

PPPHI Conference  
Braunschweig, Germany

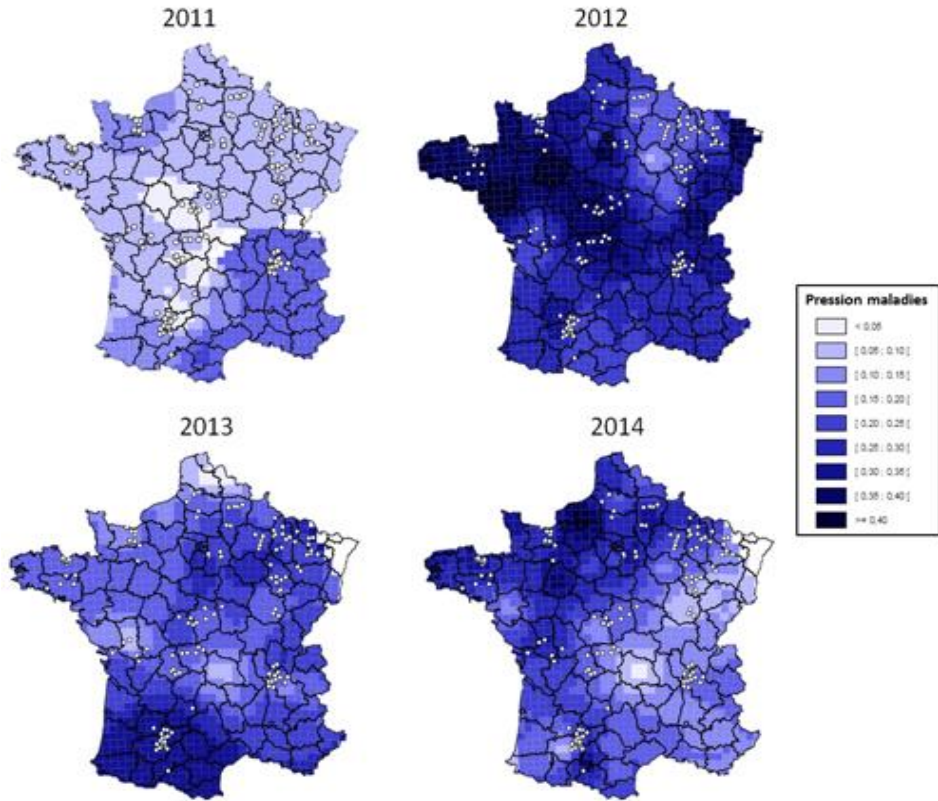
# Towards a productive pesticide-free agriculture in Europe: motivations, challenges and prospects

*Christian HUYGHE, Scientific Directorate Agriculture,  
INRAE, France*



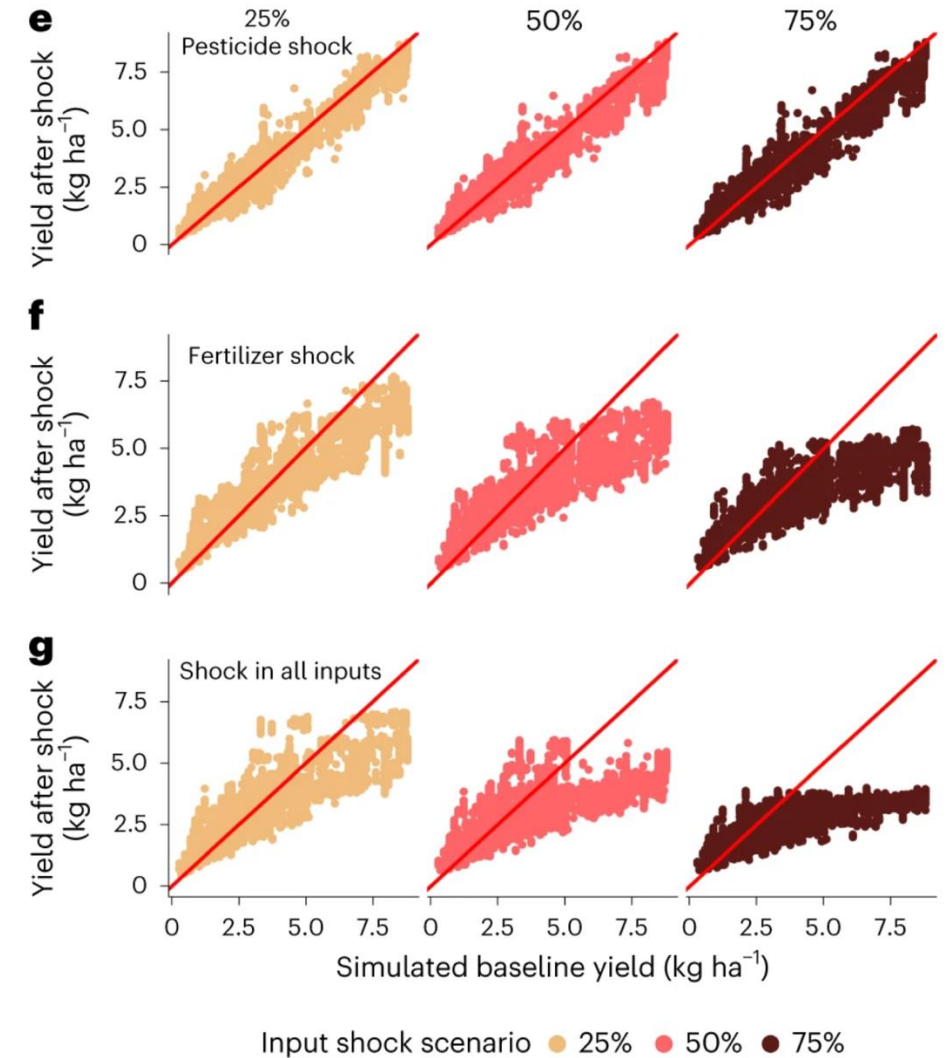
# Crop protection is compulsory to ensure safe and affordable food to all

In absence of protection, losses may be high, are variable among sites and years and not predictable



Yield losses due to foliar diseases in bread wheat in absence of any protection

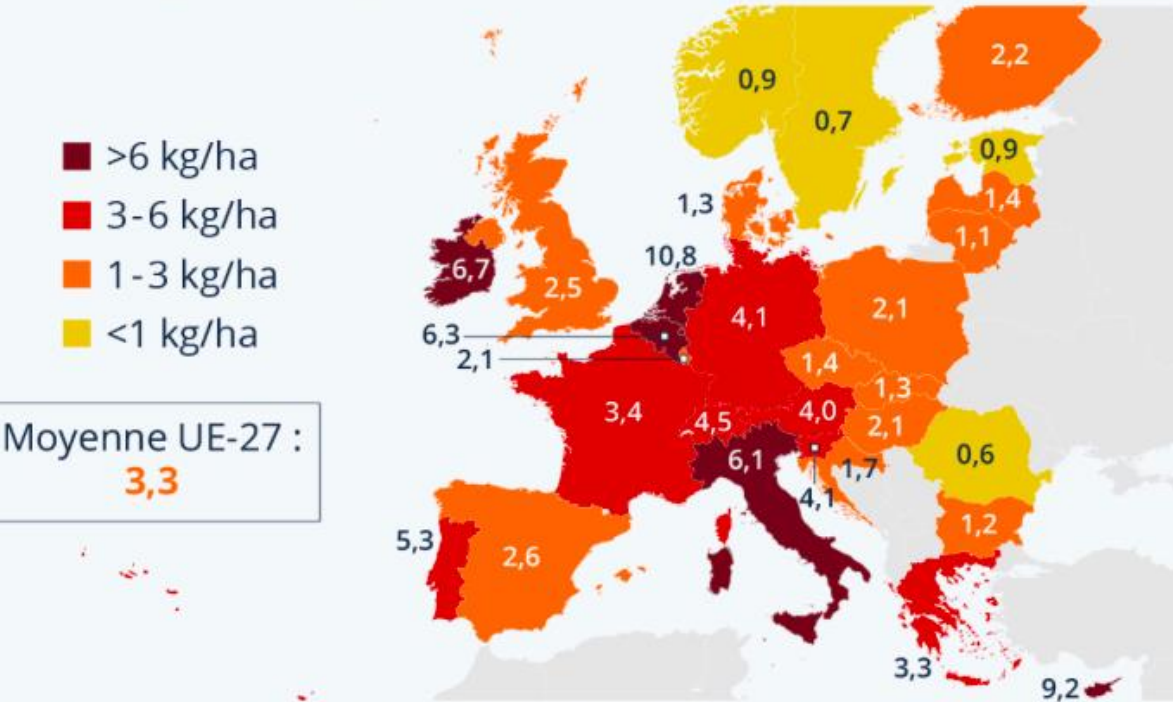
Urruty et al, 2016, ASD



From modelling approaches, at constant cropping systems, pesticide shock is smaller than fertilizer shock, but with interaction (Ahvo et al, 2023, Nature Food)

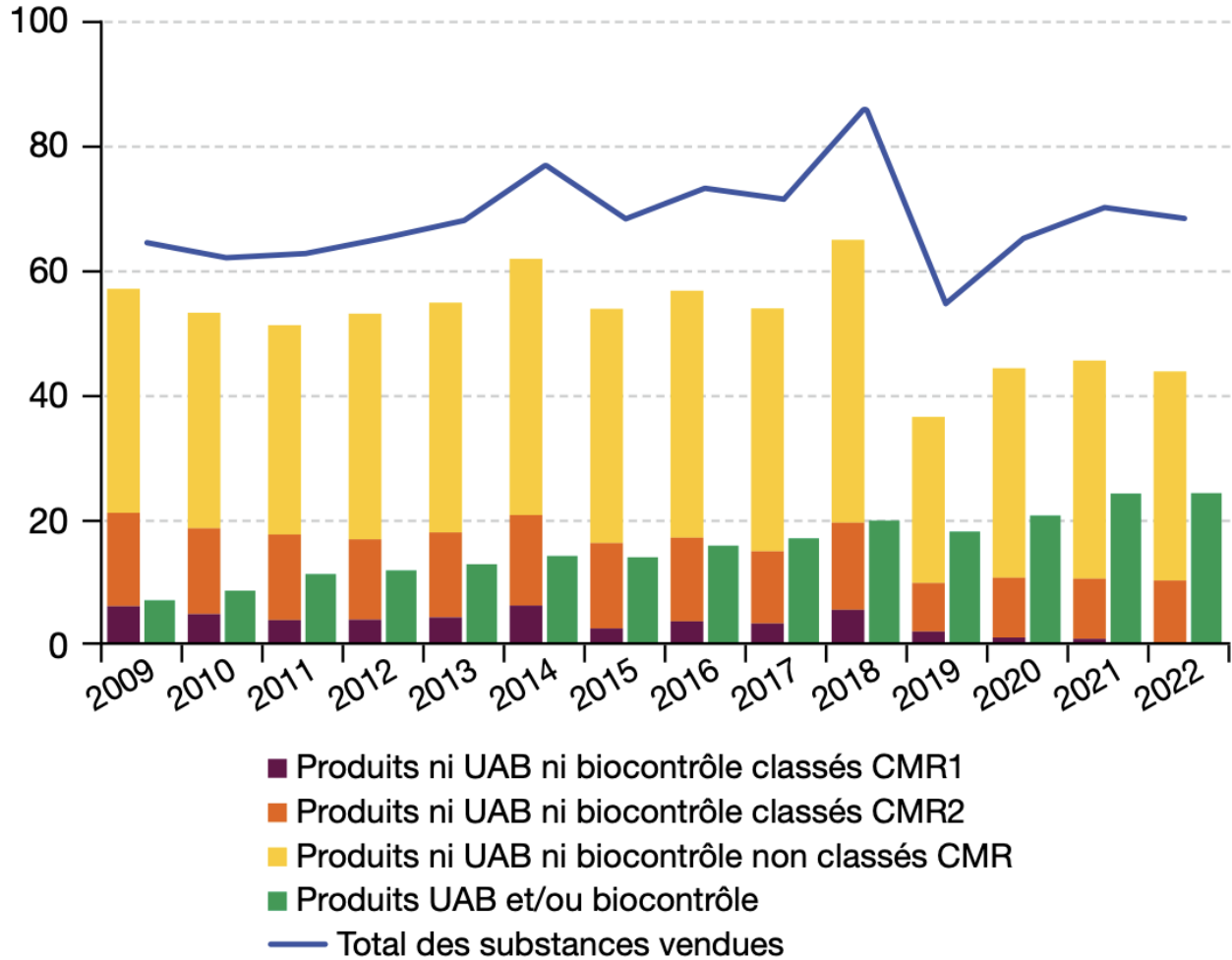
Crop protection is achieved today with massive use of chemical pesticides...

European use of pesticides (kg/ha of arable land in 2020)



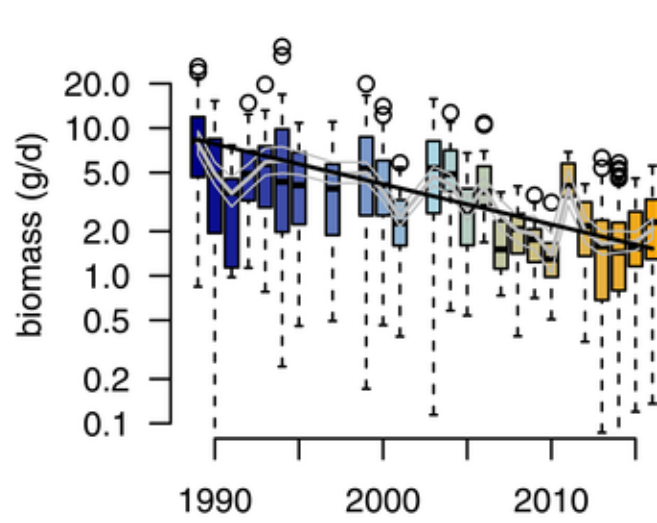
Sélection : pays de l'UE et Suisse, Royaume-Uni, Norvège. Données arrondies.  
Source : FAO

X 1000 tons



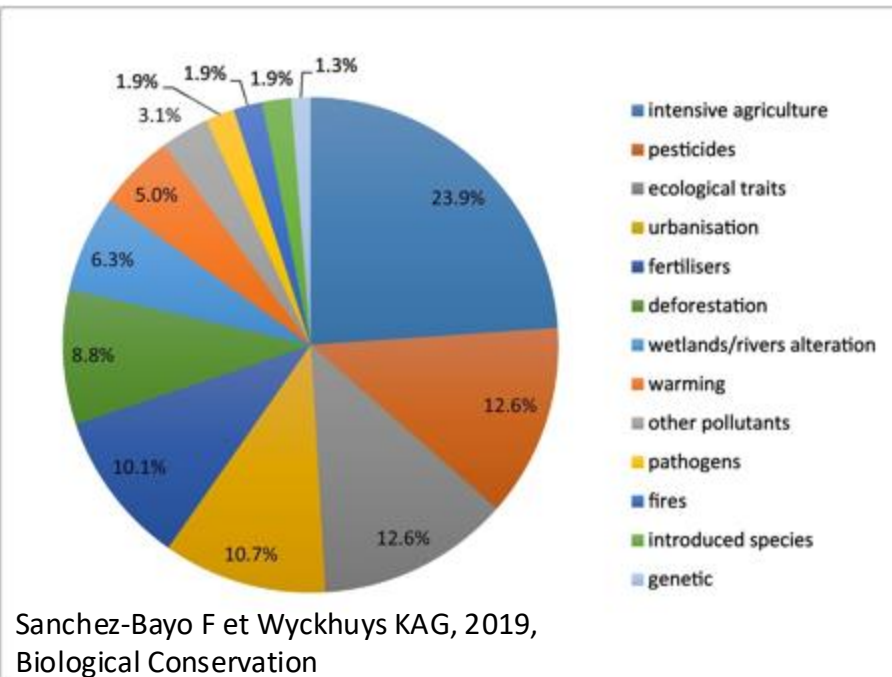
Notes : CMR = substances considérées comme les plus toxiques «cancérogènes, mutagènes et reprotoxiques» avec CMR1 pour «avéré ou présumé» et CMR2 «suspecté». Hors Banole pour la Martinique.  
Champ : France entière.  
Source : BNVD. Traitements : OFB et SDES, 2023





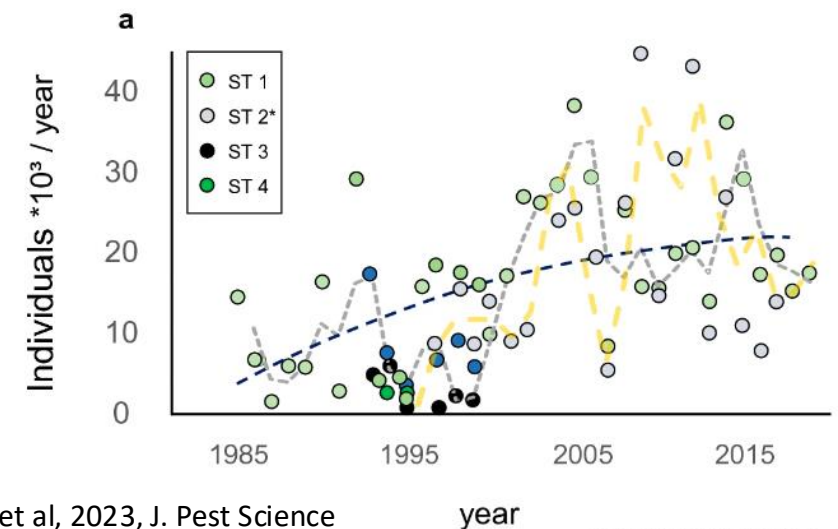
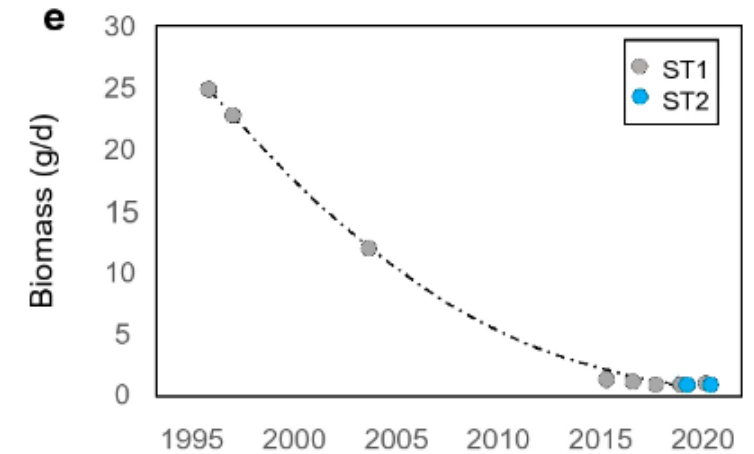
-75% of insects  
biomass in 26  
years

Hallmann CA et al. (2017) PLOS ONE 12(10): e0185809.  
<https://doi.org/10.1371/journal.pone.0185809>



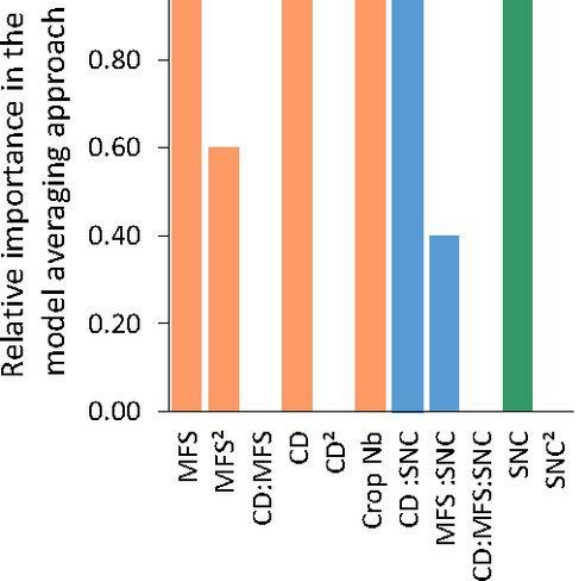
In the areas of arable  
crops in Germany

- A 95% loss in insect biomass
- Populations of aphids are increasing (loss of biological regulations)

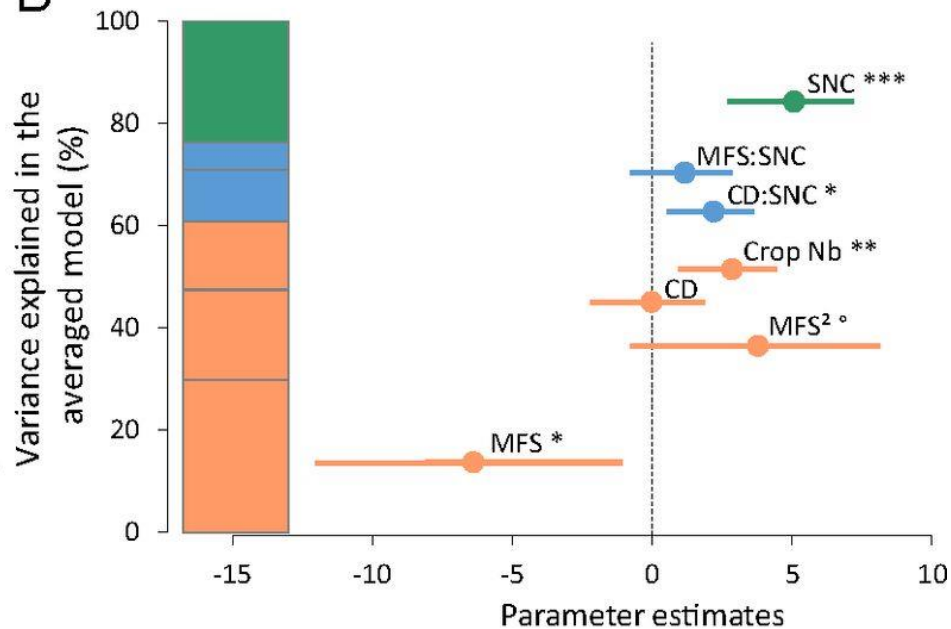


Ziesche TM et al, 2023, J. Pest Science

A



B

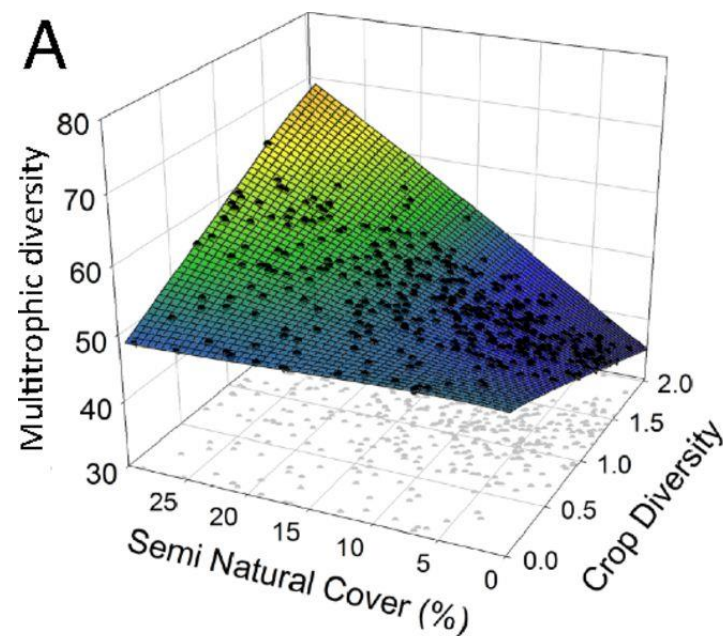


Landscape heterogeneity (mean field size, crop diversity, semi-natural cover) are essential for biodiversity

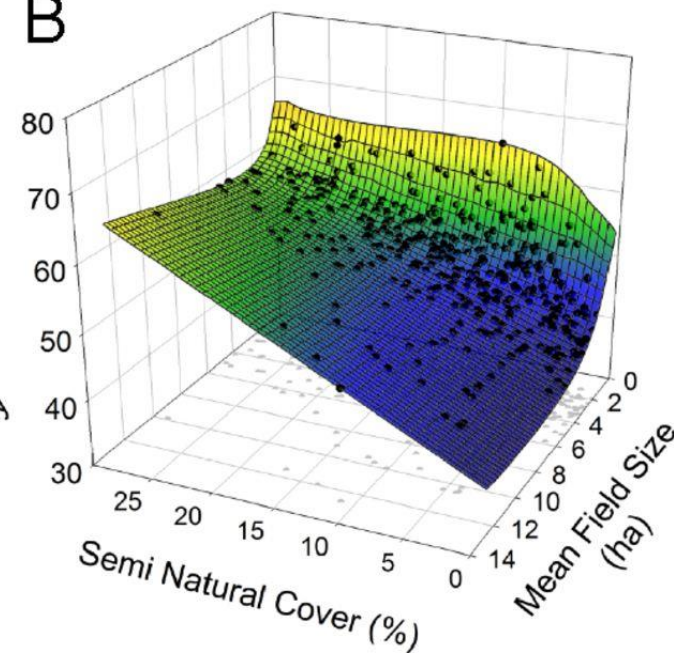
*According to Sirami et al, 2019, PNAS*

What are the items on which innovation and public policies could play a role?

A

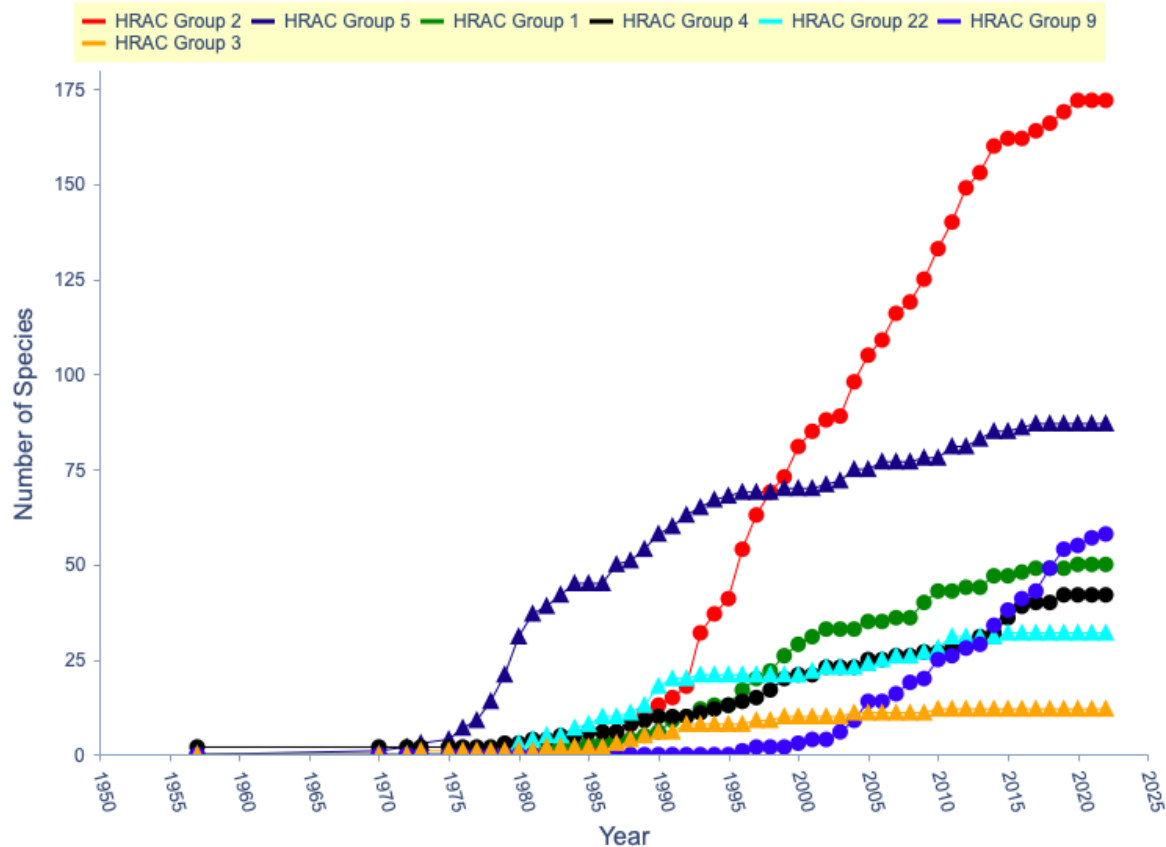


B



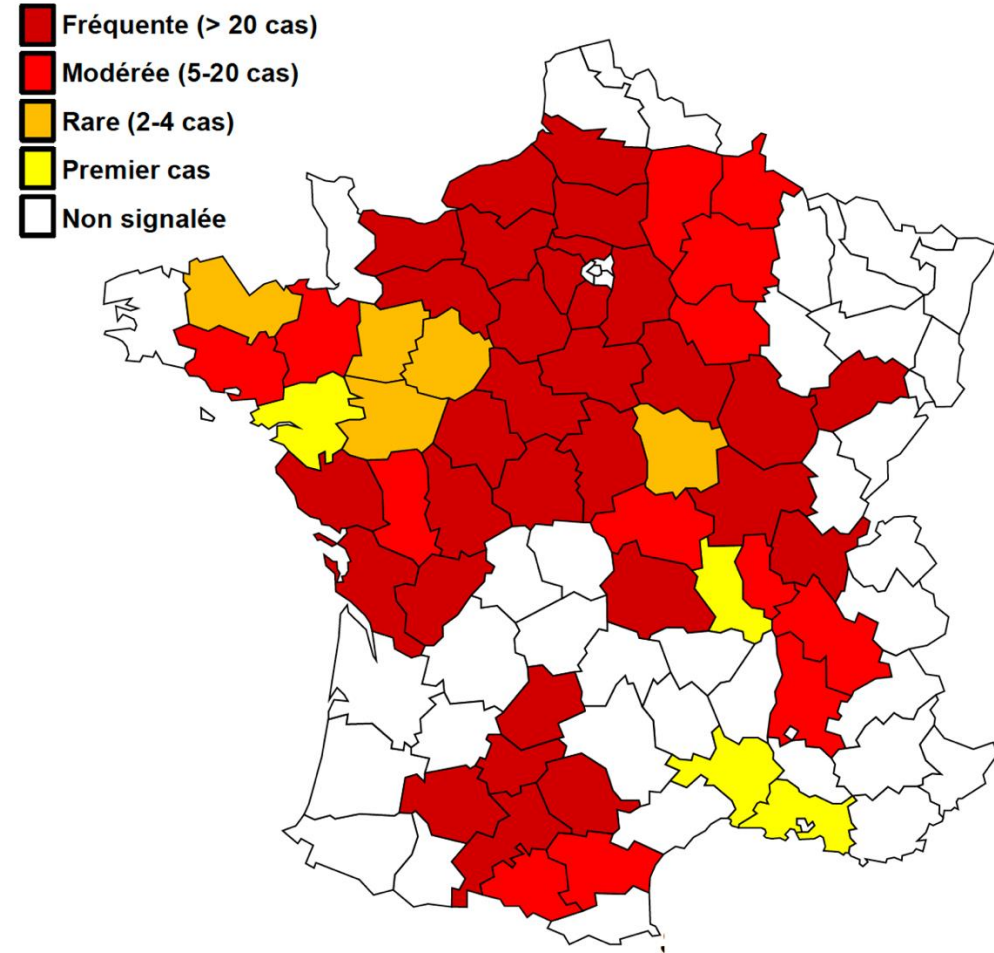
# Pesticides are losing efficacy because of emergence of resistance

Chronological Increase in Resistant Weeds Globally



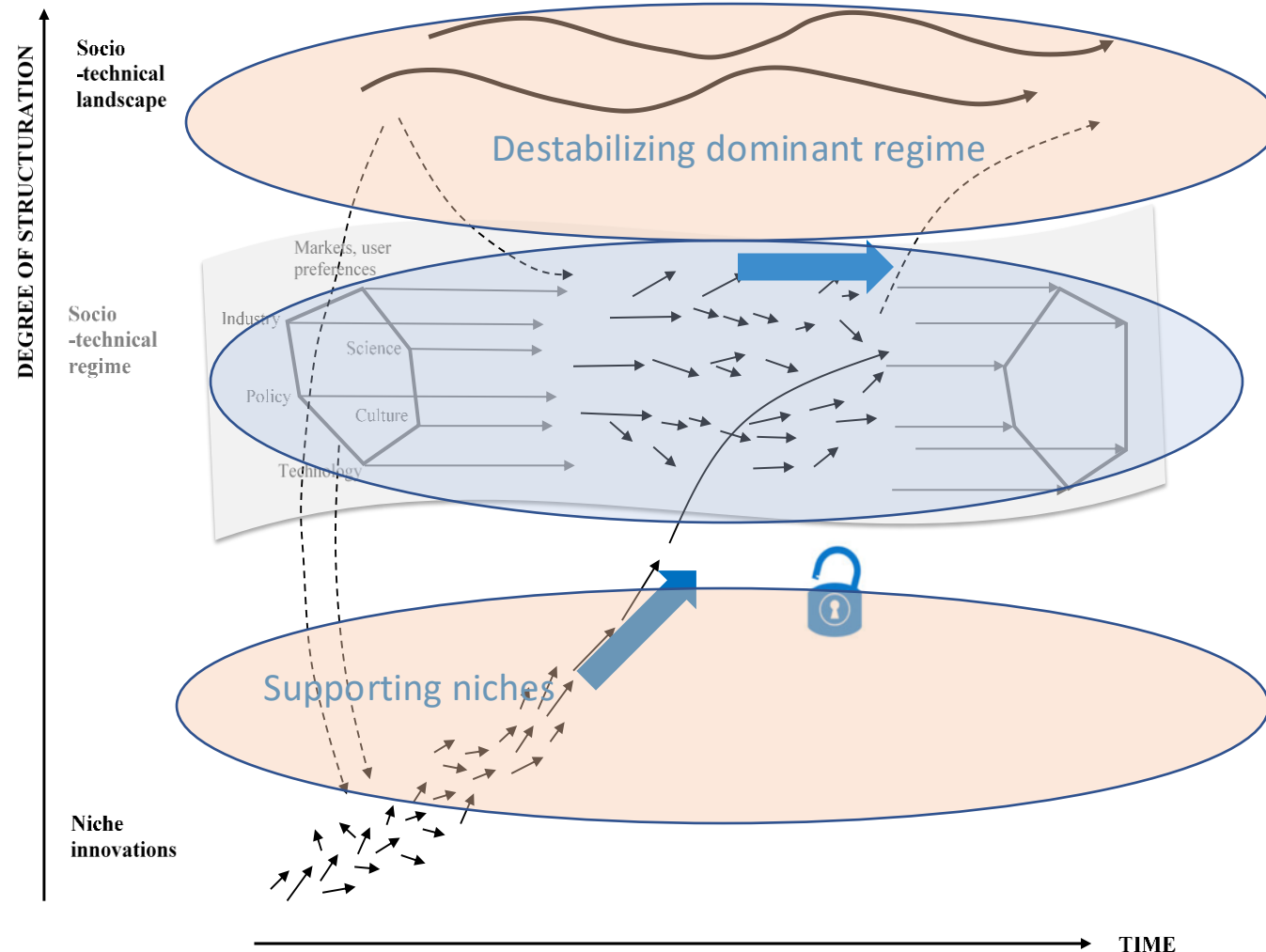
©2023 WeedScience.org, Dr. Ian Heap 06/12/2023

Emergence of resistance + active substances withdrawal = More dead-ends



Geographic distribution of resistances of rye-grass to herbicides (HRAC2, ALS inhibitors). Source : R4P network, 2024.

# Crop protection is a typical lock-in situation



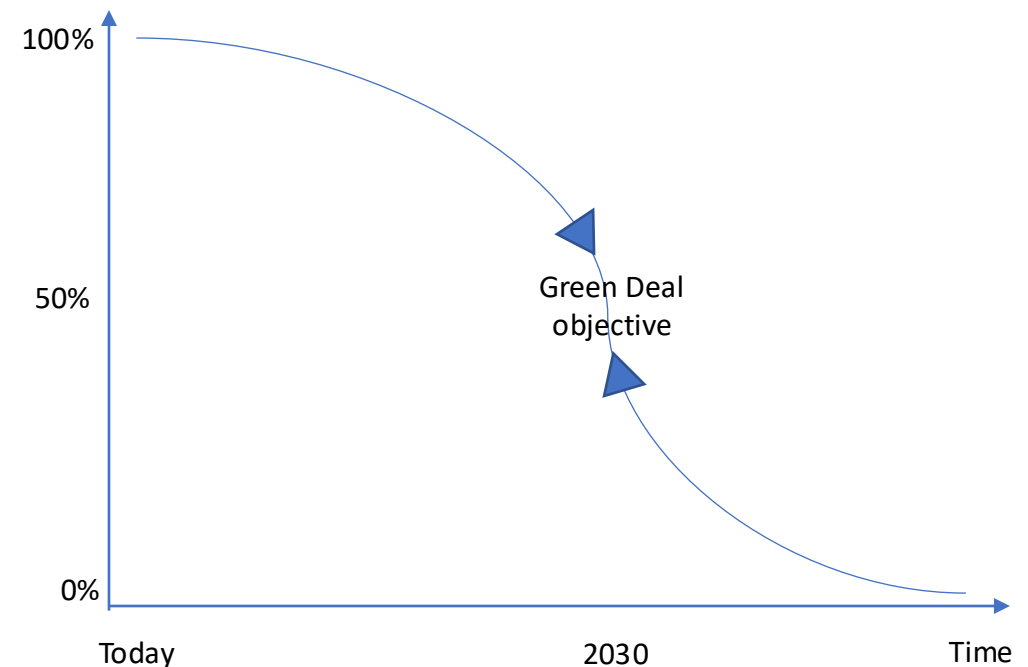
How to achieve the -50% reduction objectives?

- Incremental innovations into the existing cropping systems (**E** and **S** according to Hill and Mc Rae)

OR

- Disruptive innovations based upon paradigm shifts (**S** and **R** according to Hill and Mc Rae)

Pesticide use

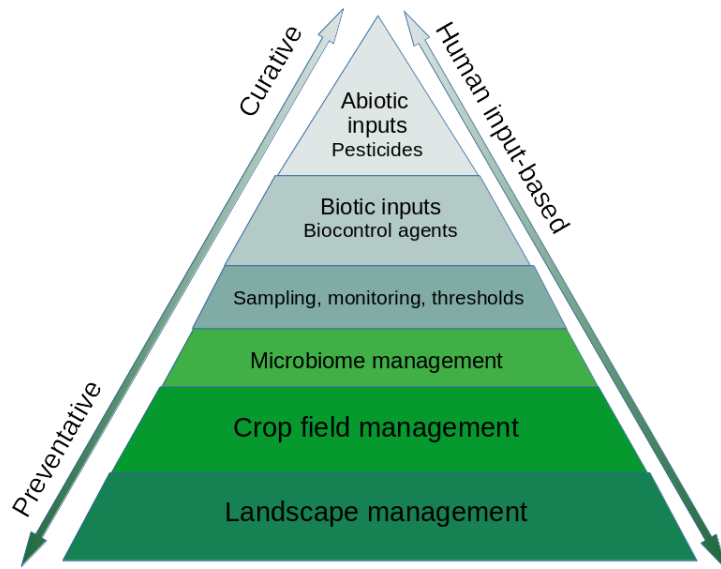


# Options for future sustainable crop protection

- Avoiding an *a priori* attitude that a trade-off between production and environment has to be accepted
- Levers already exist (genetics, biocontrol) but are not sufficient for a 0-pesticide agriculture. Innovations are required and prophylaxis must be first.
- What are the possible knowledge and innovation breakthroughs, in the coming decade?
- *A EU proposition for a revised version of the **Directive** 2009/128 (Sustainable Use of pesticides) towards a **Regulation** was released on 22 June 2022 and rejected in Dec 2023*
- *A foresight 'Pesticide-free agriculture in Europe in 2050', released on March 21<sup>st</sup> 2023 in Paris and discussed at the European Parliament in Brussels on April 27<sup>th</sup> 2023*

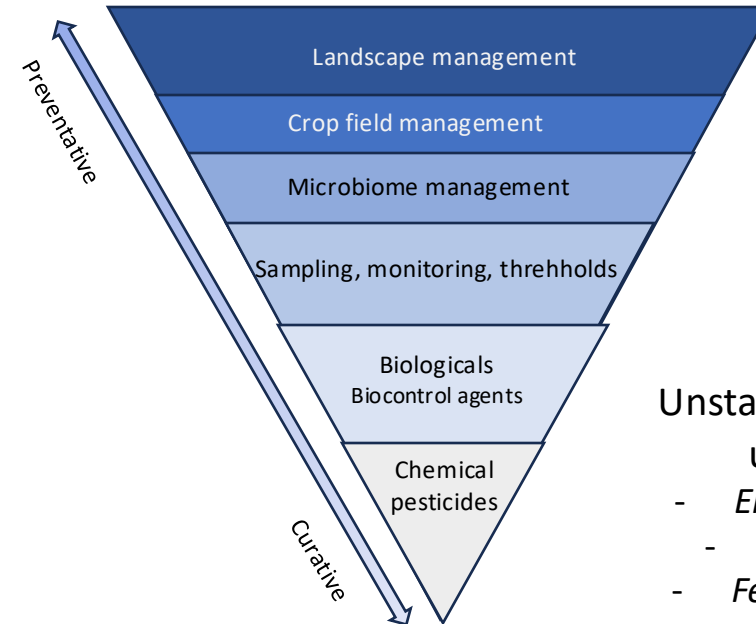


# New paradigms for new approaches



IPM triangle

*In theory*



IPM triangle

*In practice*



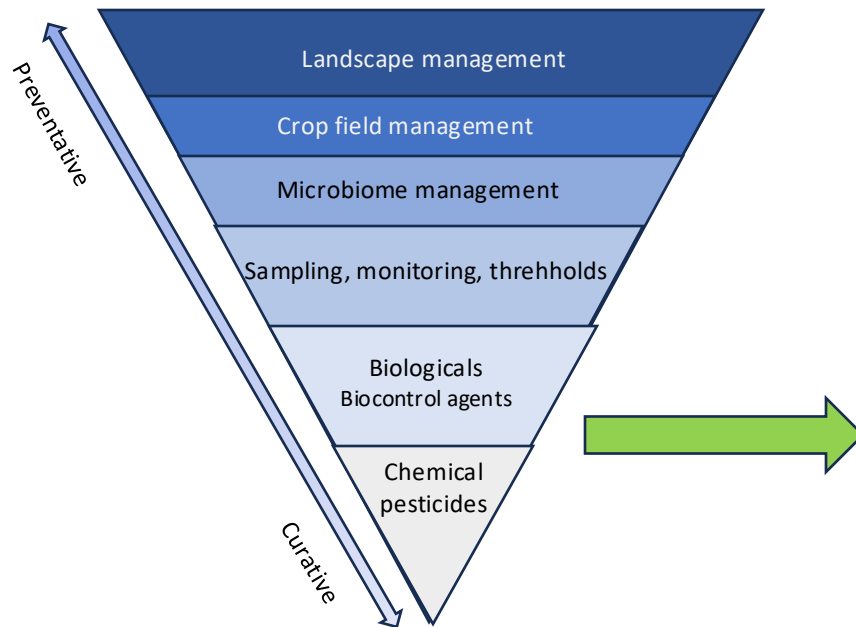
Unstable equilibrium based upon chemicals !

- Emergence of resistances
- Chemical withdrawal
- Few new molecules in the pipeline
- No new mode of actions

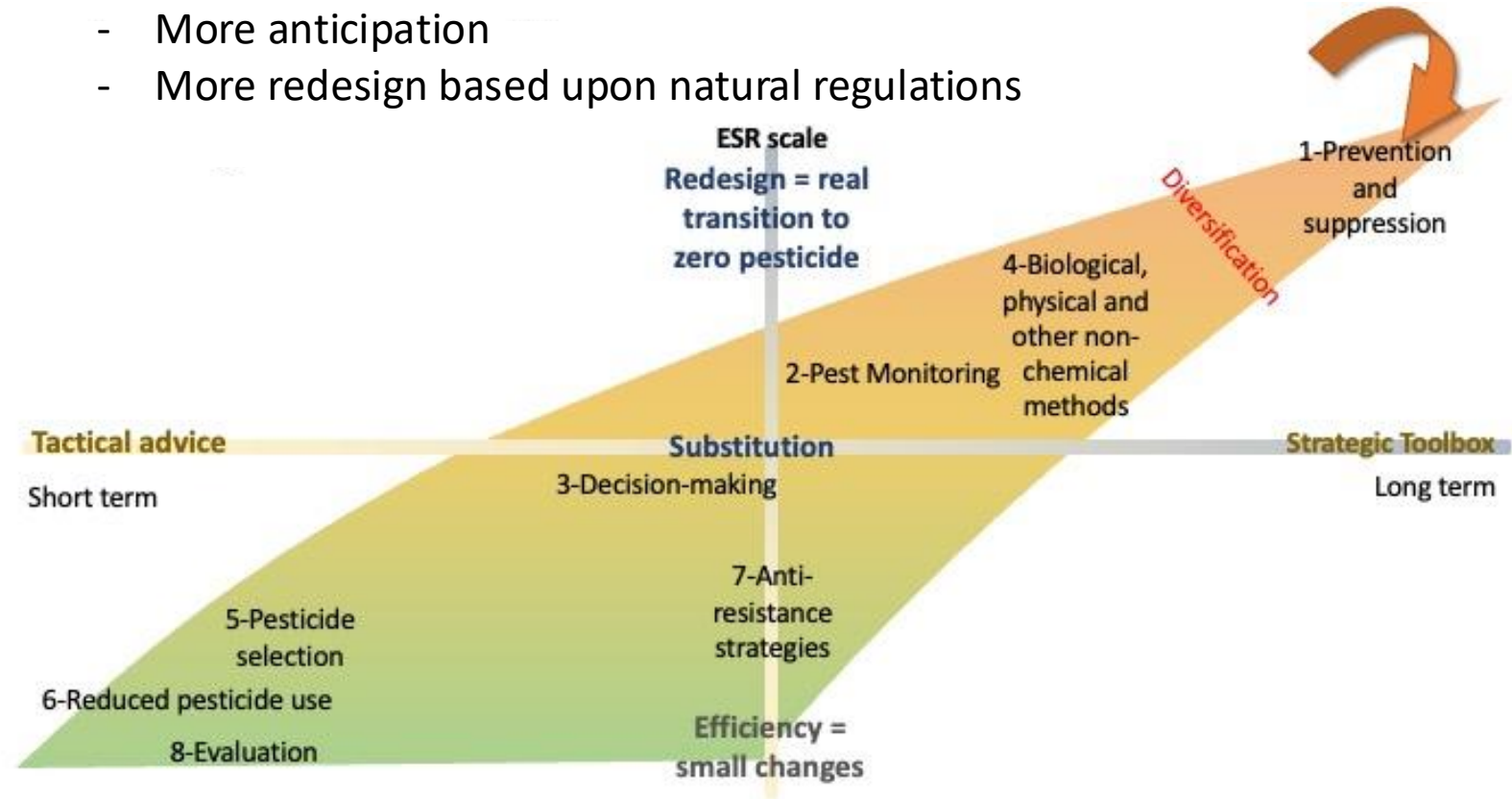
# New paradigm for new approaches

2 dimensions to consider to boost preventative approaches:

- More anticipation
- More redesign based upon natural regulations

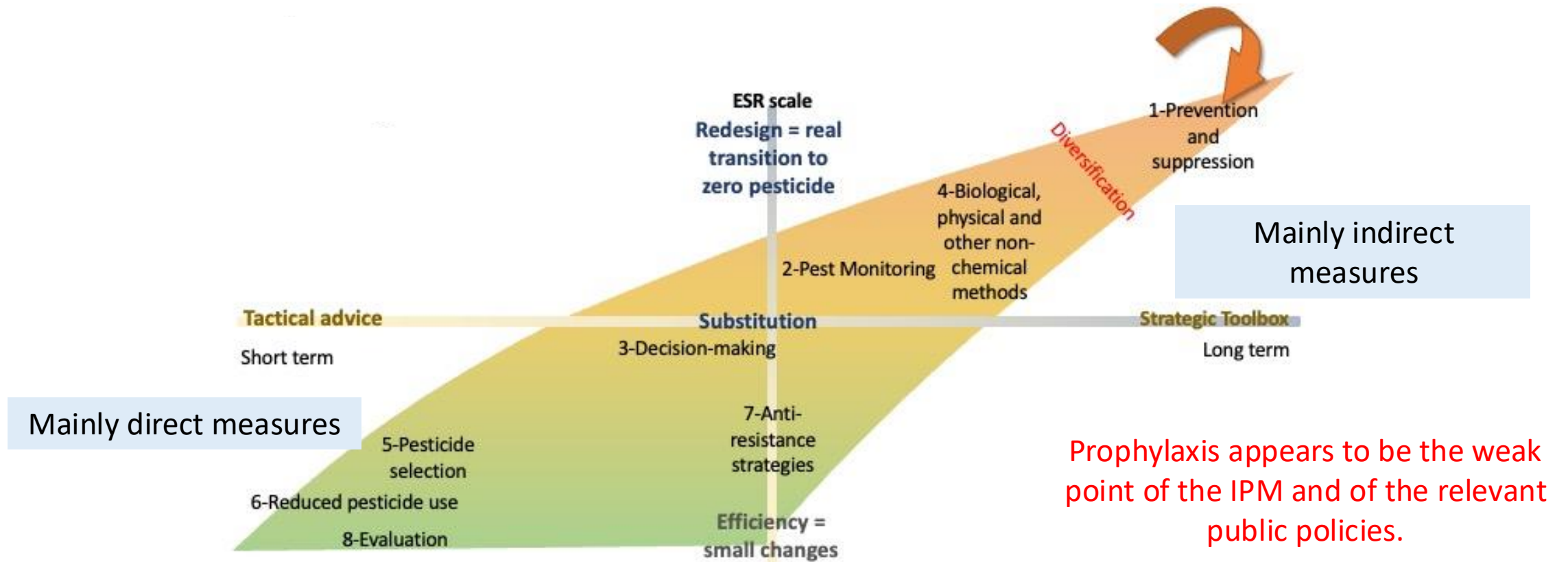


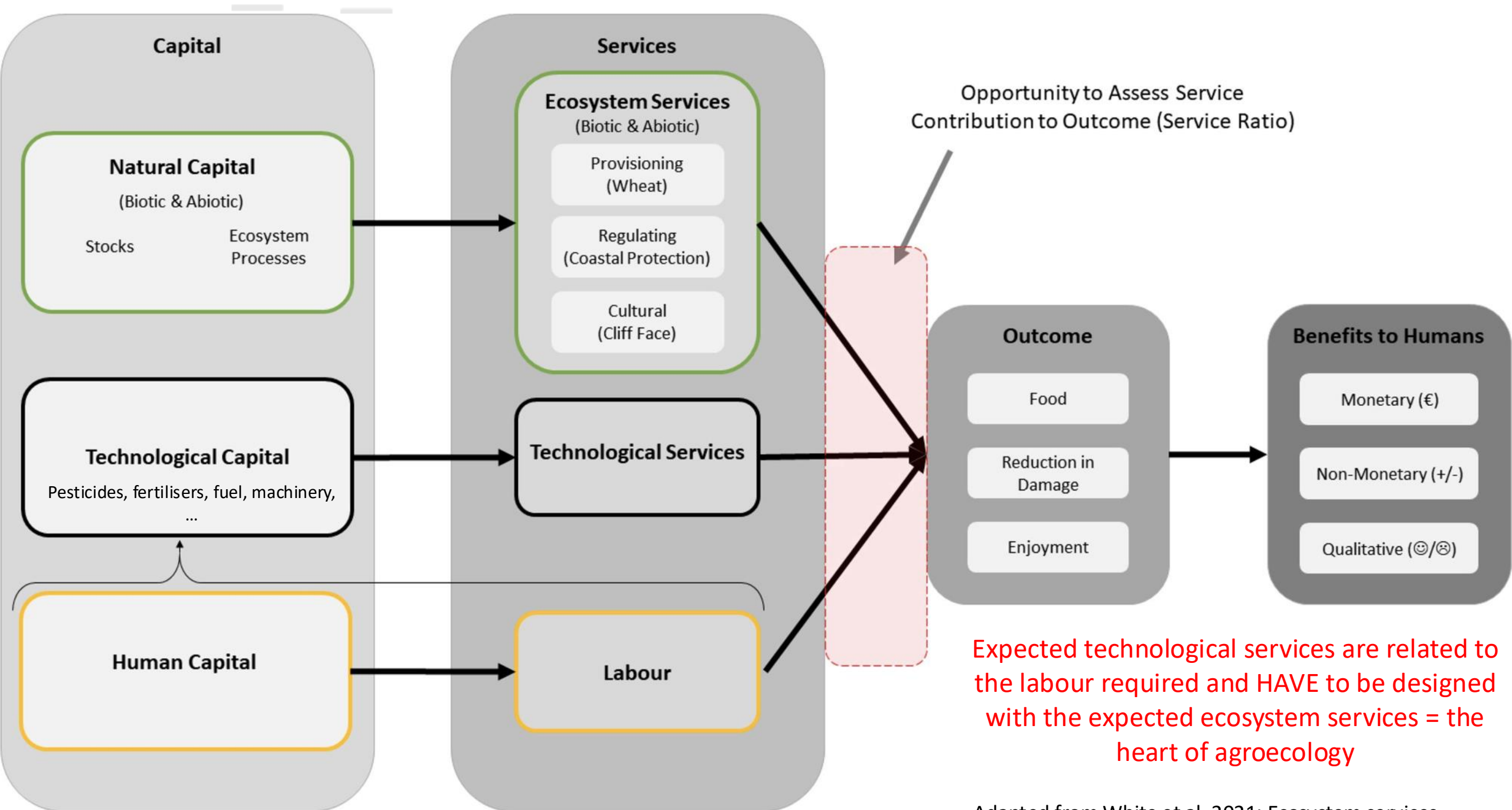
IPM triangle



Triangle in the Wind

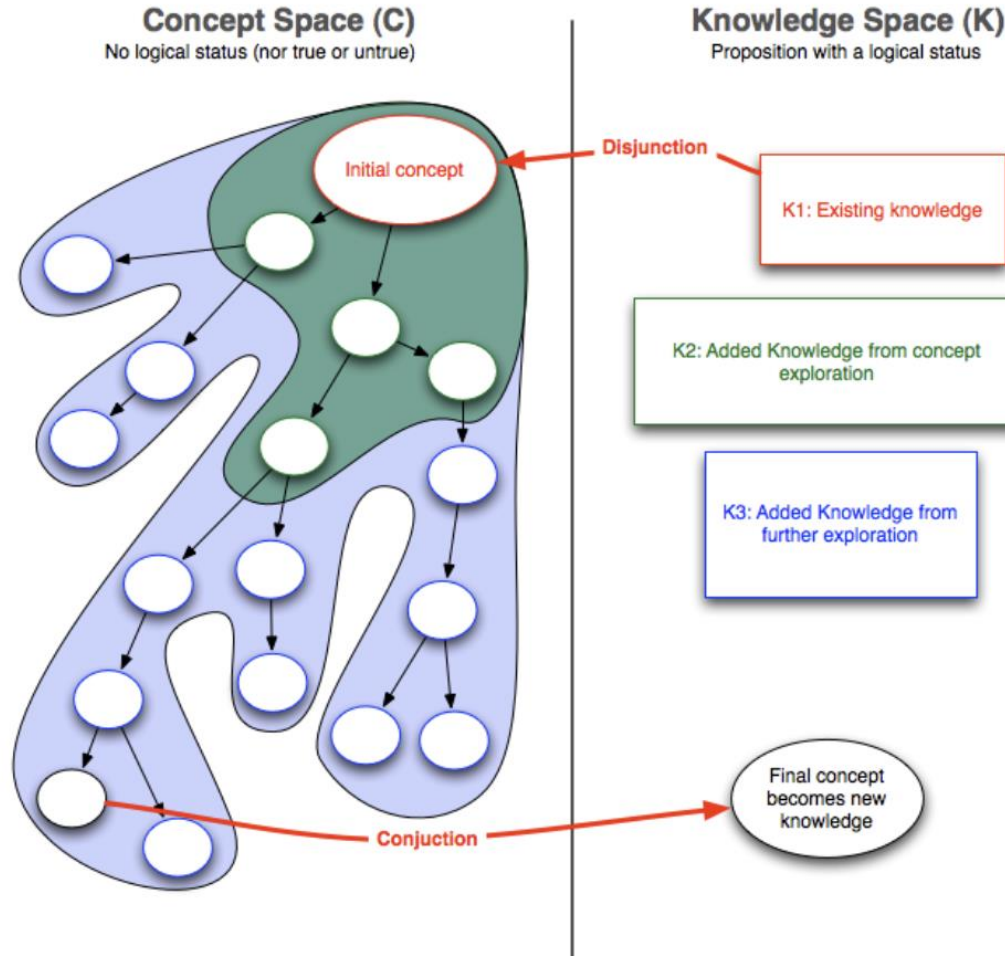
# What about the public policies?







In the COST Action TOP-Agri Network, national C-K workshops were implemented and an international workshop (11 countries in person) was held last week in Mainz



# The French C-K workshop was dedicated to prophylaxis

One key limiting issue: how to measure the efficiency of prophylaxis and the actual decrease of pressure below thresholds?

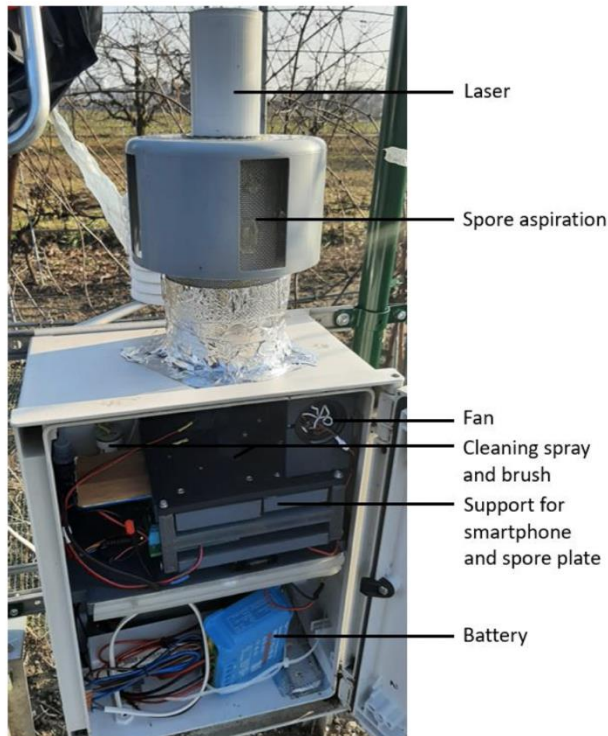
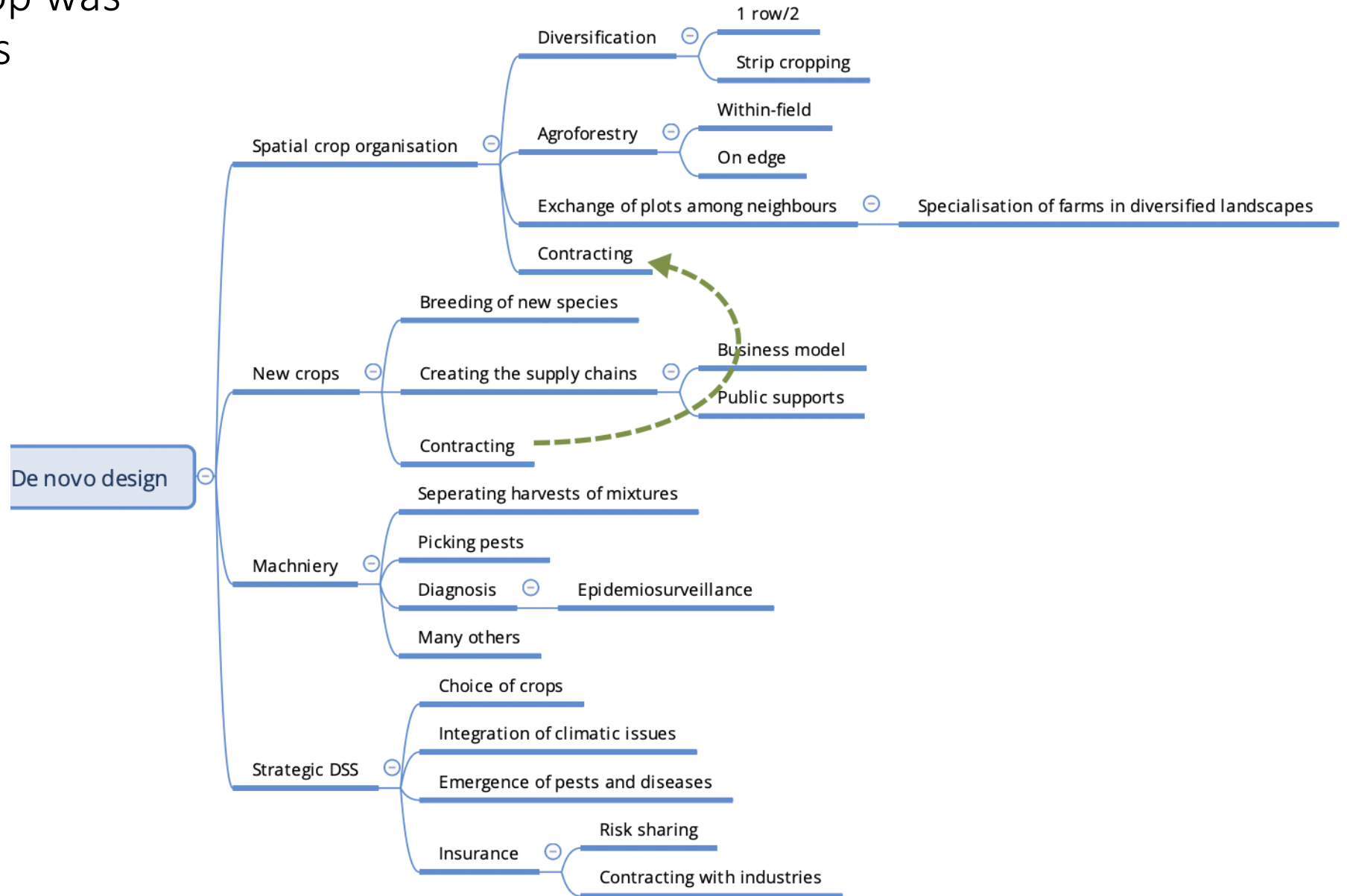


Figure 2 : Picture of the spore detector installed in field (Changins). The device measures approx. 40 x 25 x 60 cm (L x W x H).

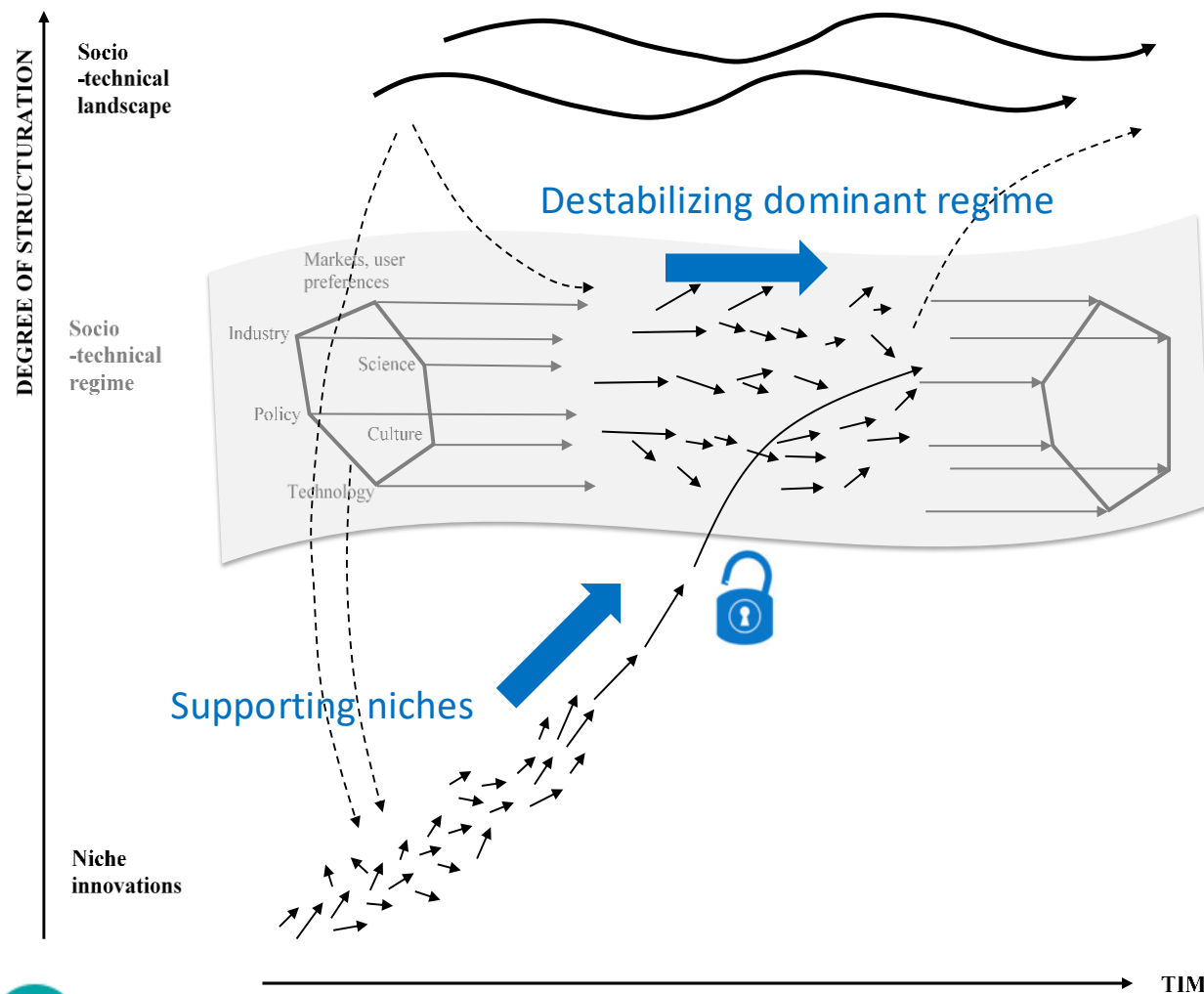


# An emerging question: how to avoid dead-ends due to chemical withdrawal?

## Reducing the use of pesticides vs. Anticipating the withdrawal of active substances

- Alongside with Ecophyto (French SUD)
- The French example: Parsada program for anticipating the possible withdrawal of 75 active substances (79% of the French sales in 2022)
- Action plans defined for the various production sectors and the various groups of weeds/pests/pathogens (metropolitant + overseas)
- Financing big (up to 7.5 M€) long (up to 6 years) projects with 360° approaches (*preventative and curative, individual levers + combinations*), including knowledge transfer to farmers: **problem-solving approaches**
- Projects proposed by production sectors AND transversal transformative projects

# How to unlock locked-in systems?



Forcing changes of the socio-technic landscape: public policies including CAP, regulations, listening societal demands

## How to go beyond?

- Setting non prescriptive extreme scenarios: 0-pesticides (*PPR, European Research Alliance*)
- Participatory approaches and living labs: involving new players (Klerkx et al, 2020)

Supporting rupture innovation. R&I is essential

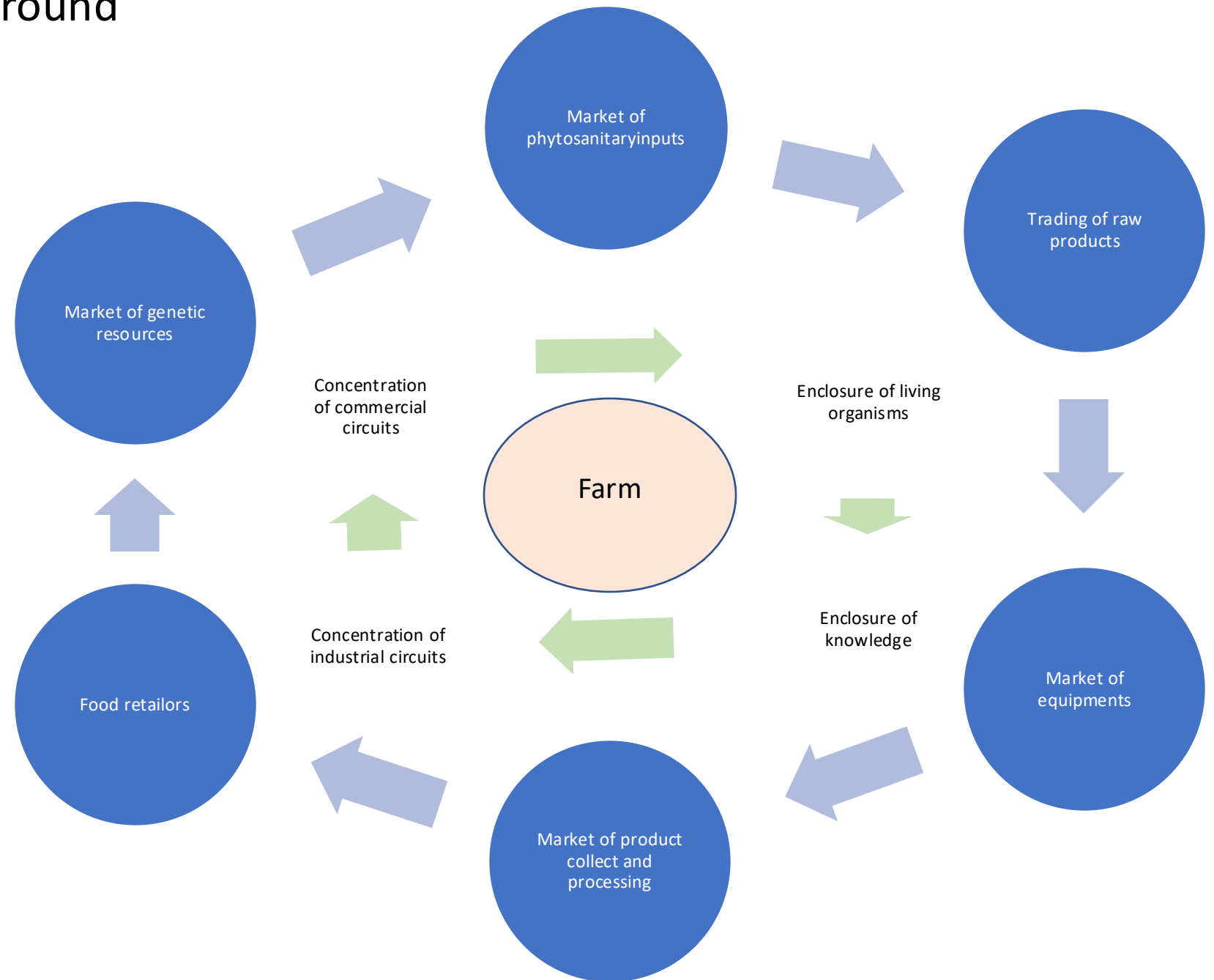


# Strong socio-technic lock-in around farms (Geels, 2002)

Adapted from Valiorgue (2020)

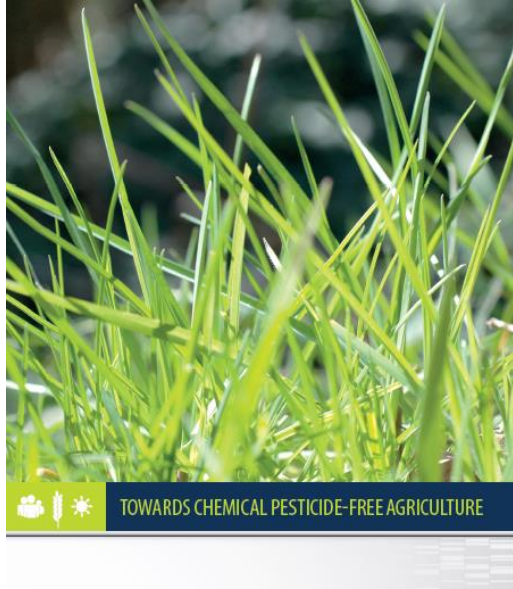
Three major issues to consider to foster transition

- The enclosure patterns
- The weight of specific investments at farm level
- Considering the key role of agri-food industries



# European Research Alliance

## Towards Chemical Pesticide-free Agriculture



- 3 preparatory workshops organized at
  - Inra, Paris, October 2018
  - JKI, Berlin, May 2019
  - Luke, Helsinki, October 2019
- Signature of the MoU
  - SIA, Paris, February 2020
- Annual General Assembly
  - Next: 20 May 2025, Bucharest



A unique context with emerging fronts of science

- Microbiota and its impact on plant health
- Plant-plant interactions and their impacts on crop diversification
- Chemical ecology, insect and plant odorscapes
- Ecological immunology and plant immunity



### Today

- 38 organisations
- 21 countries

### Achievements

- An increasing scientific community
- Contribution to a foresight study published in March 2023
- A Cost project: CA 21134
- A CSA: Fortuna
- A Life-PLP: Agrowise

# COST ACTION 21134

Towards zero Pesticide AGRIculture : European Network for sustainability (TOP-AGRI-Network)

**Action Chair: Christian Huyghe (France)**

**Action Vice-Chair: Renata Bazok (Croatia)**

**WG1 leader: Mugur Jitea (Romania)**

**WG2 leader: Danilo Christen (Switzerland)/Christian Andreasen (Denmark)**

**WG3 leader: Dimitris Tsitsigiannis (Greece)/Sevgi Marakli (Turkey)**

**WG4 leaders: Riccardo Bommarco (Sweden)/Kathrin Grahmann (Germany)**

**WG5 leader: Silke Dachbrodt (Germany)/Federic Leoni (Italy)**

**Grant Awarding Coordinator: Elisabete Figueiredo (Portugal)**

**Starting 1<sup>st</sup> November 2022**

**Now: 381 participants**



# Conclusions

- Crop protection is compulsory for ensuring food production that is safe, sustainable and affordable to all
- Pesticide-based crop protection is not sustainable
- Major bio and tech breakthroughs are changing the game
- To achieve a succesful transition:
  - Redesigned cropping systems where prophylaxis is first
  - New varieties
  - Biocontrol and biostimulation: breakthroughs in odorscapes and plant microbiota
  - Machinery and robotics
  - A commitment of actors all along the supply chains
  - Adapted economics and policies



Thank you for your  
attention ...