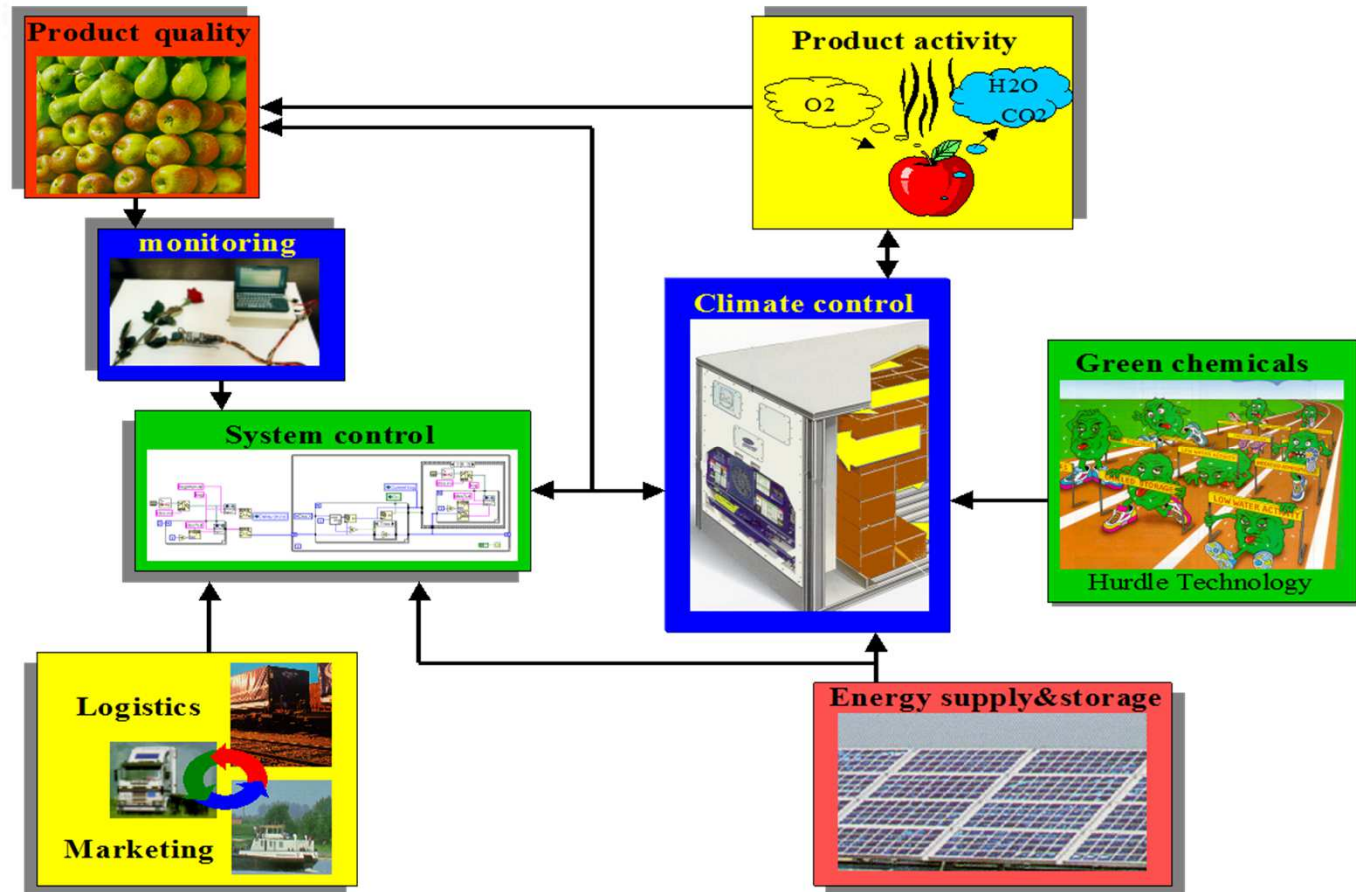
Solar

the Greenery  
INTERNATIONAL

ECOFYS

WAGENINGEN  
UNIVERSITY & RESEARCH

Economie Ecologie Technologie



**WHY RUPTURE? ....Energy for climatisation 70% reduced & stand alone & less product loss & **cross-sector network****



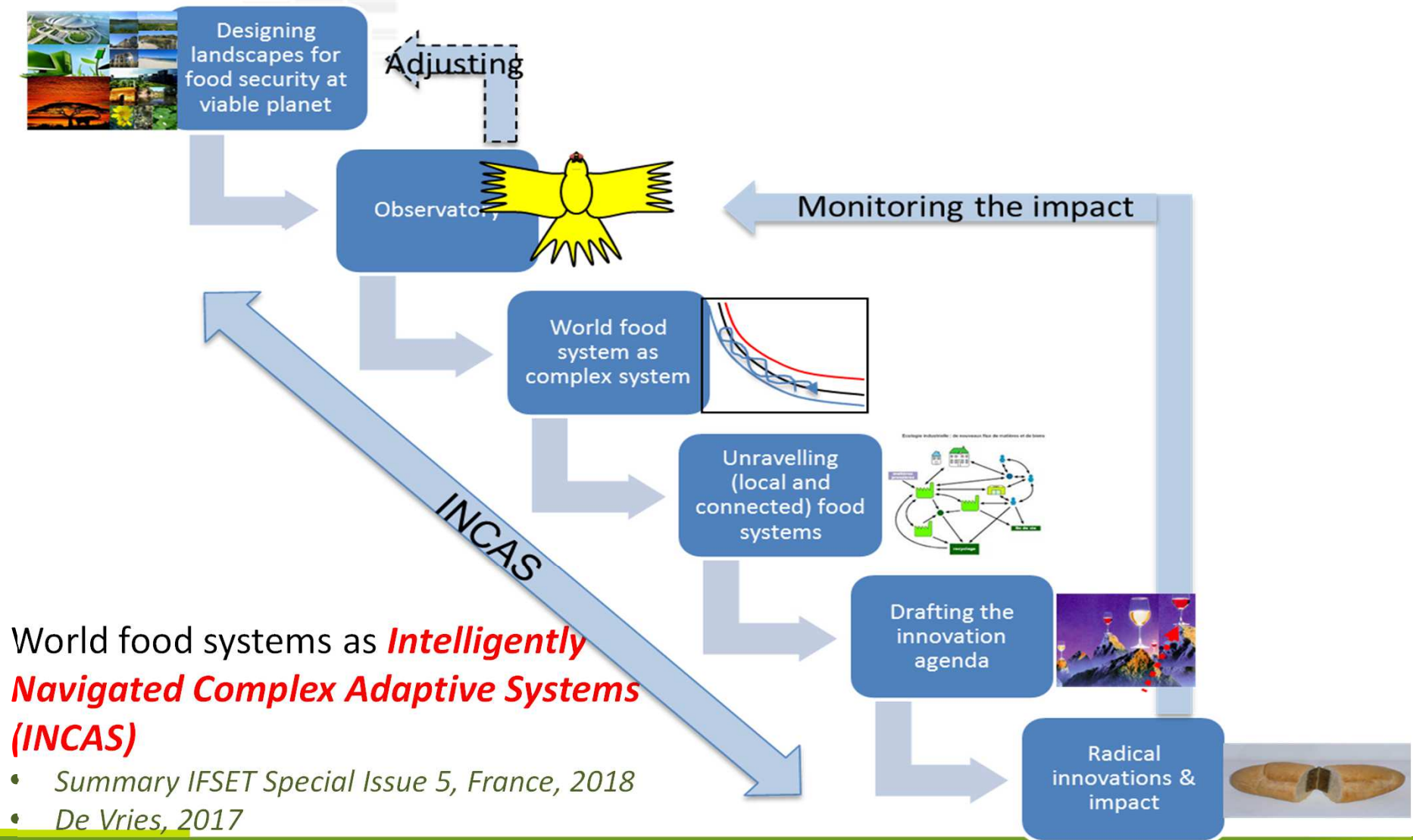
## The way ahead (I)

Understanding what are the consequences of  
*new technologies for business*  
and what are the consequences of  
*new business & value propositions for technology  
development*

*always with the ambition to strive for substantial  
environmental and/or social improvements to  
maintain our planet viable*



# The way ahead (II) Need for bio-economy systems approach and joint platforms



# We need inspiration & creativity

*Thanks to MC Escher*

*Thanks to all colleagues, young and many years young*

***Thanks to you***

*Diversity interconnected*



*Thinking in spirals, not in circles*



*Changing the landscapes & melting zones*



*Creating ruptures*



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

*EFFoST Conference on sustainability & food, Rotterdam, 12 – 14 / 11 / 2019*