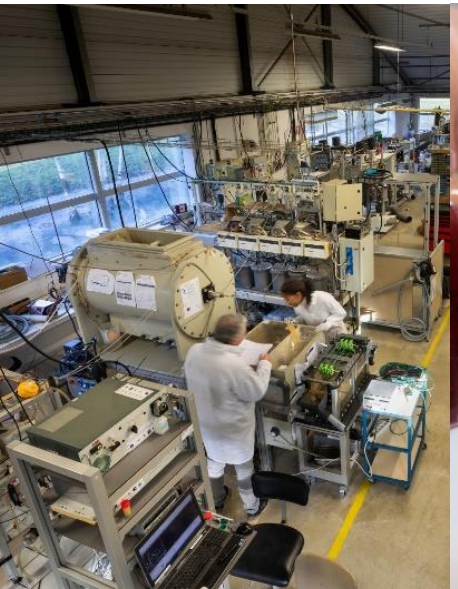
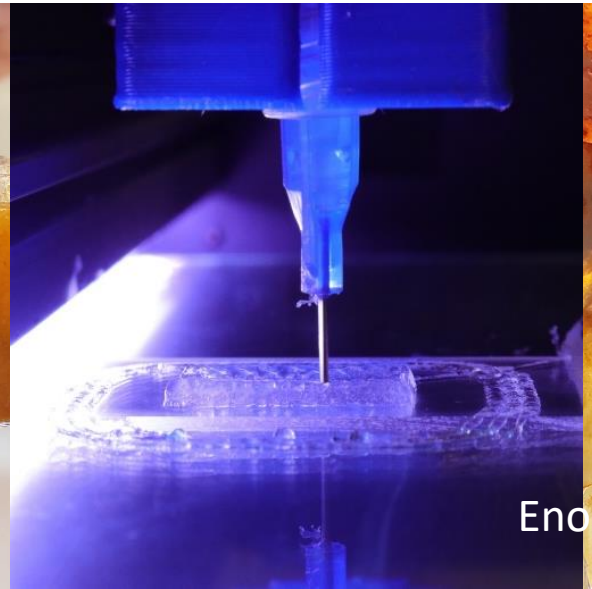
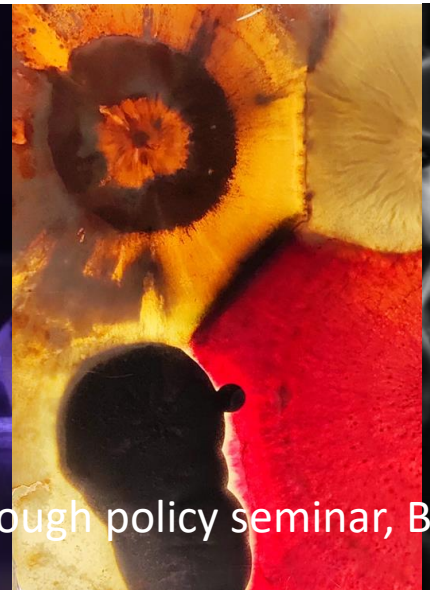
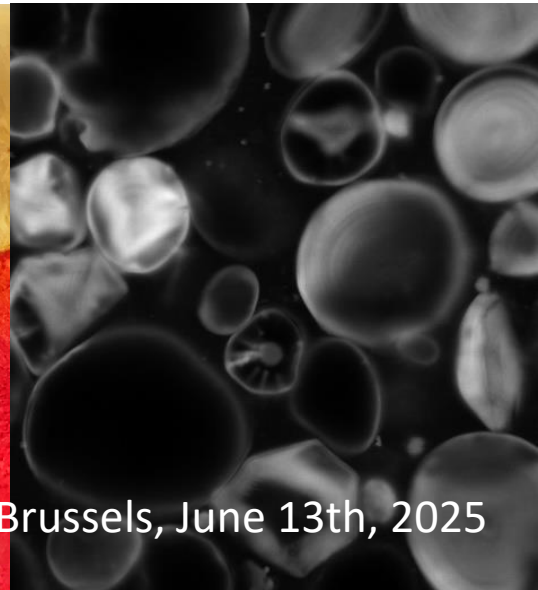
A perspective on innovation and research needs for food

Catherine M.G.C. Renard, INRAE TRANSFORM & Carnot Qualiment



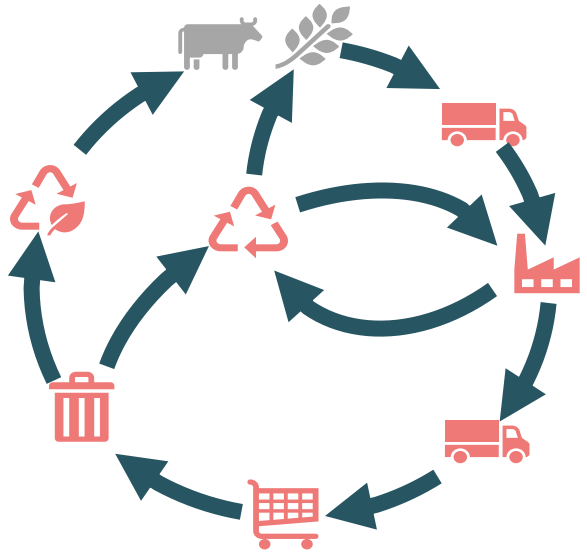




Enough policy seminar, Brussels, June 13th, 2025

Division TRANSFORM

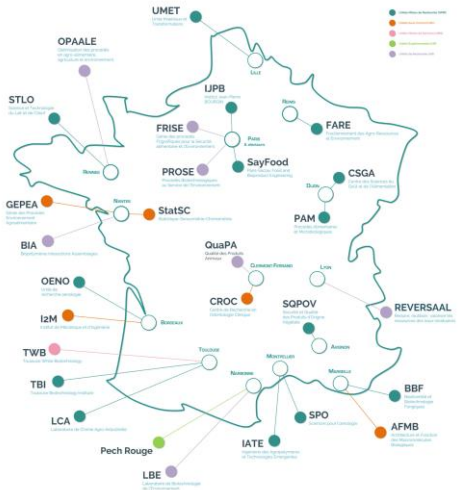
Science for Food, Bioproducts and Waste Engineering

- Three key scientific topics
  - 1 - Study of biobased matter / structure-function-property relations
  - 2 - Eco-design of new technologies for processing these biobased matter
  - 3 - Building circular bioeconomic systems
- Developped on food and non food applications

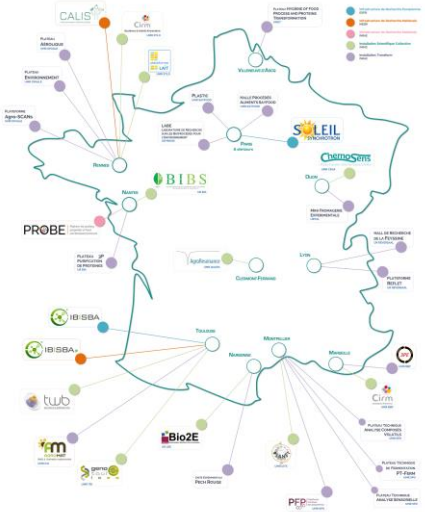


600 staff and appx 200 PhDs

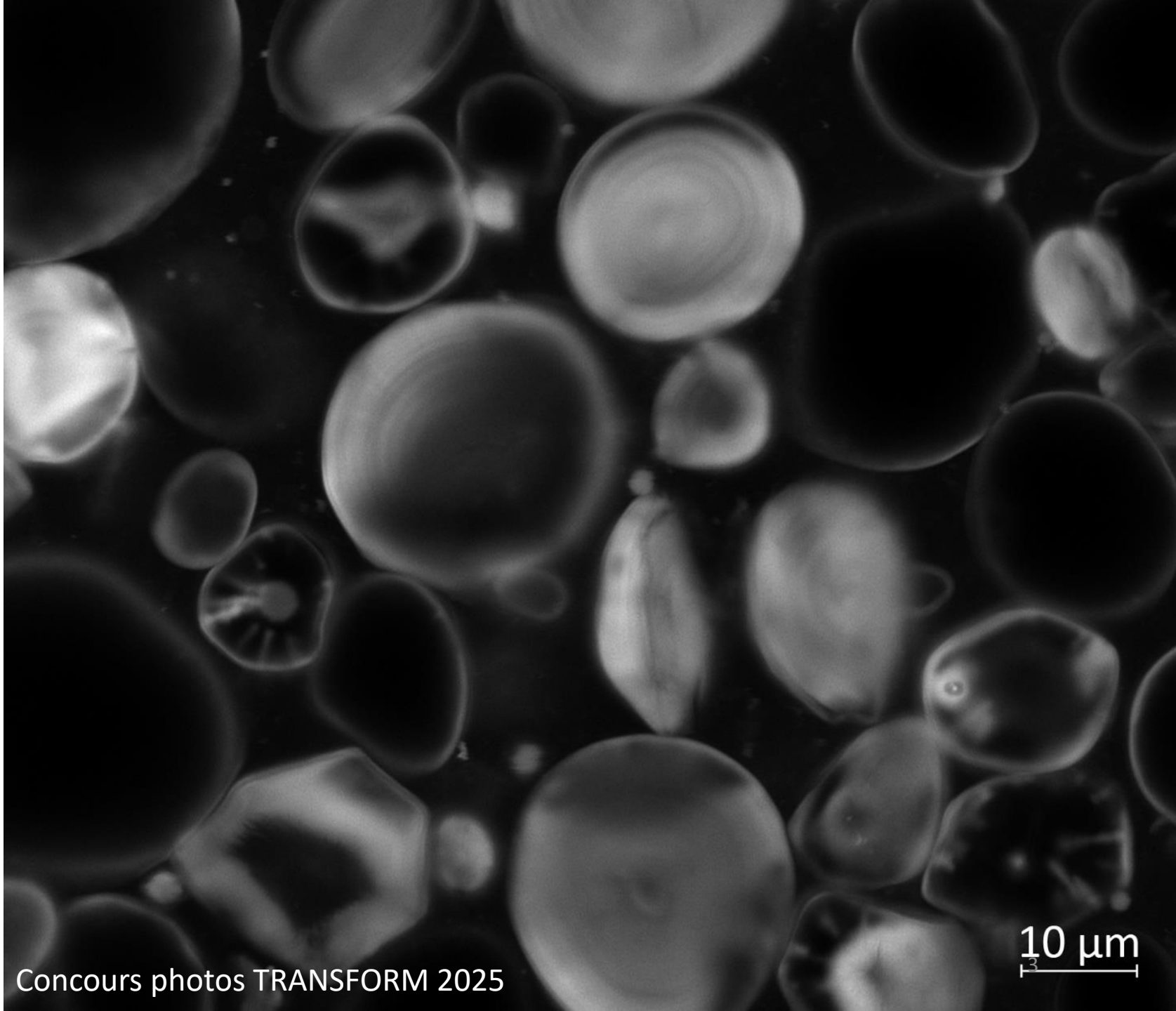
28 (joint) research units with higher education institutions throughout France



Specialised plaforms for analytical or process



Priorities for food 2026-30



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Four key drivers and priorities for research on food & processing

Ensuring safe and sustainable food for all in the context of global change

- Transition towards agroecology and transition of agricultural systems
  - Modification of agricultural practices
  - More varied, diverse and heterogeneous products, notably plant products
- Towards a circular and sober bioeconomy
  - Renewed interest in co-products
  - Monitoring and palliating contaminants
  - Integrating LCA-type approaches soon in development
- One health: better equilibrium between plant and animal foods
  - Plant foods for better nutritional equilibrium – consumer acceptance
  - Role of innovative protein sources
  - Safe & nutritious food for all ages and conditions
- New possibilities for data and models integration
  - Generative AI for data exploitation and structuration
  - From models to digital twins

Accelerating action to reduce greenhouse gas emissions in the food value chain

Where are the main levers?

- **Agricultural production** is generally the main source of greenhouse gas
  - Evolution of agriculture and husbandry means a need to adapt to the raw materials of the future

- A third of food produced is **wasted or lost**, notably at the consumer's stage (in EU)
  - How can waste and loss be limited, linked to consumer's behaviour and circular bioeconomy?
  - Connection to logistics, including the cold chain, and packaging

- The food industry itself needs to become **more resource-efficient**
  - Shift towards electric energy, more efficient water use
  - Use more of the raw material, for food or integrated in a circular bioeconomy
  - Food factory of the future, better monitoring

Agroecology as a lever for more resilient agricultural productions

In an increasingly uncertain environment, resiliency more important than productivity

Agroecology principles

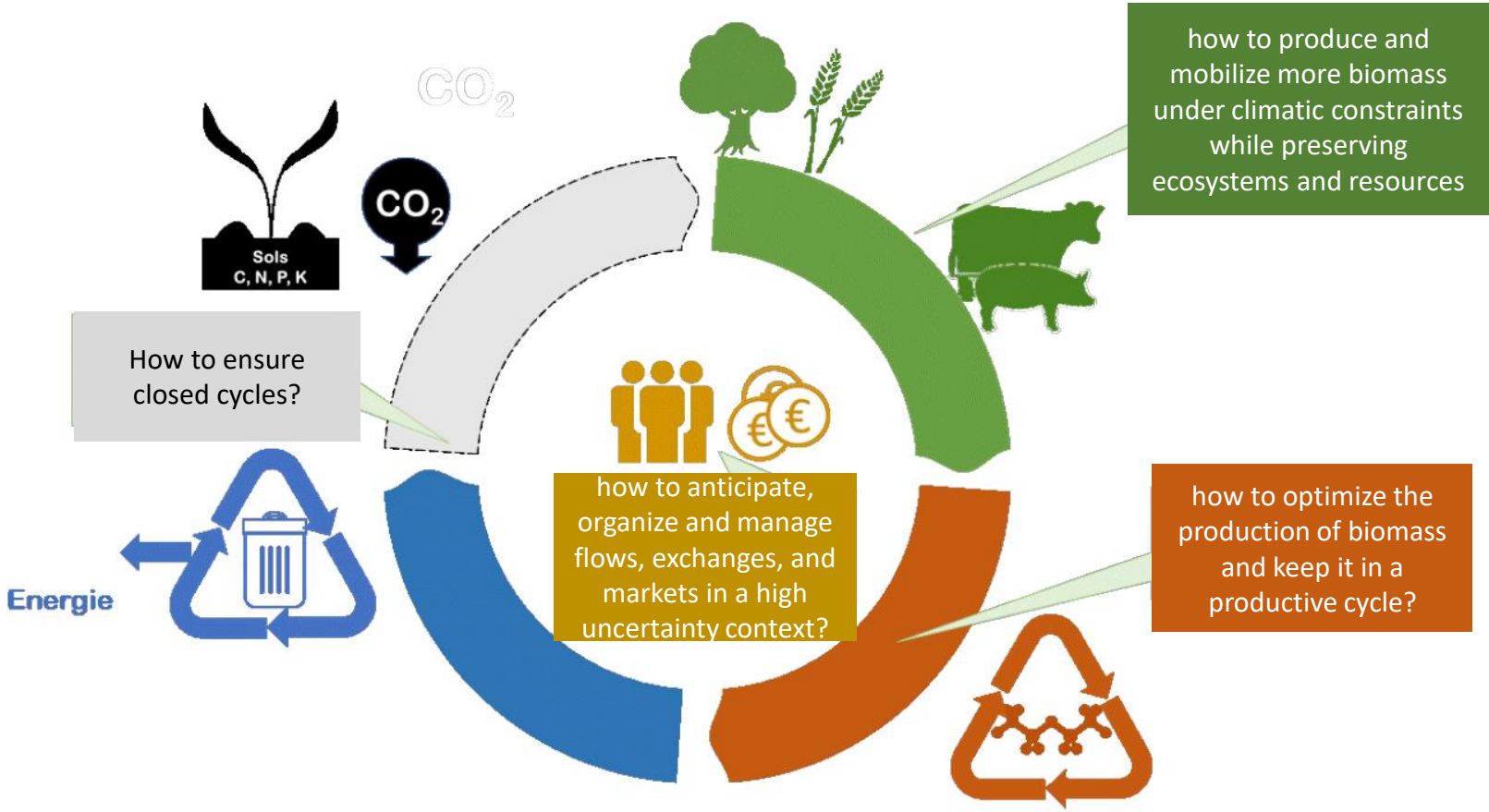
- Relies on biological and ecological processes vs synthetic chemical inputs: central place of biodiversity
- Maximize the closing of biogeochemical cycles (N-P-K, micro)
- Exploit and maximize biological regulations
  - Biocontrol / biostimulation
  - Plant interactions – plants and plants beneficial micro-organisms

Its consequences for food production

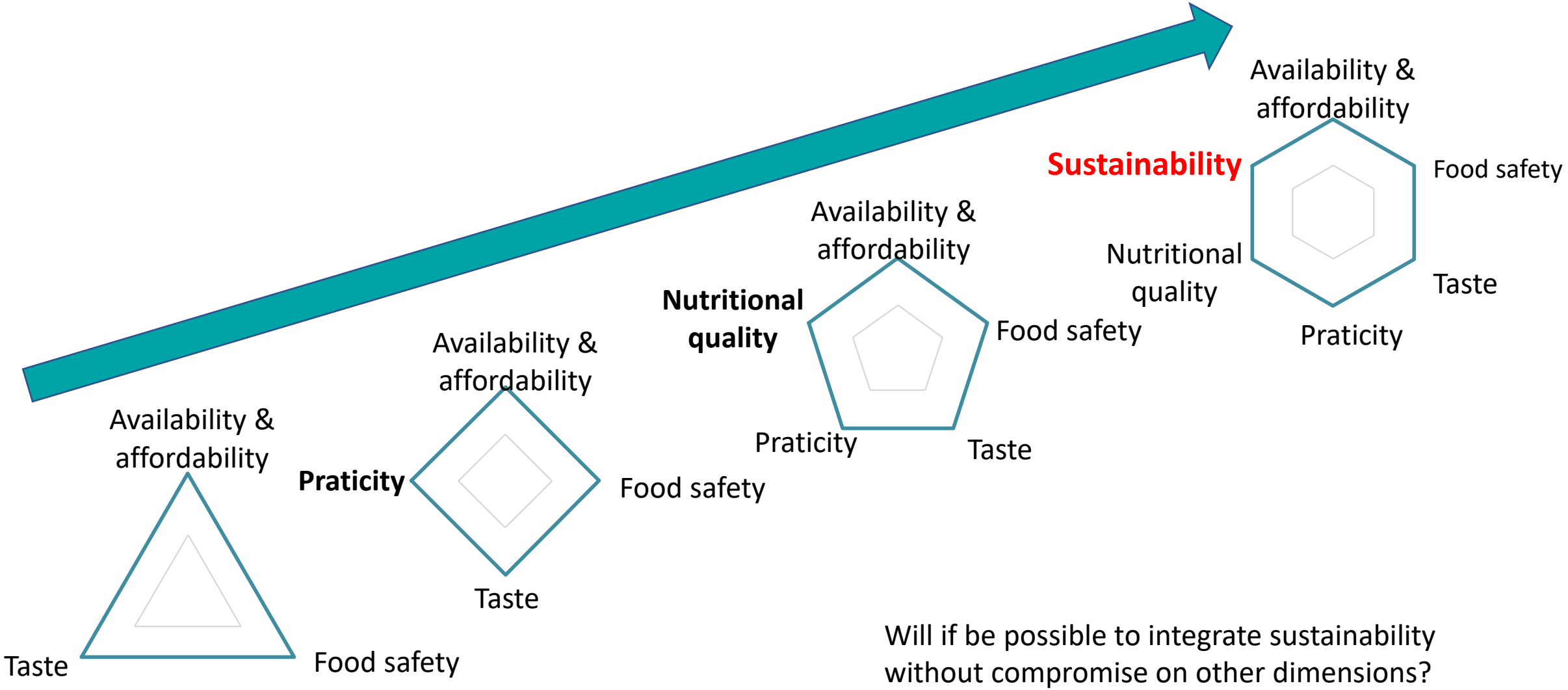
- Crop diversification is a source of complication in the structuring and functioning of the upstream and downstream of agricultural sectors
- Longer rotations: new species:
  - The role of pulses
  - Diversification cereals or pseudo-cereals
  - Introduce species adapted to tomorrow's conditions

The circular bioeconomy, a vision and a priority for INRAE

- Contributes to a climate-neutral economy
- Restoring natural resources, biodiversity and amplifying ecosystem services
- Contributes to the development of territories
- Participates in adaptation to the consequences of climate change



Innovation for food needs to take into account many dimensions



Will if be possible to integrate sustainability without compromise on other dimensions?

Innovation for food is at a cross-roads

A big gap between what actors of the food chain and consumers believe about food production

J. Vermeer, 1658
Rijksmuseum Amsterdam

or

Halle pilote STLO, 2020

- To say nothing of new processes like HPP, PEF, …

Food innovation faces many double binds and paradoxical injunctions

- Safe, organic, nutritionally adapted, local foods...
  - but the determinants of purchase are price & taste
- Fresh, minimally processed foods,
  - but practical and with long conservation periods
- A sustainable diet
  - but without changing eating or culinary habits

Three pillars integrated with a digital toolbox

Integration of models and data for digital twins and multicriteria optimization

Design and evaluate the food factory of the future in its chains from farm to fork including environmental, technological, economical, safety factors

Impact of agroecological transition of agriculture

Evaluate the impact of agroecological transition on processability and qualities of agricultural raw materials

Think processing as enabling technologies to valorise diversity and variability of raw materials

Question the scale of processing to propose robust and versatile processing, from farm gate to fork

More sober food process operations

Towards processes that do not require fossil fuels for energy

Ecodesign robust and sustainable processes e.g. by mobilising fermentations, decreasing water and energy use

Decrease losses and waste by revisiting logistics and integrating processes

Sober fractionment processes that better use the functionalities of agricultural raw materials

Food transition: safe and sustainable food for all

Designing foods adapted to individuals and population needs, while minimising risks e.g. allergenicity or contaminants

Improve flavor and nutritional density of foods from less conventional sources to ensure their acceptabilitry

Food packaging at the interface: stability, migrations and contamination in recycling and reuse chains

Our unique tools

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Large research platforms

Existing multilocation structuration

- 4 analytical platforms with dedicated and original methodologies and applications: BIBS, AgroResonnance, PF polyphenols, Chemosens
- **CALIS** (Consumer Alimentation Health)
- **IBISBA** (Inspiring Biotech Solutions) **soon to become an ERIC,** leader in biotechnologies in Europe

Future developments

- Structuration and recognition of our pilot plants notably on milk processing and oenology

(1) BIBS (Nantes), AgroResonance (Clermont-Ferrand), PF Polyphenols (Montpellier), ChemoSens (Dijon)
(2) PF Lait (Rennes), FROMEX (Poligny), Halle de l'UMRF (Aurillac / MICA)

Thank you for your attention

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