How to design healthy and sustainable Food Systems ?

Monique Axelos, Hugo de Vries

How to design healthy and sustainable Food Systems ?

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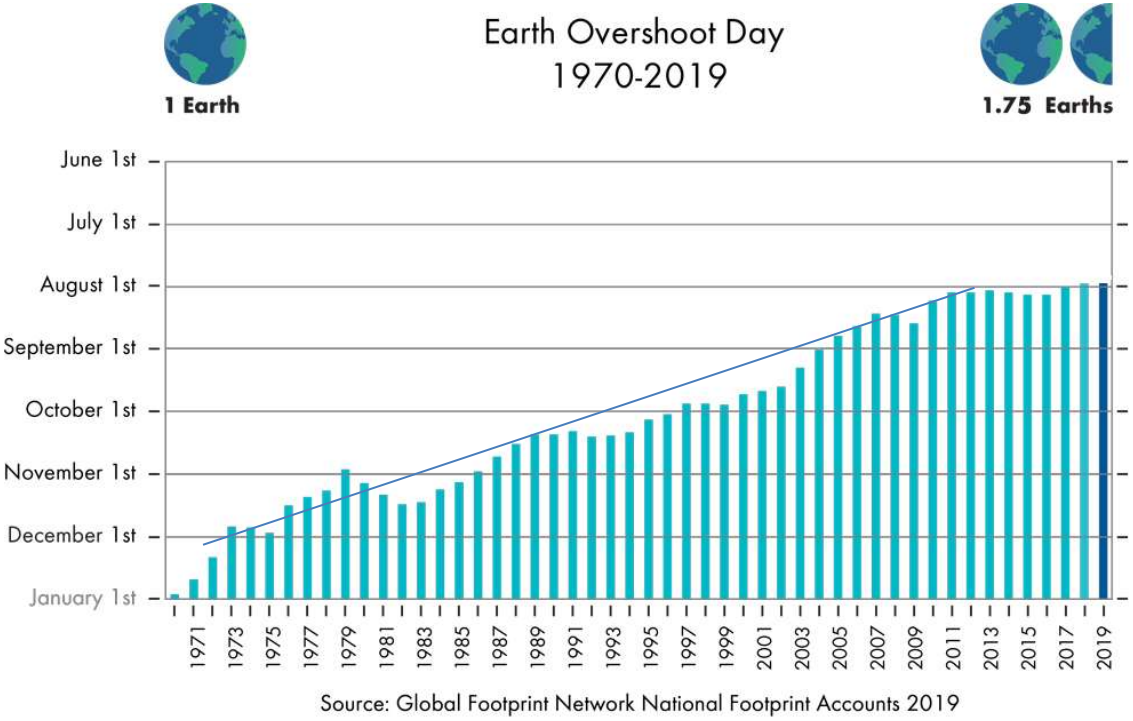
Content

- Where are we?
- What do we need?
- What is a food system?
- What does it mean for food?
- And for food science and technology > radical innovations?
- Examples of potential solutions?
- A need for a food systems approach?

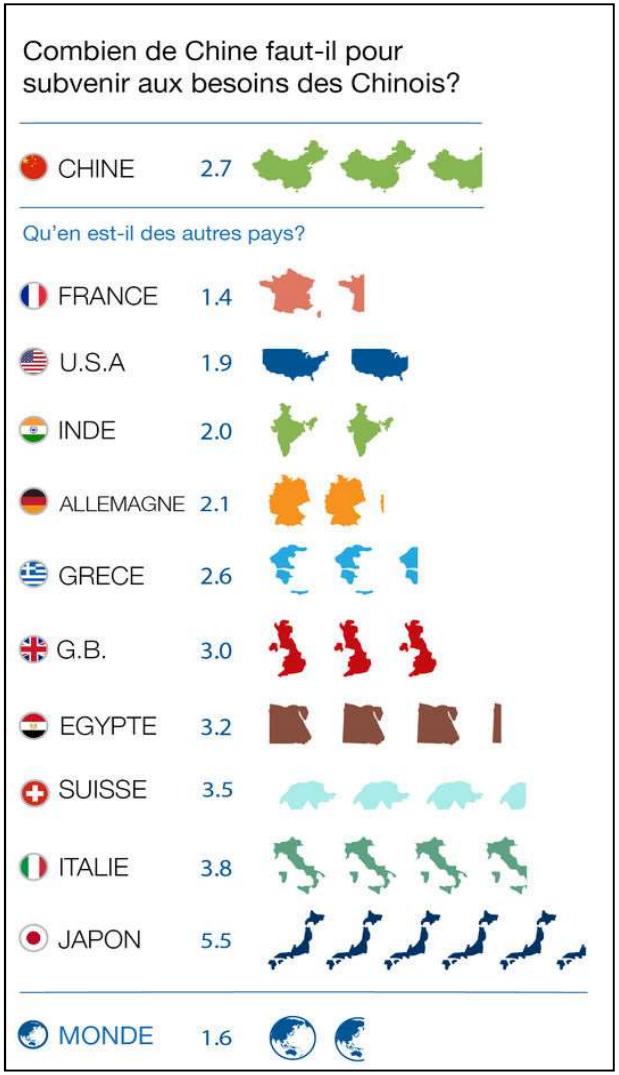
Where are we?

- An enormous challenge!

  Earth overshoot day 2019 is july 29 !



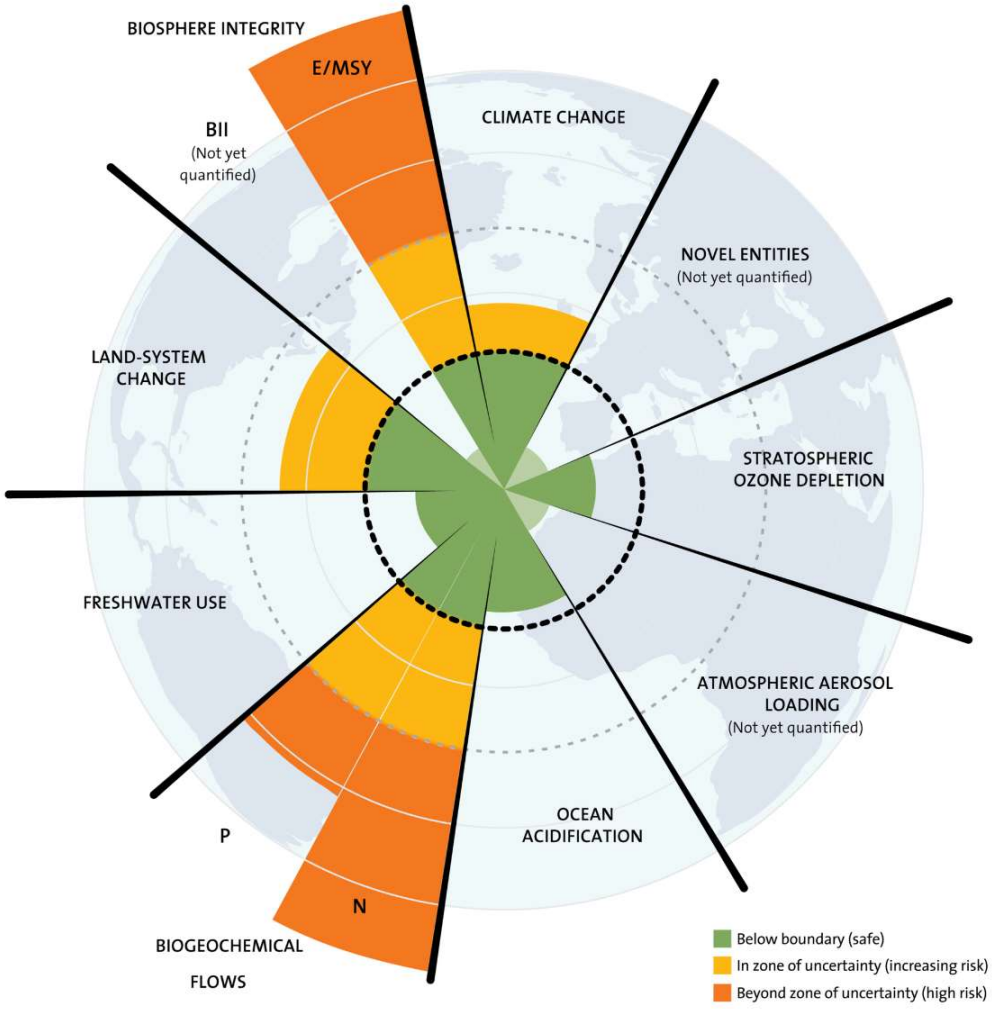
Source: Global Footprint Network National Footprint Accounts 2019



And yet in some alarming zones

The nine **Planetary Boundaries** - 2015

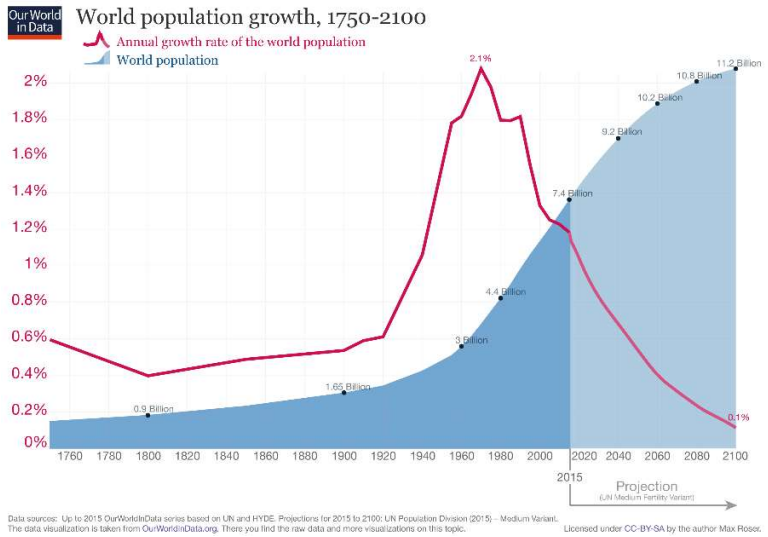
https://www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research.html

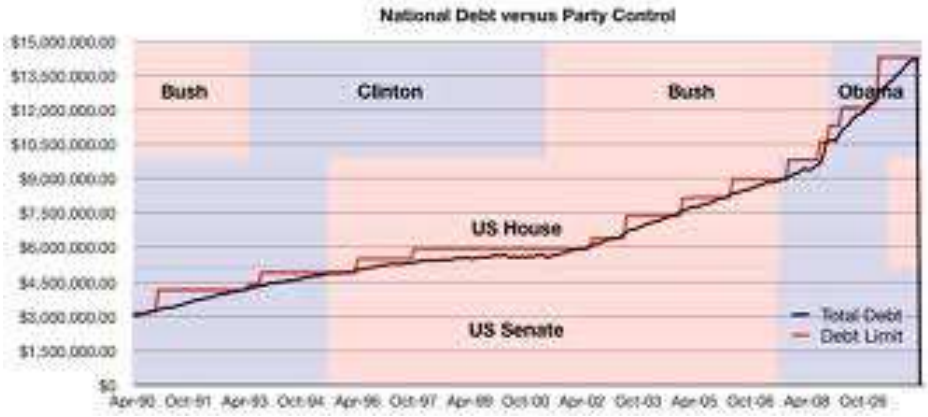


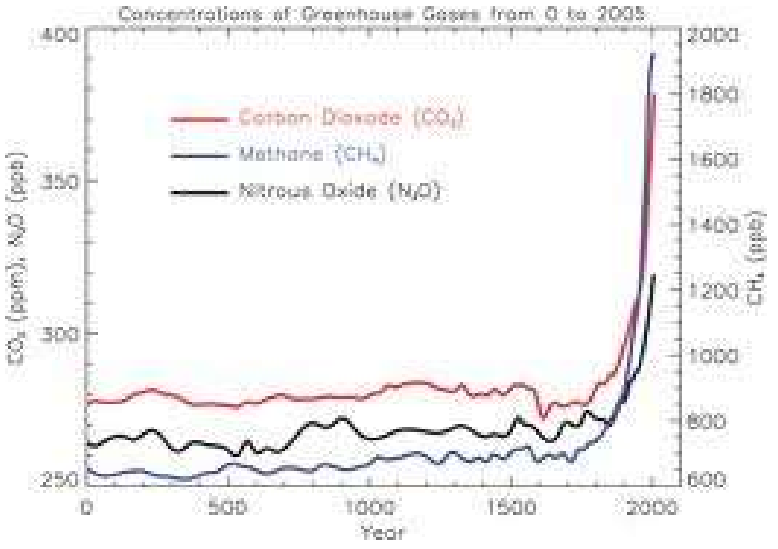
And other major challenges?

Exponential curves

We are not heading towards a sustainable way of life

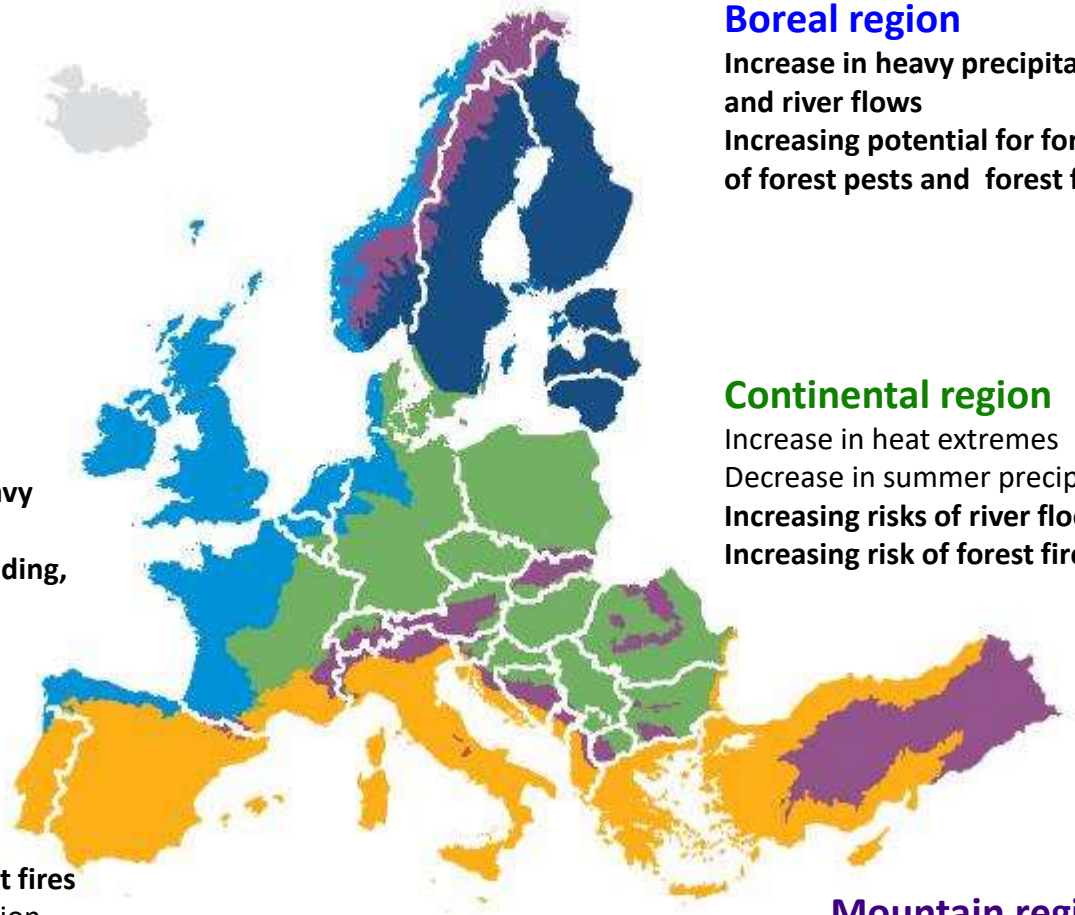






http://www.worldometers.info/

Challenge of climate changes:



Artic region
Biodieversity loss

Boreal region
Increase in heavy precipitation events and river flows
Increasing potential for forest growth but risks of forest pests and forest fires

Atlantic region:
Increasing risk of heavy precipitation,
river and coastal flooding,

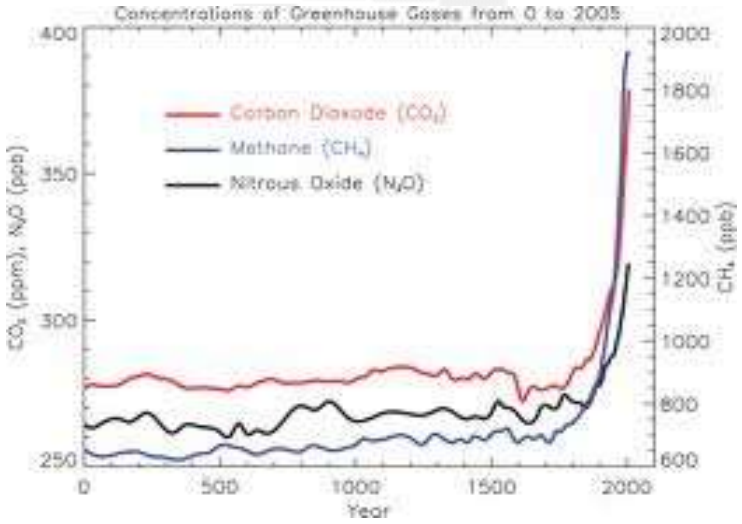
Continental region
Increase in heat extremes
Decrease in summer precipitation
Increasing risks of river floods
Increasing risk of forest fires

Mediterranean region
Large increase in heat extremes
Increasing risk of drought and forest fires
Decrease in crop yields, in precipitation
Increased competition between different water users
Increasing risks for livestock production
High vulnerability to spillover effects of climate change from outside Europe

Source: EEA, 2015

Mountain region
Upward shift of plant and animal species
High risk of extinction species
Increasing risks of forest pests

Challenges for Food:

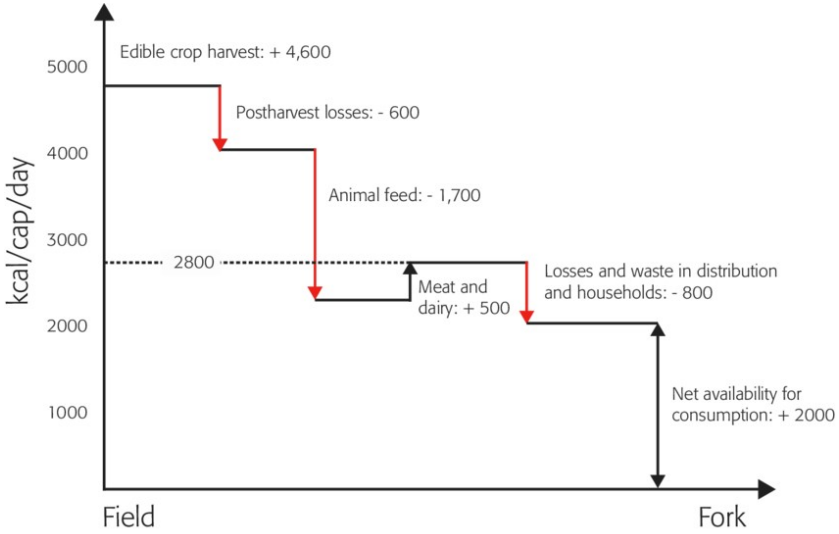


Food systems emissions : 20-30 % of total GHG emissions

Agriculture: the largest contributor of non-C02 GHGs

30% by weight of all food produced is lost in the food supply chain !

- In low income countries : storage - transport and processing levels
- high-income countries : retail and consumer levels

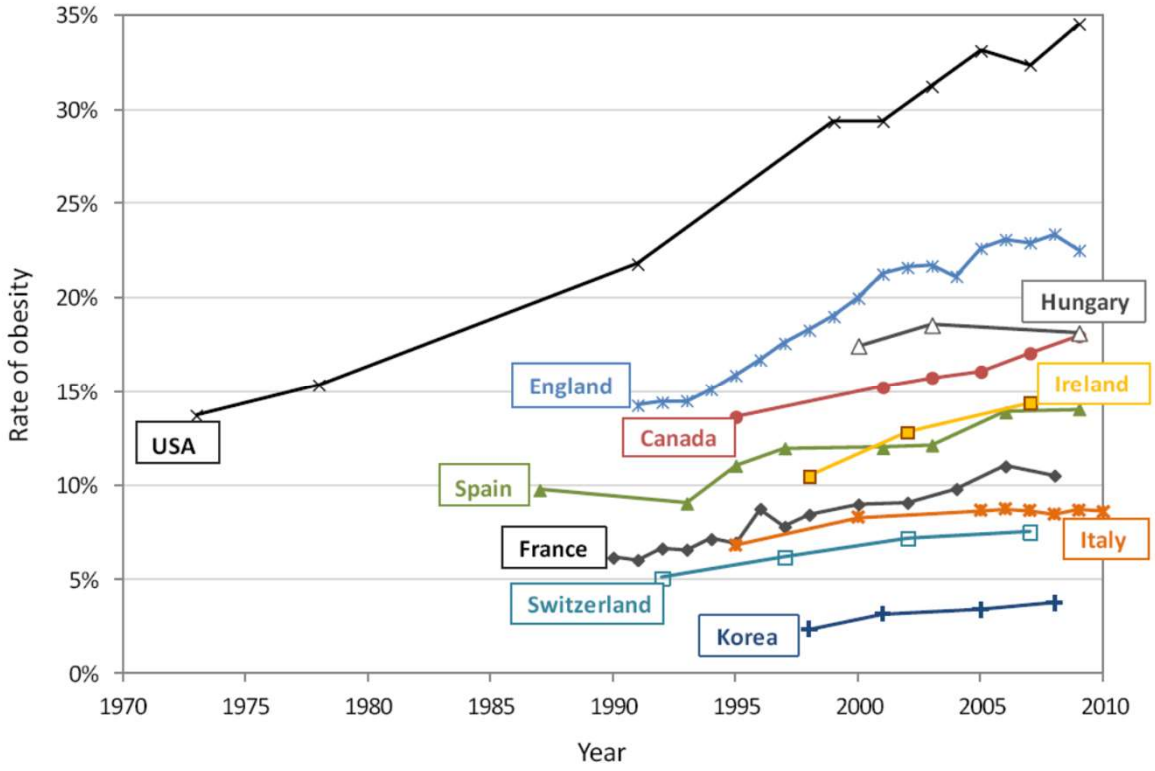


57 % of calories are not consumed

Challenge of malnutrition

Poor diets are associated with considerable health burdens and public expenditure in European countries.

- **Overweight and Obesity**
- **Chronic diseases**
- **Lack of micronutrients**



Source: OECD Obesity Update 2012

What do we need?

A viable planet!, i*n terms of:*

- *Healthy inhabitants*
- *A viable environment*
- *A pleasant & respectful socio-economic context*
- *An aesthetic image*

- *There is no one simple recipe !!*

➡ ***Systemic approach from the soil to the plate and back***

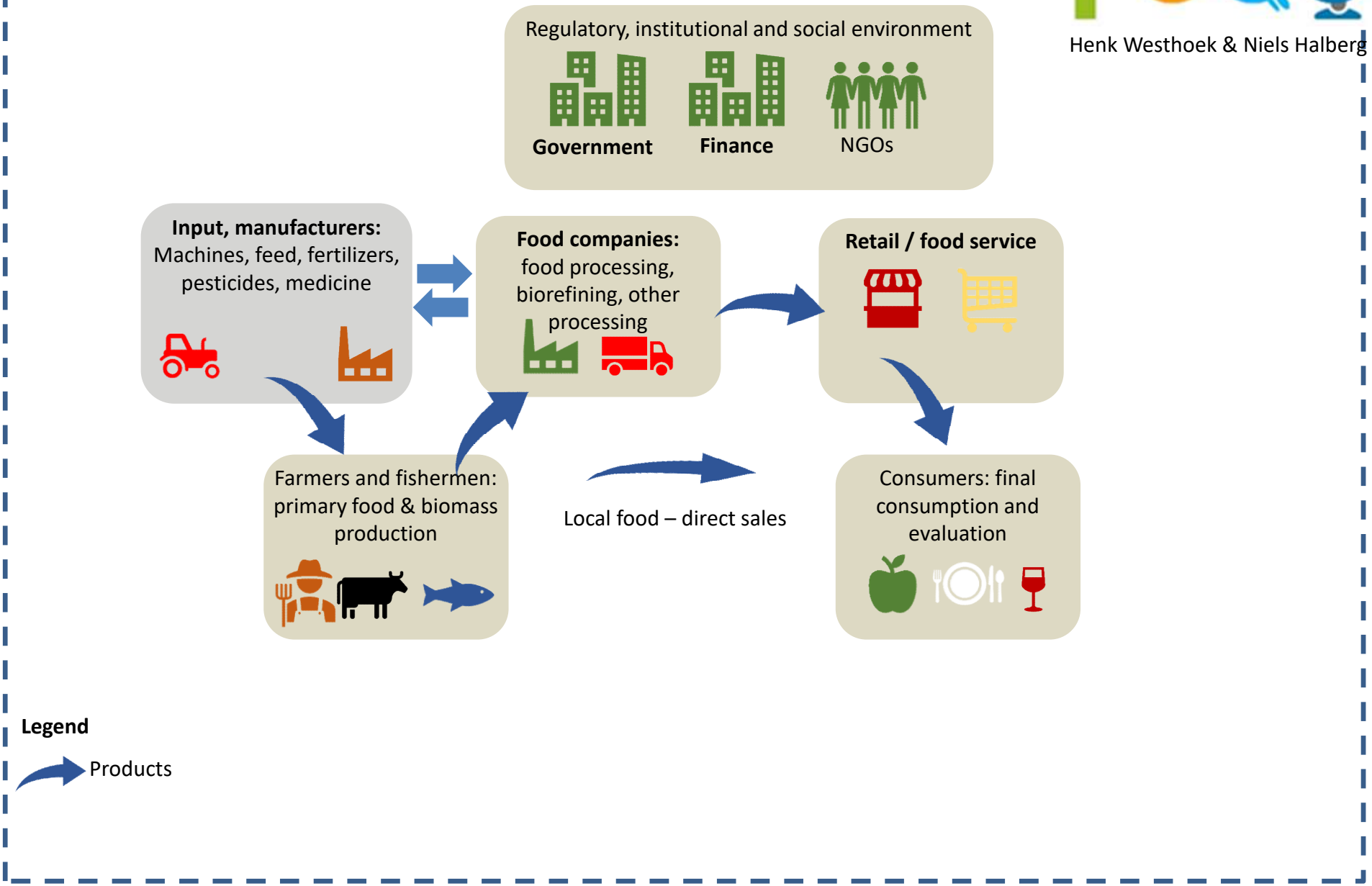
What is a food system?

A food system considers all the elements (environment, people, inputs, processes, infrastructures, institutions) and activities that relate to primary producing, processing, distributing, preparing and consuming food; and the socio-economic and environmental outcomes of these activities. *(HLPE, 2014)*

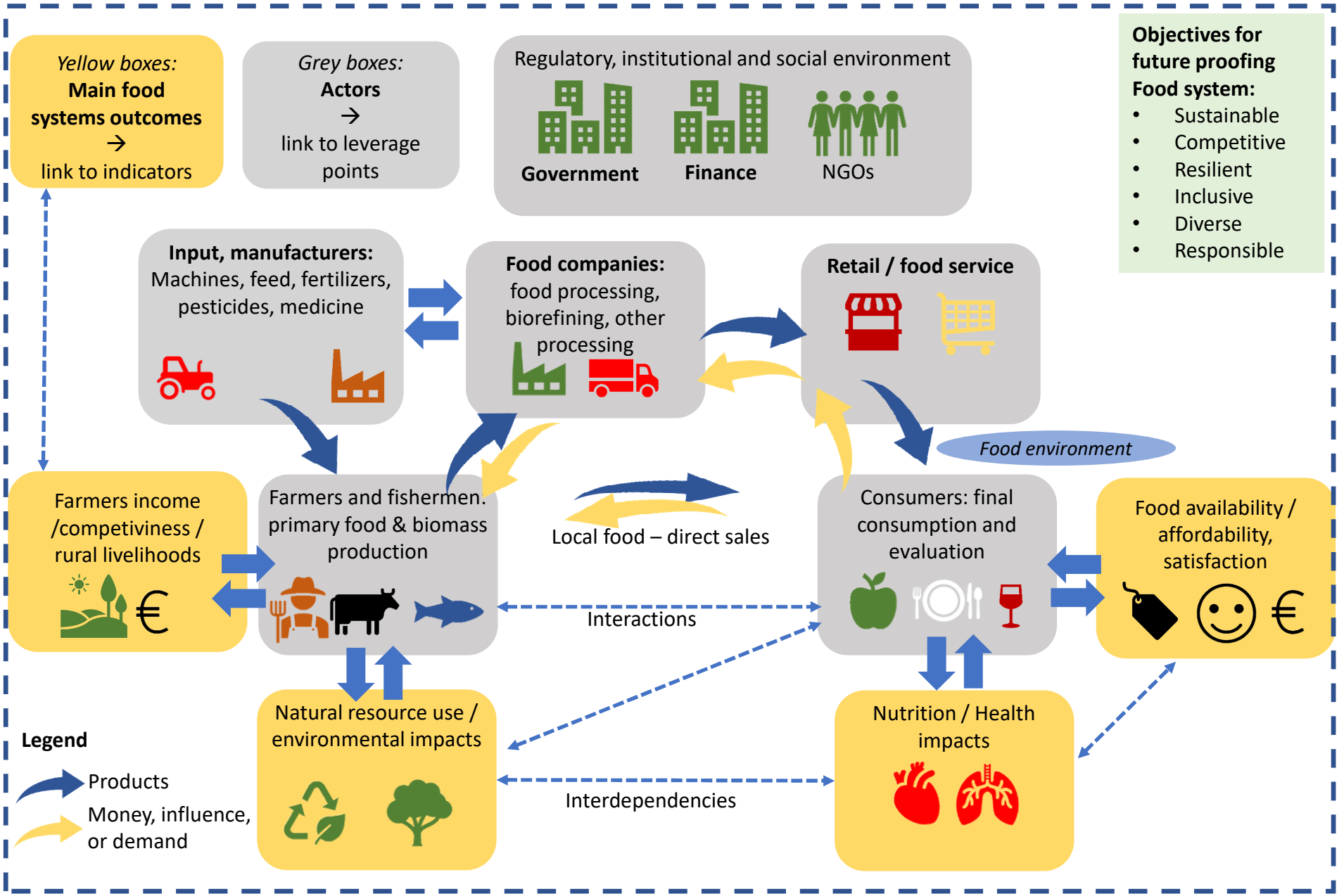
→ look in a more integrated way at biophysical flows (food) – economic and institutional setting and health, environmental and economic outcomes

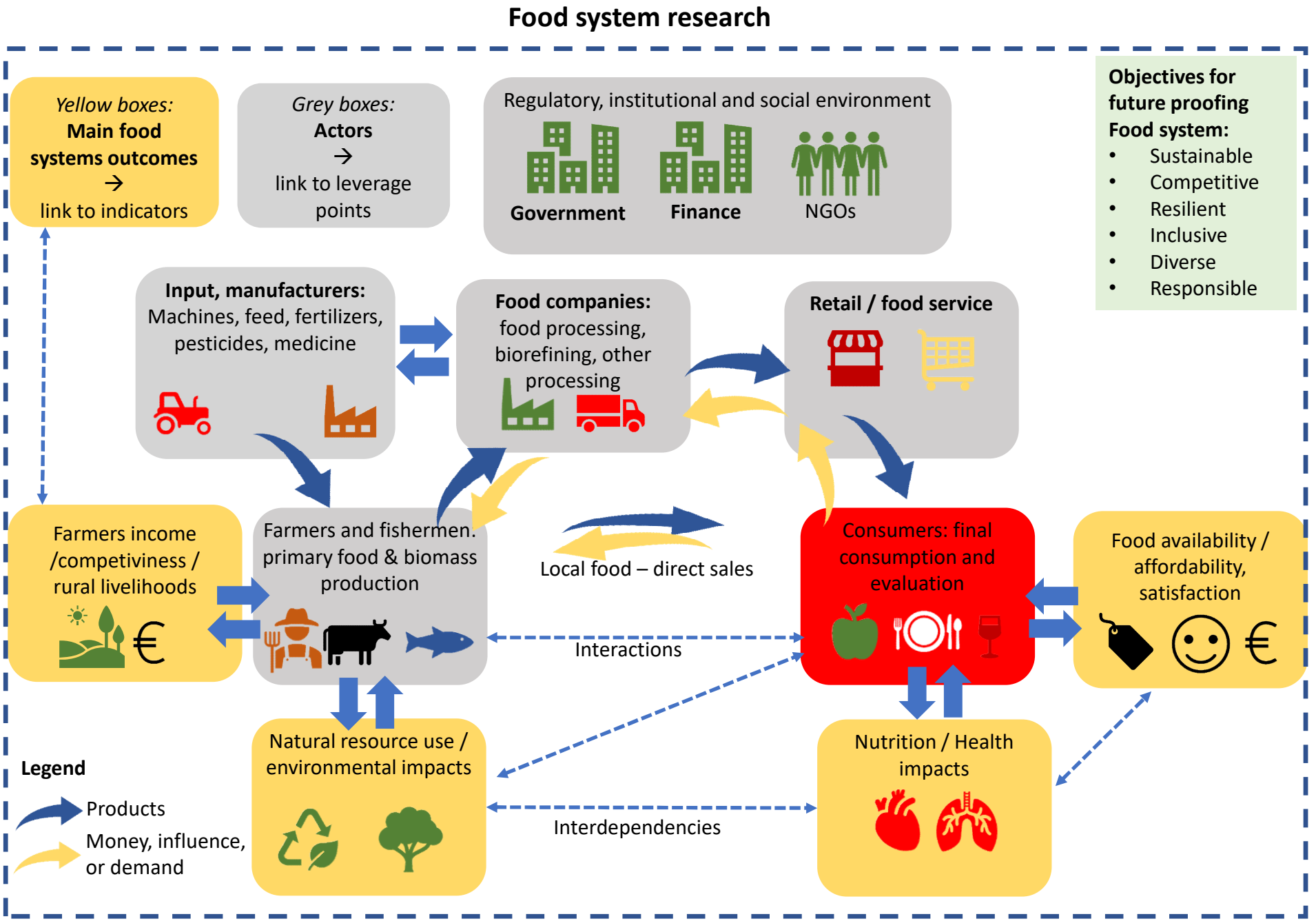
Actors in a food system

Henk Westhoek & Niels Halberg



Food system research



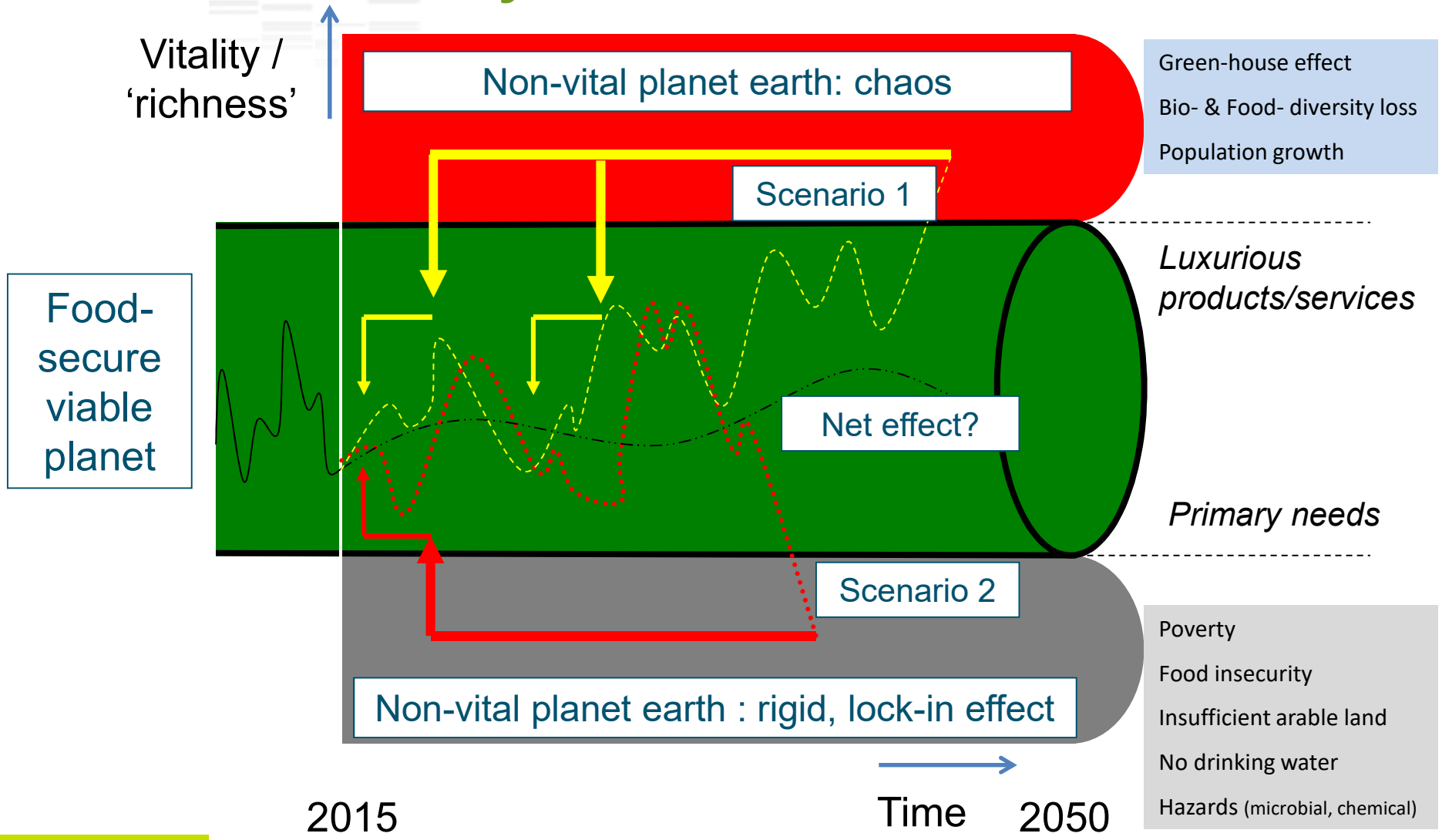

Food system research
Yellow boxes: **Main food systems outcomes** → link to indicators
Grey boxes: **Actors** → link to leverage points
Regulatory, institutional and social environment
Government
Finance
NGOs
Objectives for future proofing Food system:
• Sustainable
• Competitive
• Resilient
• Inclusive
• Diverse
• Responsible
Input, manufacturers: Machines, feed, fertilizers, pesticides, medicine
Food companies: food processing, biorefining, other processing
Retail / food service
Farmers income /competiviness / rural livelihoods
Farmers and fishermen: primary food & biomass production
Local food – direct sales
Consumers: final consumption and evaluation
Food availability / affordability, satisfaction
Interactions
Natural resource use / environmental impacts
Interdependencies
Nutrition / Health impacts
Legend
Products
Money, influence, or demand

A future proof system needs:

- Involving citizen in food systems strategies : Understanding their perceptions and motivations to facilitate the transition: Diets can be a leverage point to a healthy and sustainable food system…
- …but only if its combined with action in other sectors,
- Including the orientation of production priorities, cutting food loss an waste, and protecting nature
- Including cultural aspects, gastronomy – food as an art of eating and producing well, and something that connects people together

What does it mean for food?

> we need to redefine the limits



Despite these multiple threats , we have a lot of opportunities to adapt to change through innovations

1. *Avoiding unnecessary exploitation of resources*
2. Efficiently transforming and using agro-resources
3. *Valorizing new co-products and waste streams and re-valorizing all biomass to avoid waste*

Radical innovations needed in Food systems / ruptures (I)

1. *Avoiding unnecessary exploitation of resources*: ***towards alternative consumption patterns***

- Eating low density – high satiety food,
- Using alternative protein sources to decrease meat consumption
- using the richness of nature's structures (biomimetics),
- *Moving f*rom products towards services & de-materialization,
- ..

Radical innovations needed in Food technology / ruptures (II)

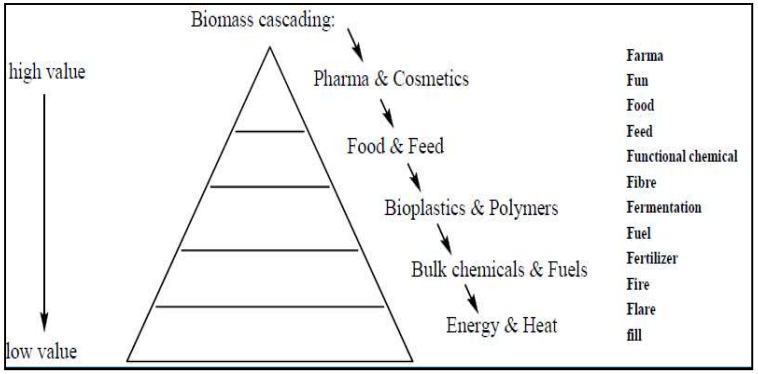
2. Efficiently transforming and using agro-resources *:*

- targeted processes (not over-dimensioned)
- process intensification ,
- new ICT driven processes (virtual design, domotics, 3D printing, …),
- eco-efficient dynamic storage,
- waterless systems,
- *novel biomaterials & packaging concepts, etc.*

Radical innovations needed in Food systems / ruptures (III)

3. Valorizing new co-products and waste streams and re-valorizing all biomass:

- eco-pyramid valorization,



Sources: Poyry and Sanders

Feedstock	Crop yield kg/ha/a (fresh)	Residues kg/ha/a	Fractions
Wheat	8000	11800	
Rye	3800	4400	
Corn	8160	8700 Type / MC / Share d.w. Stalk 70-75 50 Leaf 20-25 20 Cob 50-55 20 Husk 45-50 10	
Sugar cane	58000-88000	24000-37000	
Sugar beet	69300	4700	

Food Science becomes more and more trans disciplinary
(management, economics, genetics,…)

Eco-efficiency as a driver

Ex. waterless system: dry fractionation

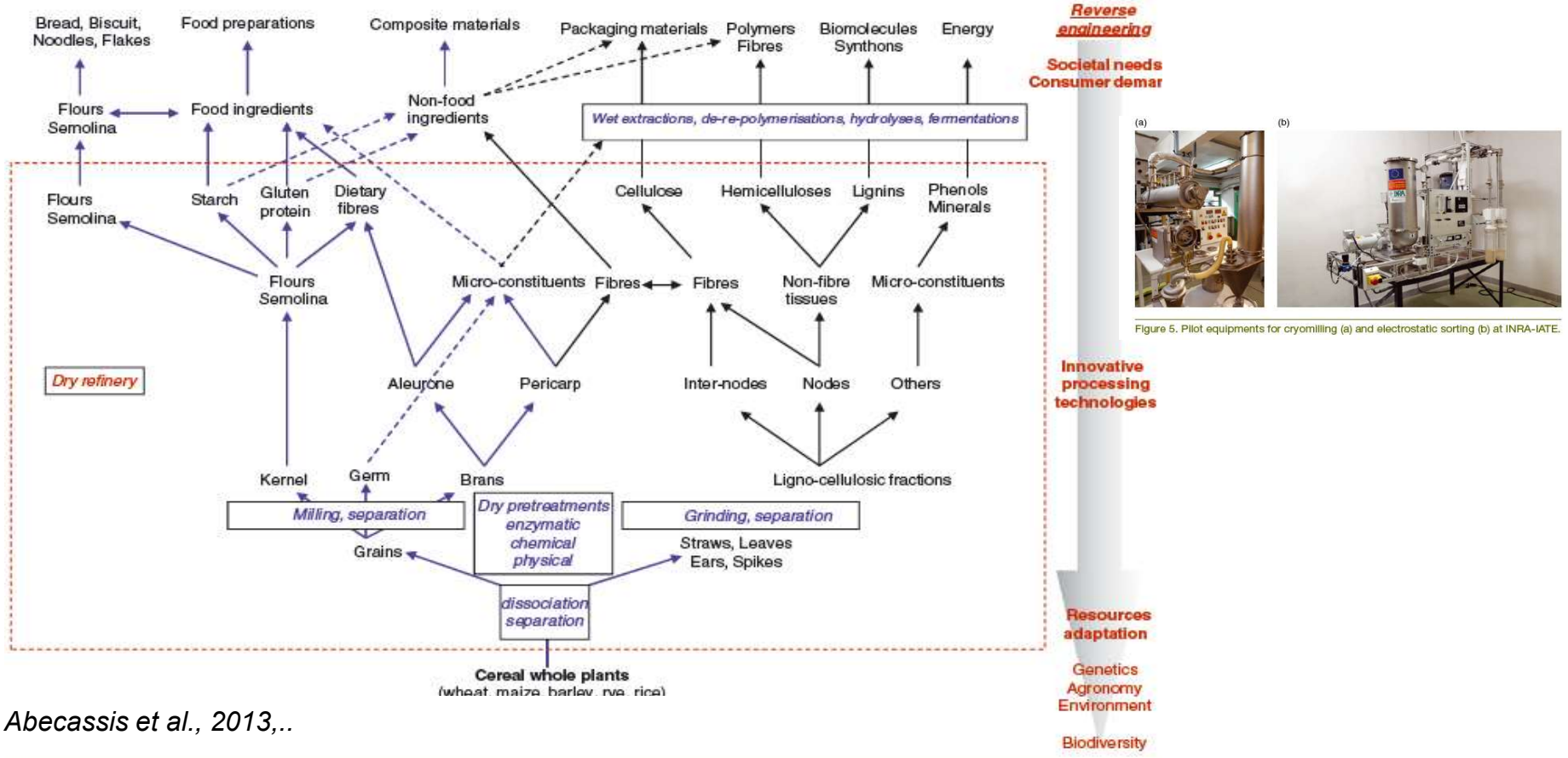


Figure 5. Pilot equipments for cryomilling (a) and electrostatic sorting (b) at INRA-IATE.

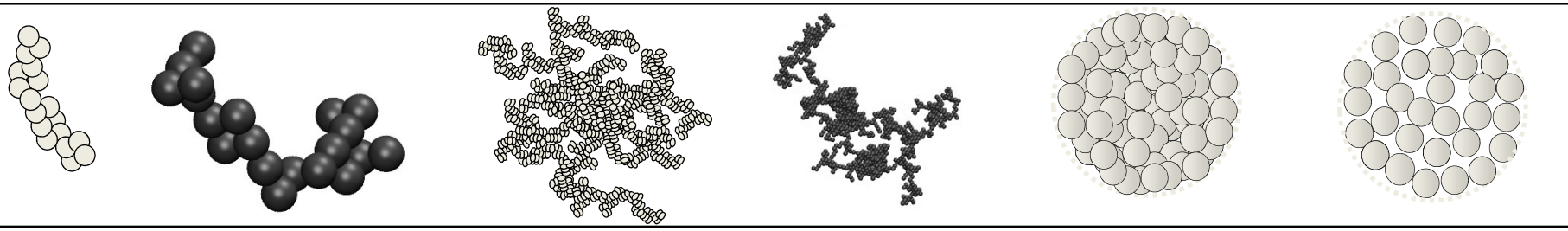
Abecassis et al., 2013,..

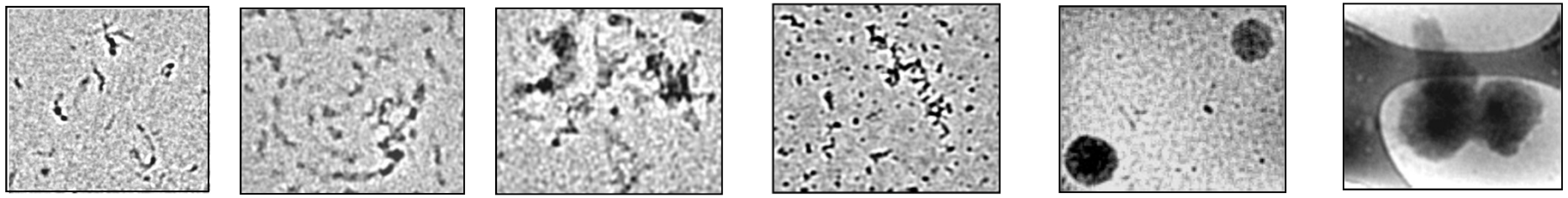
WHY RUPTURE? .... Integral use of biomass, no *water added* during processing (thus no drying), local applicability, avoiding water transport, local employment

Globular whey proteins: playing with t-T-shearing

Eco-efficient process

Primary aggregates	Low branched aggregates	Fractal aggregates d_f =2	Fractal aggregates d_f=2.2	Globular dense aggregates	Globular porous aggregates
80 °C			**80 °C**	**120 °C**	
Static conditions (24 h)			Dynamic conditions (160 s)		
Building units : primary aggregates			**Building units: native WPI**		
0.003 M		**0.1 M**	**0.003/ 0.1 M**	**0.003 M**	**0.1 M**

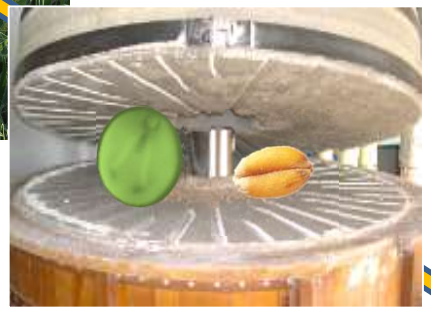




Examples: Innovation from the field to the plate:

ref: INRA « Flexiprocess » project
M.H. Jeuffroy & C Michon
Anne-Flore Monnet

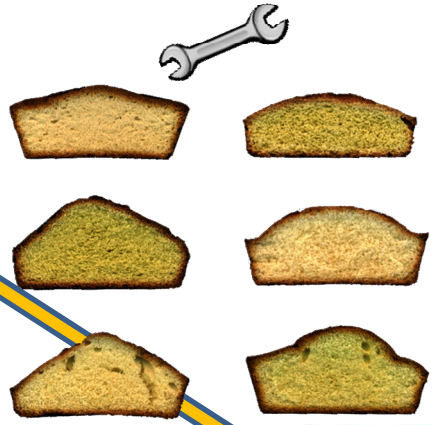
% wheat/legumes

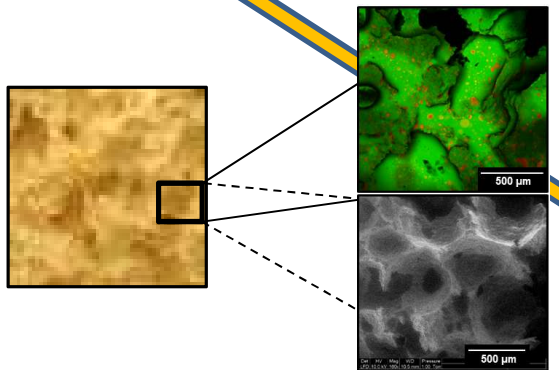


Rupture : New type of agriculture

Reduction of fertilizers

Dry fractionation





Nutritional advantages

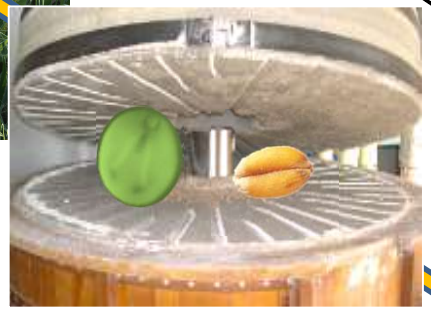
Approval ?

Examples: Innovation from the field to the plate:

ref: INRA « Flexiprocess » project
M.H. Jeuffroy & C Michon

French National strategy for protein transition

% wheat/legumes



Rupture : New type of agriculture

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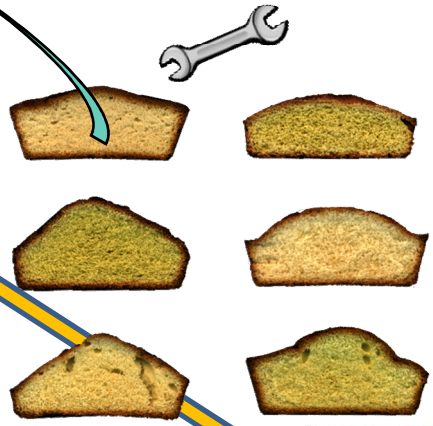
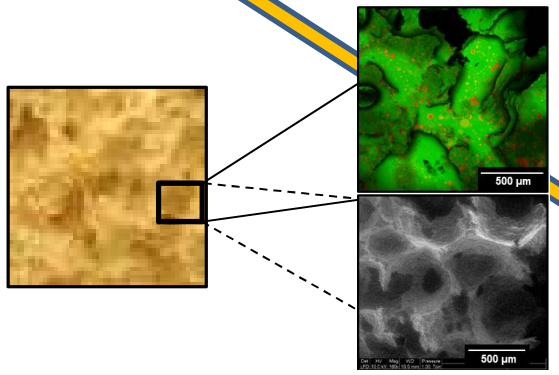




Nutritional advantages

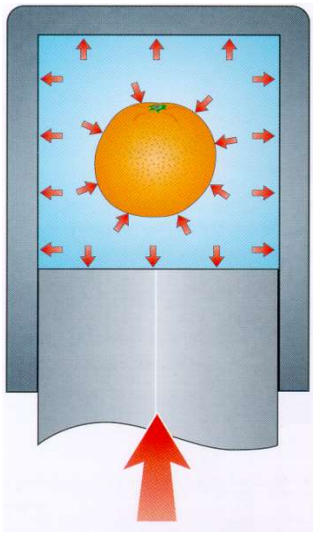
Approval ?

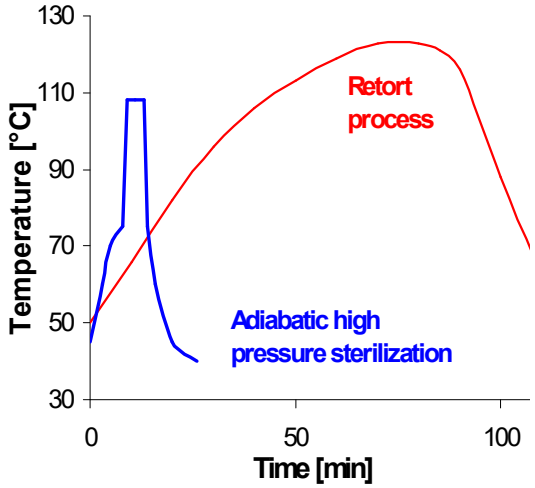
Ex. alternative proteins sources & products

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 texture and nutritional profiles, ...

Ex. process intensification: HPHT

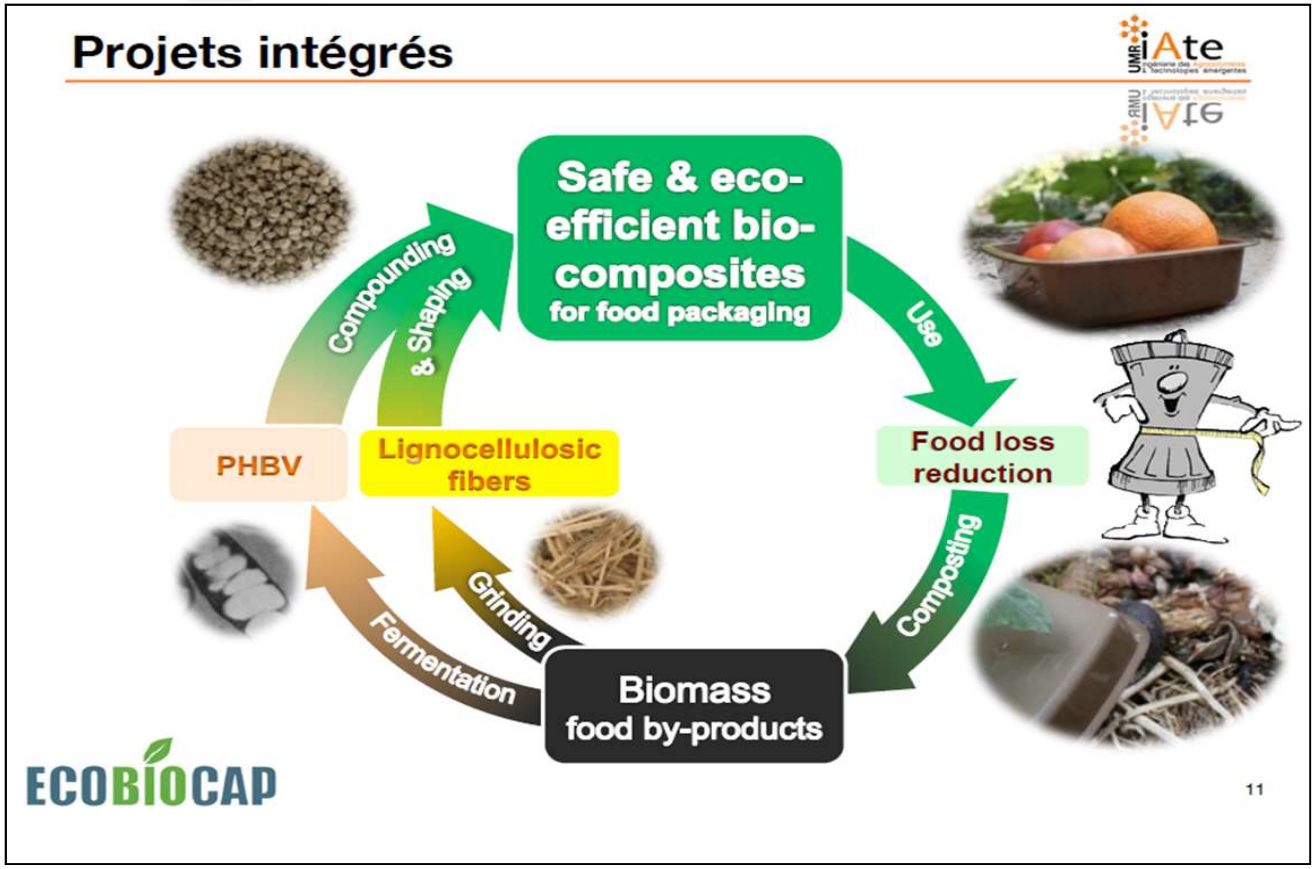




Why rupture? Adiabatic heating >> time for processing enormously reduced & No re-packing > treatment in the package itself

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)

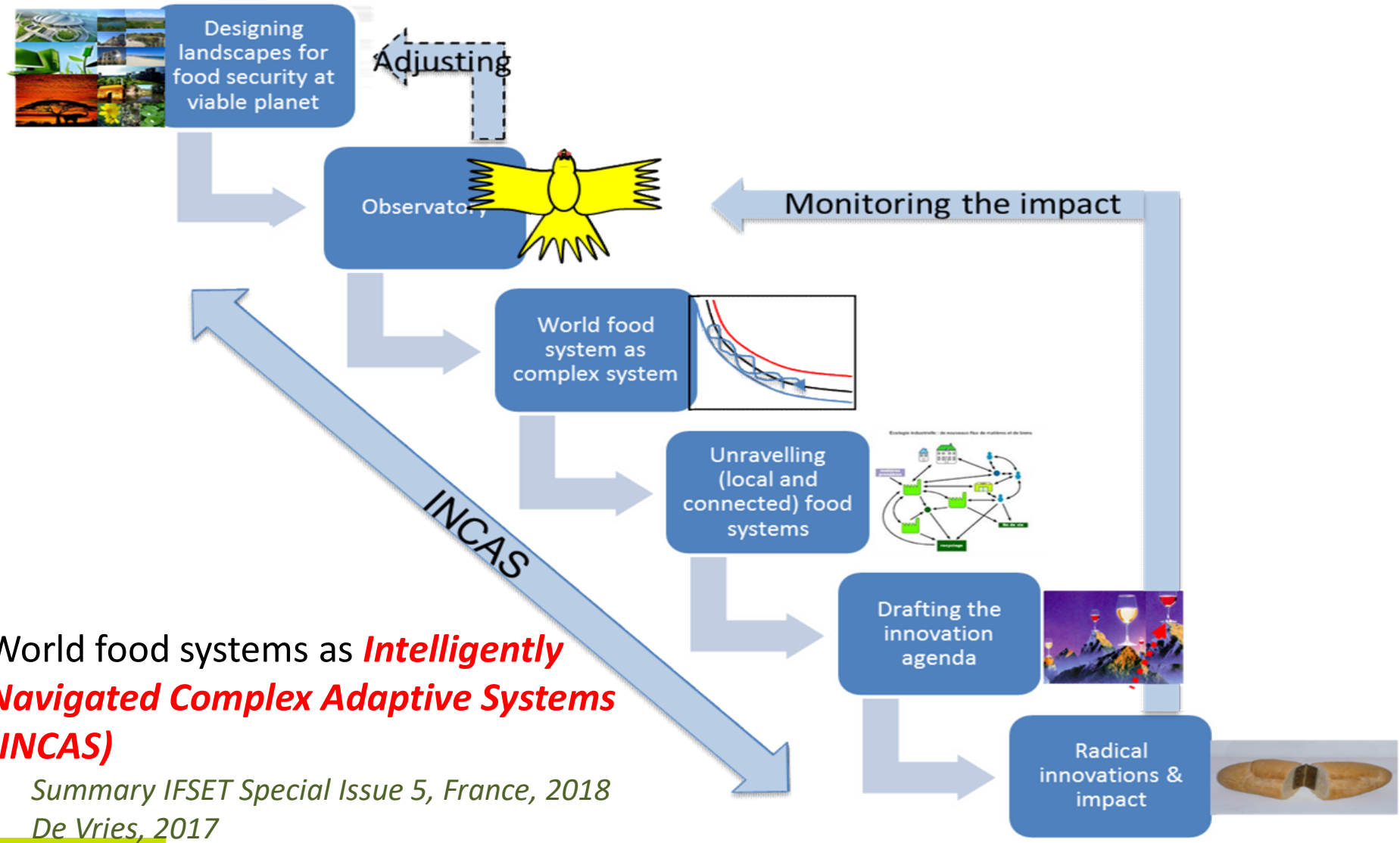
Ex. biodegradable packaging materials



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

FP7 European project, Gontard et al

Need for food systems approach



World food systems as ***Intelligently Navigated Complex Adaptive Systems (INCAS)***

- *Summary IFSET Special Issue 5, France, 2018*
- *De Vries, 2017*

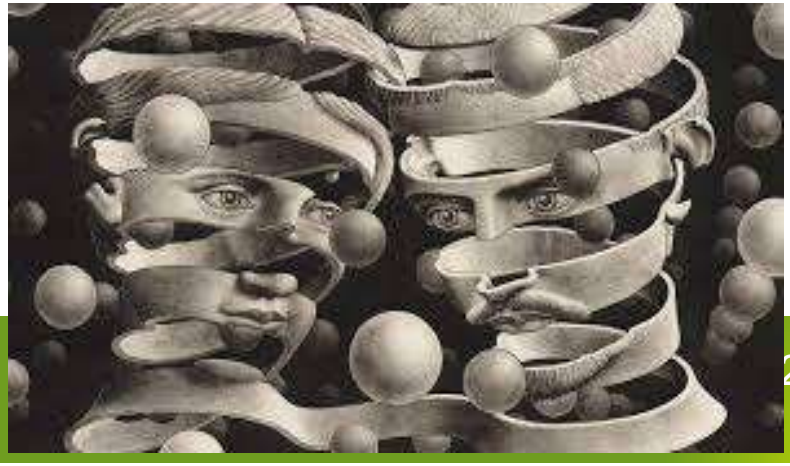
We need inspiration & creativity

Diversity interconnected

Thinking in spirals, not in circles

Changing the landscapes & melting zones

Creating ruptures



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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