

Euragri Conference

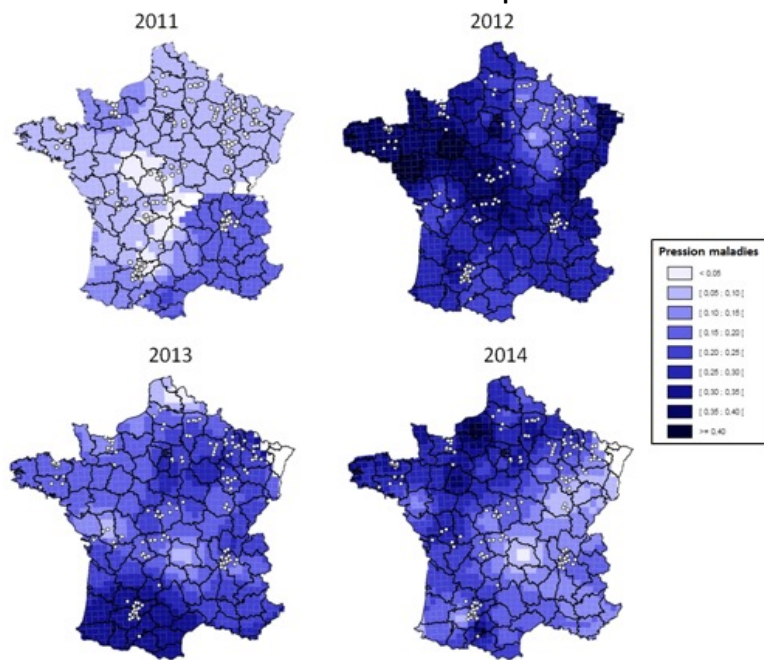
Towards a productive pesticide-free agriculture in Europe: motivations, challenges and prospects

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

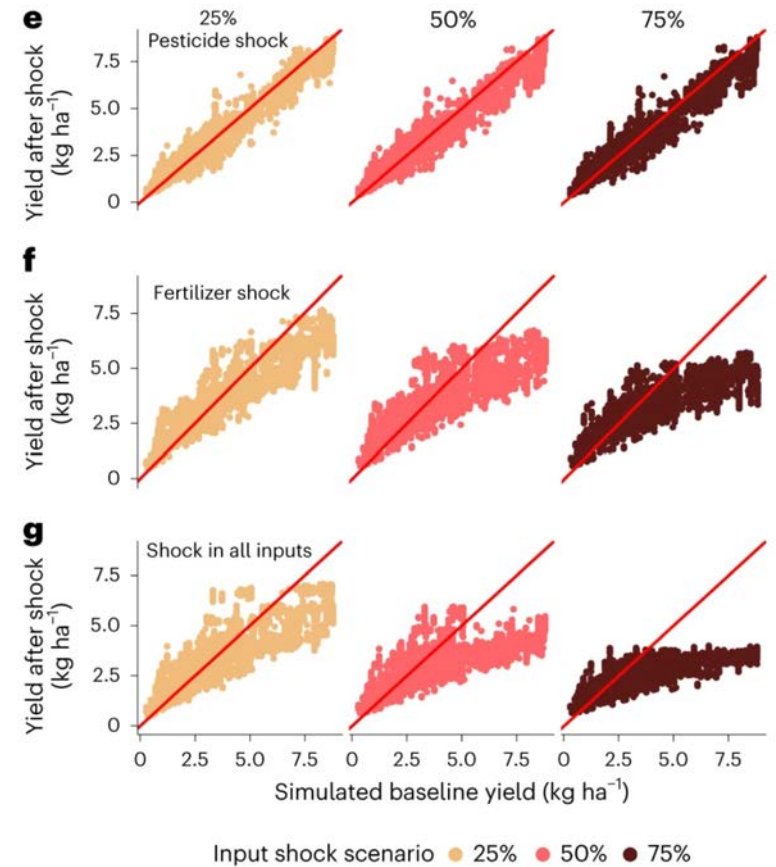


Crop protection is compulsory to ensure safe and affordable food to all

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



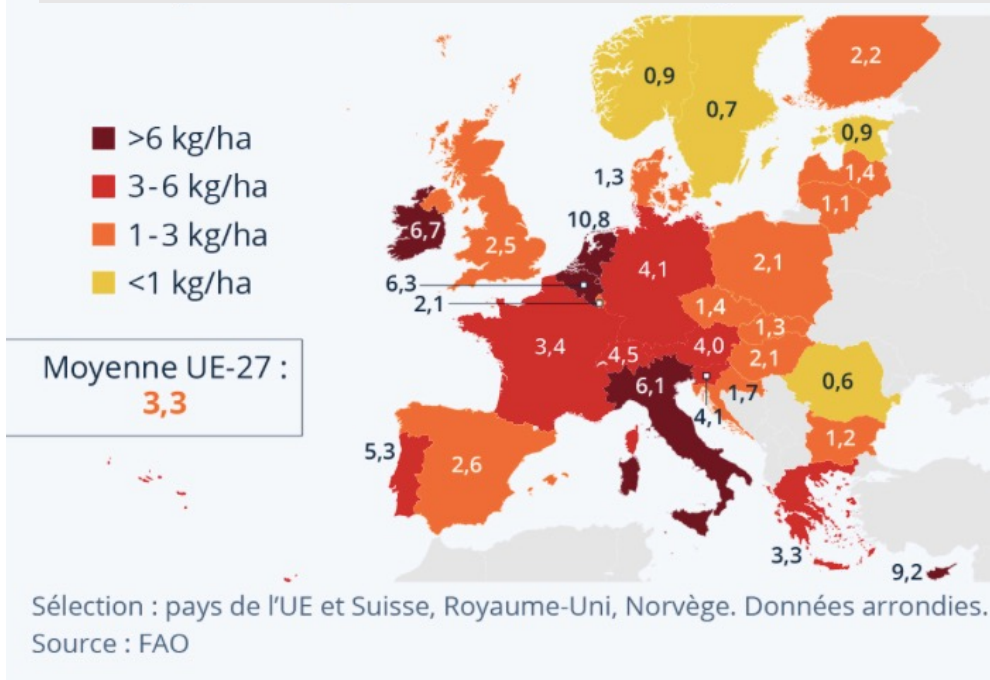
Yield losses due to foliar diseases in bread wheat in absence of any protection
Urruty et al, 2016, ASD



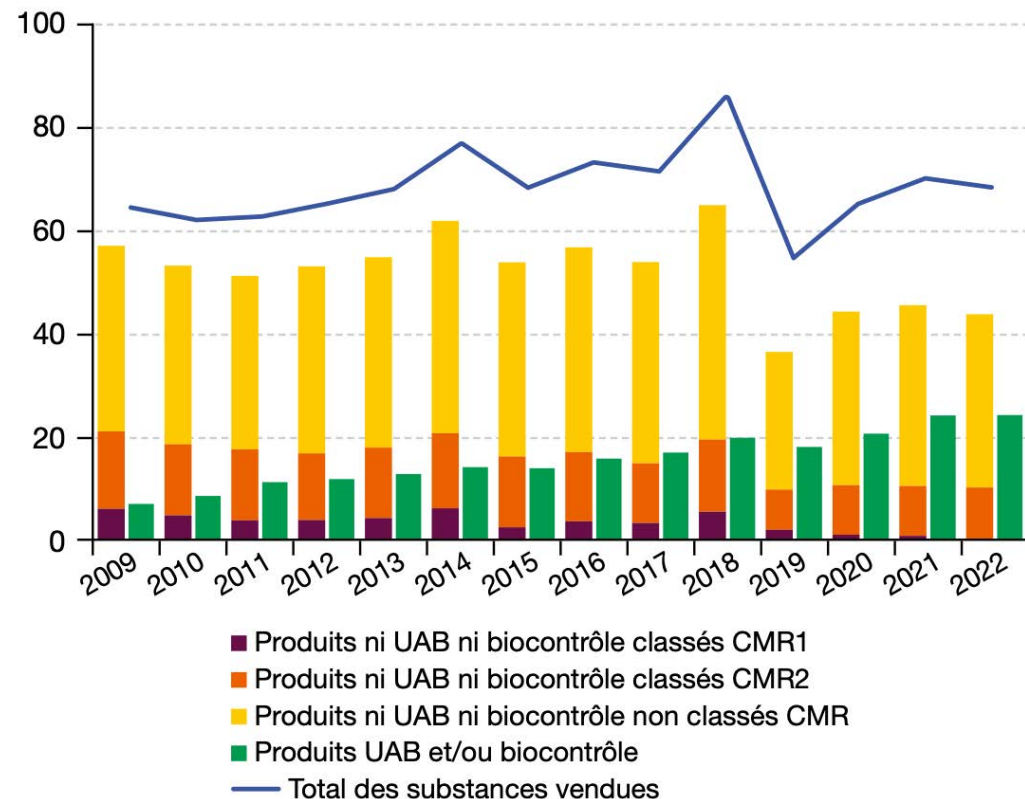
From modelling approaches, at constant cropping systems, pesticide shock is smaller than fertilizer shock, but with interaction (Ahvo et al, 2023, Nature Food)

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

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

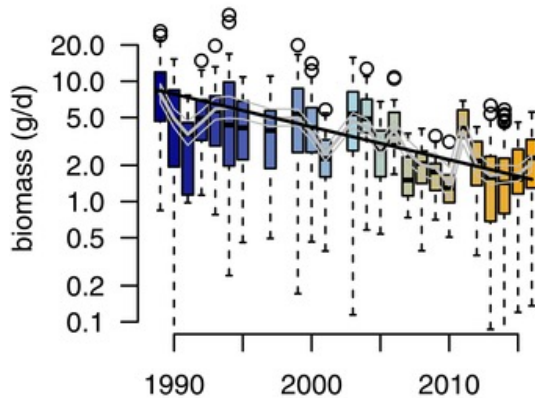


X 1000 tons



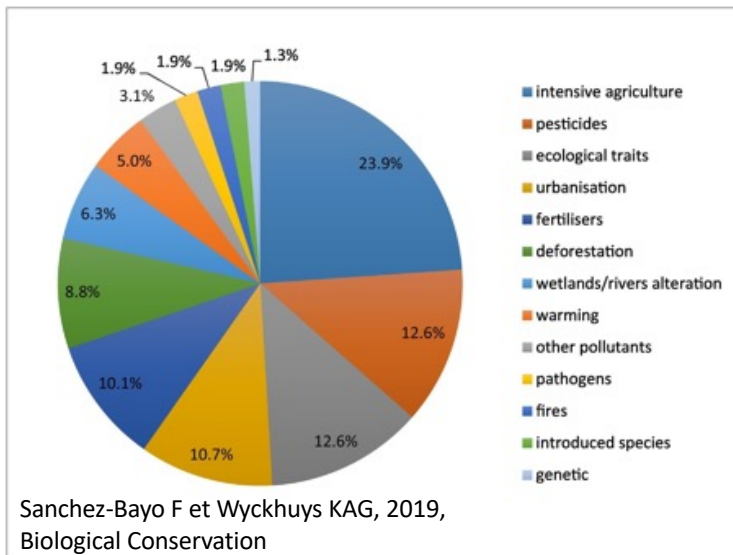
Notes : CMR = substances considérées comme les plus toxiques « cancérogènes, mutagènes et reprotoxiques » avec CMR1 pour « avéré ou présumé » et CMR2 « suspecté ». Hors Banole pour la Martinique.
Champ : France entière.

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>

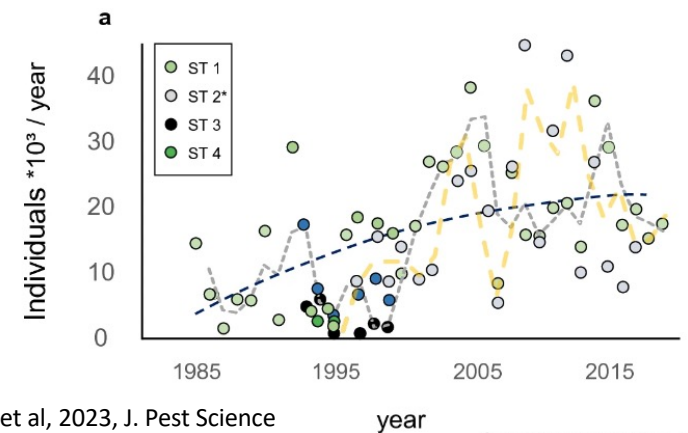
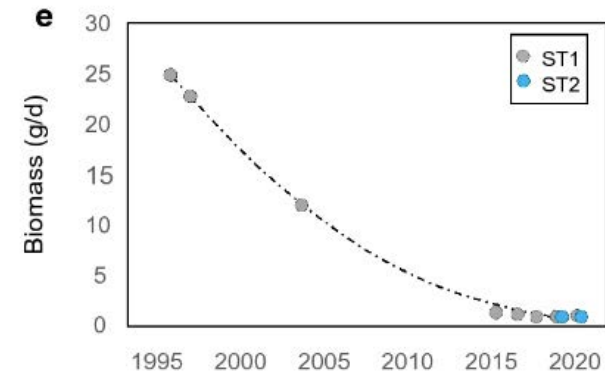


Sanchez-Bayo F et Wyckhuys KAG, 2019,
Biological Conservation

...generating an unsustainable pressure on environment and biodiversity, pesticides being a cornerstone of cropping systems

In the areas of arable crops in Germany

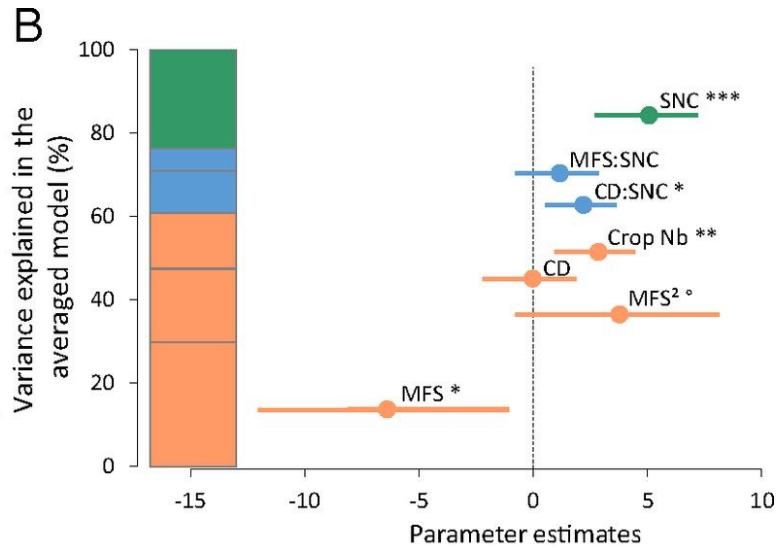
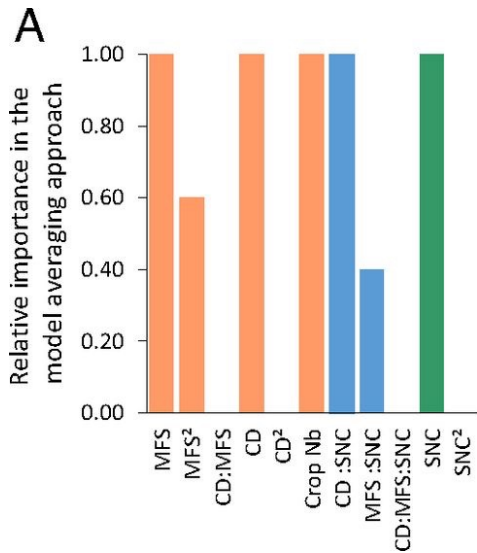
- A 95% loss in insect biomass
- Populations of aphids are increasing (loss of biological regulations)



Ziesche TM et al, 2023, J. Pest Science

year

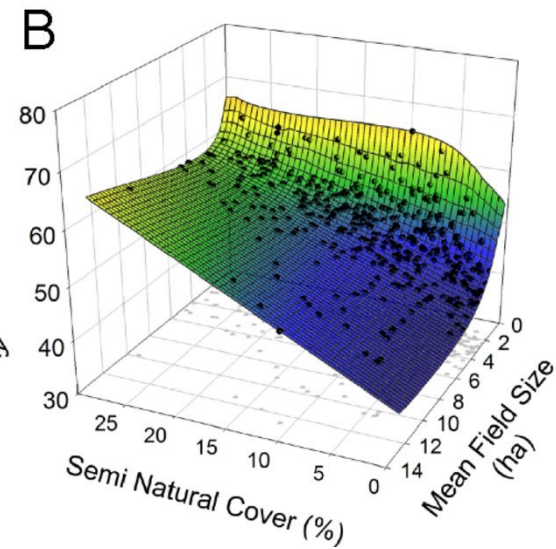
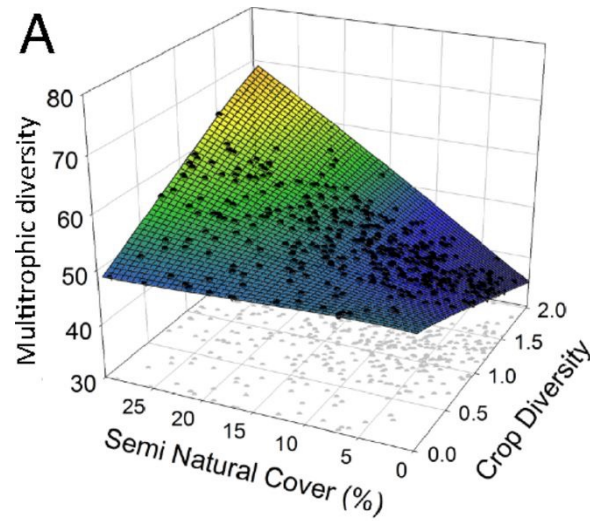
INRA Agricultural practices, pesticide load and land use are the main sources of insect losses



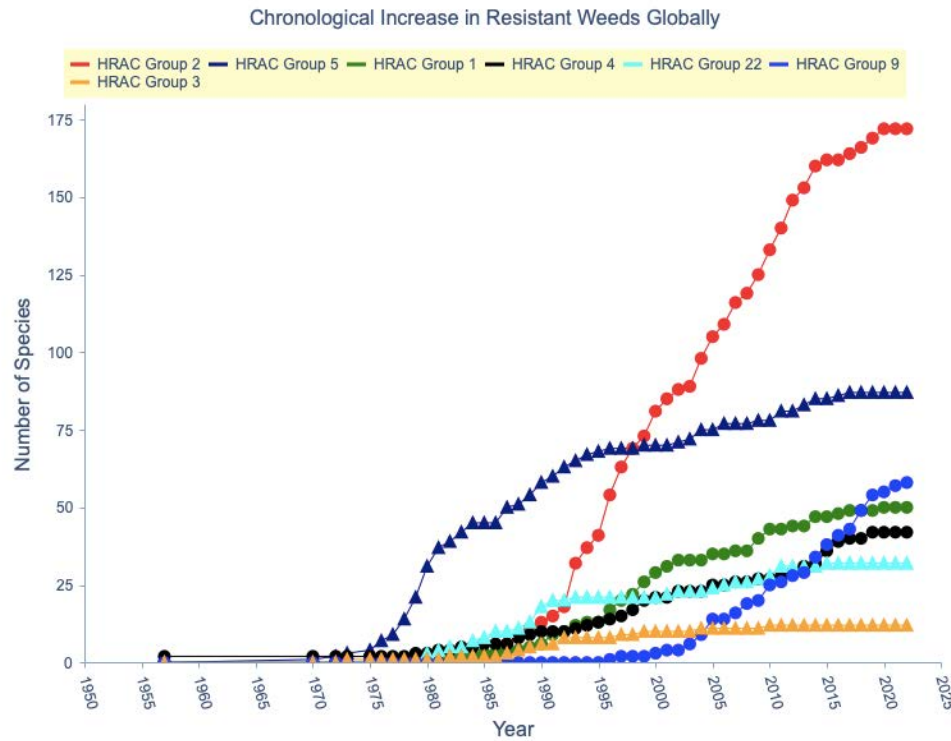
Landscape heterogeneity (mean field size, crop diversity, semi-natural cover) are essential for biodiversity

According to Sirami et al, 2019, PNAS

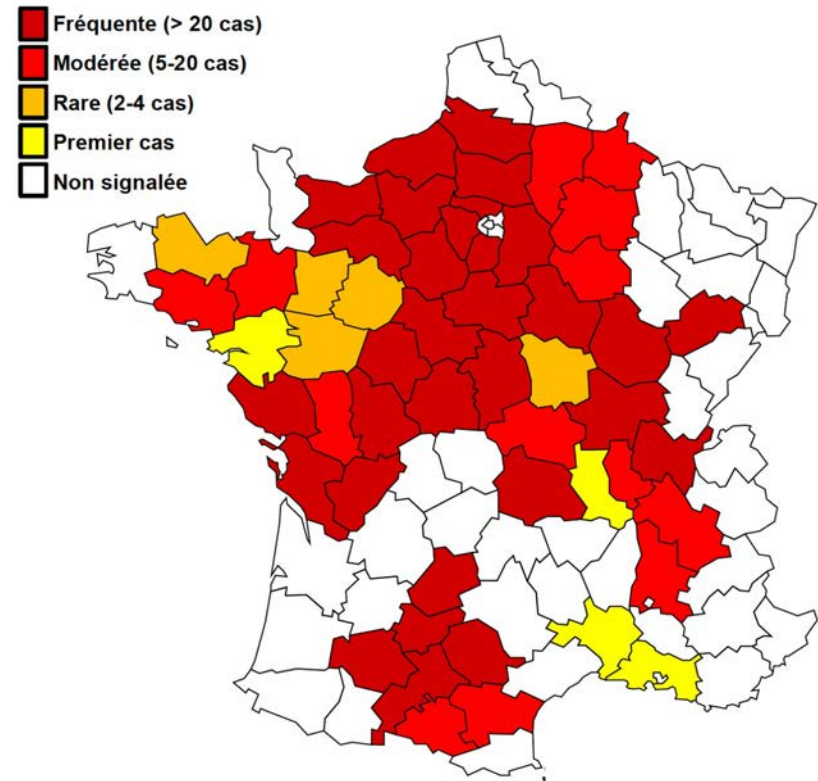
What are the items on which innovation and public policies could play a role?



Pesticides are losing efficacy because of emergence of resistance

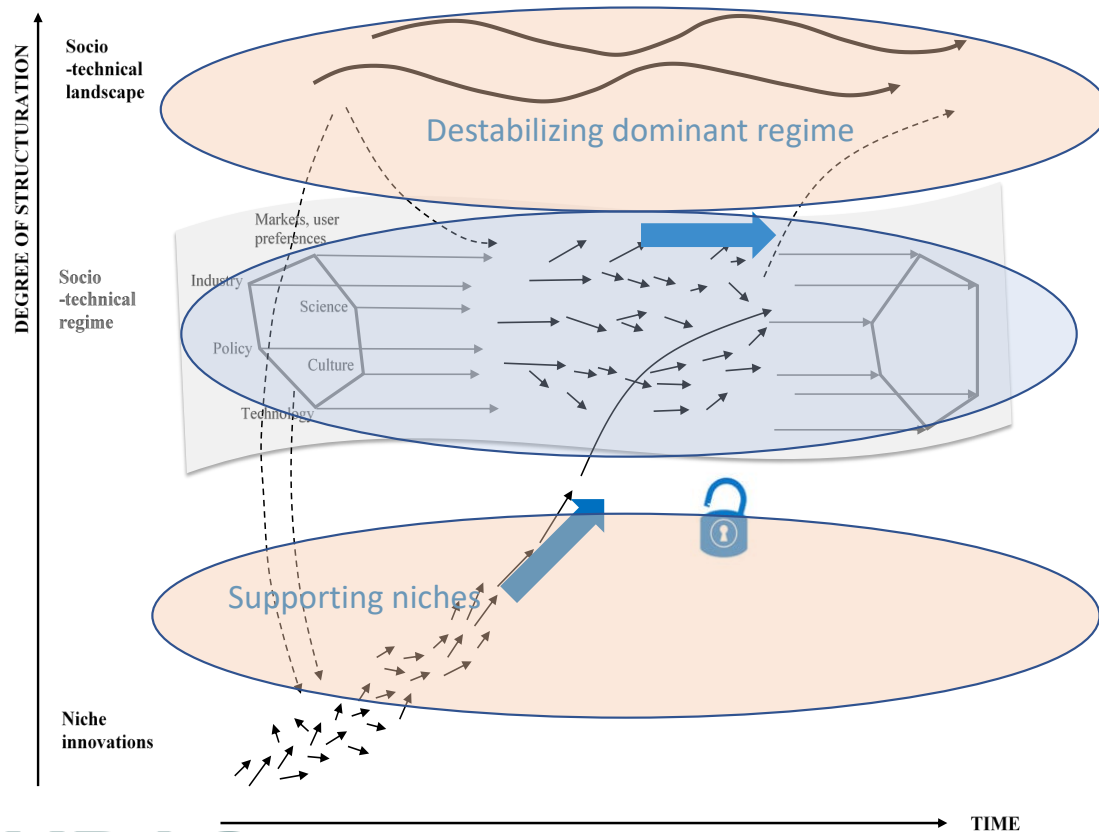


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Geographic distribution of resistances of rye-grass to herbicides (HRAC2, ALS inhibitors). Source : R4P network, 2024.

Crop protection is a typical lock-in situation



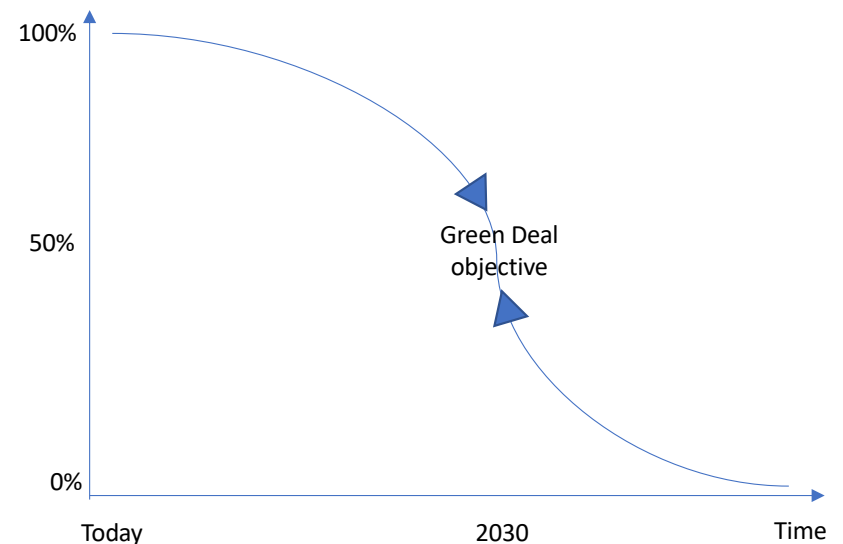
How to achieve the -50% reduction objectives?

- 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)

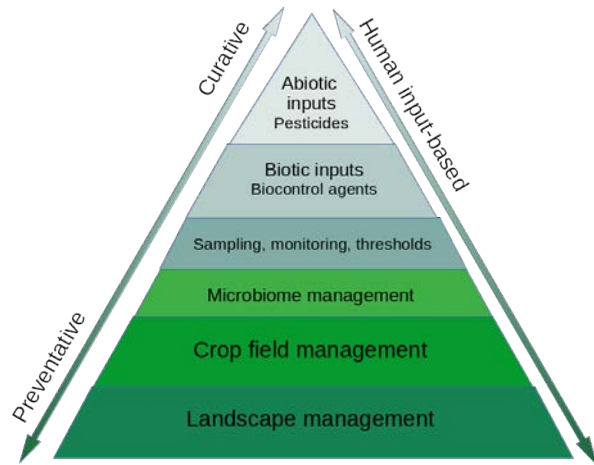
Pesticide use



Options for future sustainable crop protection

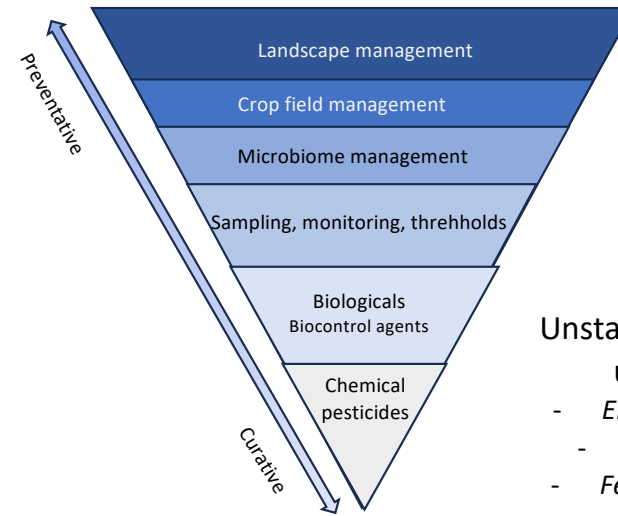
- Avoiding an *a priori* attitude that a trade-off between production and environment has to be accepted
- Levers already exist (genetics, biocontrol) but are not sufficient for a 0-pesticide agriculture. Innovations are required and prophylaxis must be first.
- What are the possible knowledge and innovation 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 21st 2023 in Paris and discussed at the European Parliament in Brussels on April 27th 2023*

New paradigms for new approaches



IPM triangle

In theory



IPM triangle

In practice



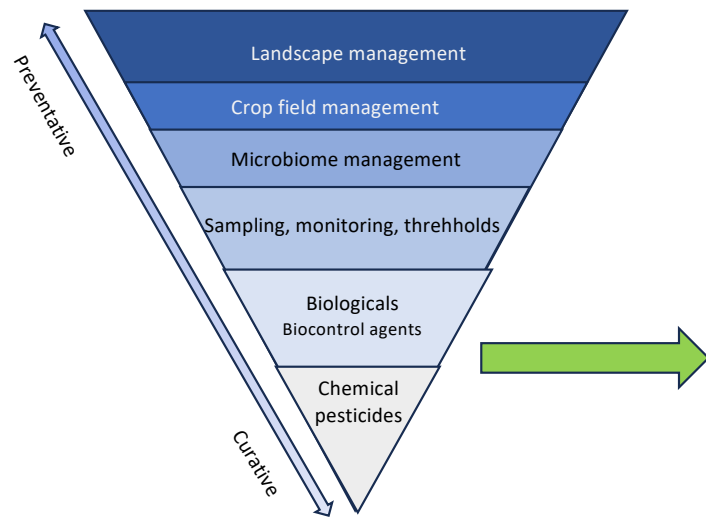
Unstable equilibrium based upon chemicals !

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

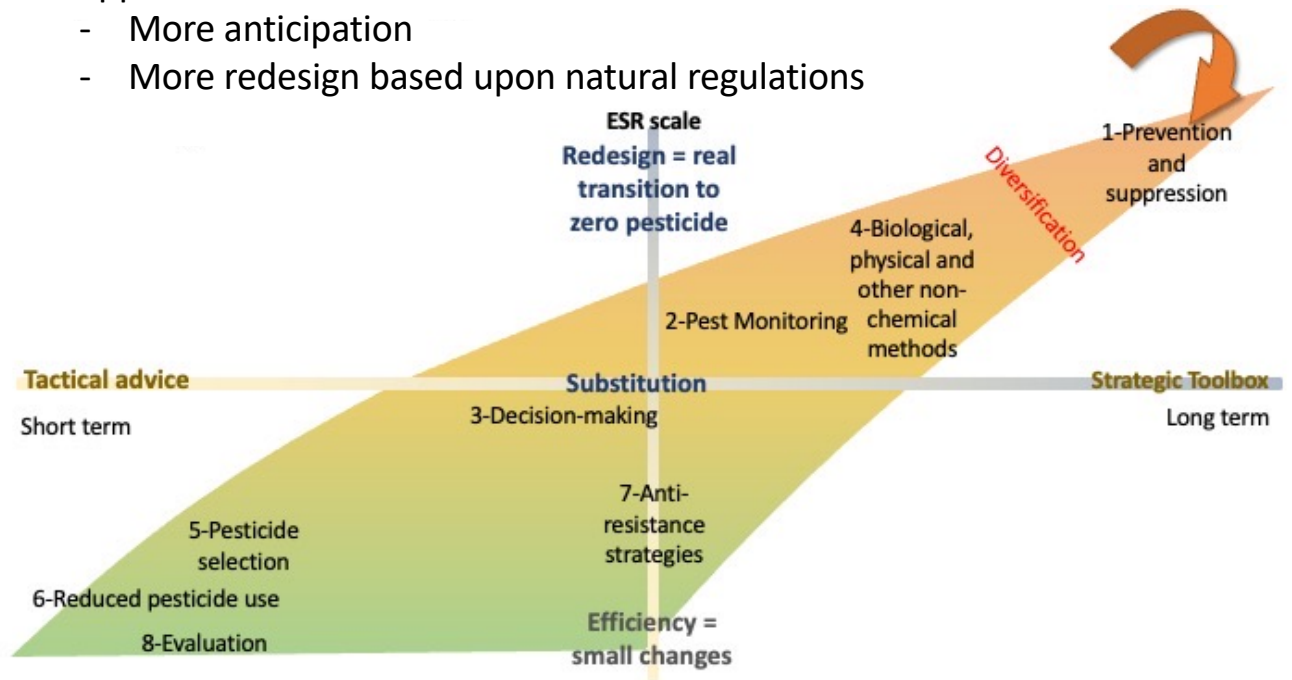
New paradigm for new approaches

2 dimensions to consider to boost preventative approaches:

- More anticipation
- More redesign based upon natural regulations

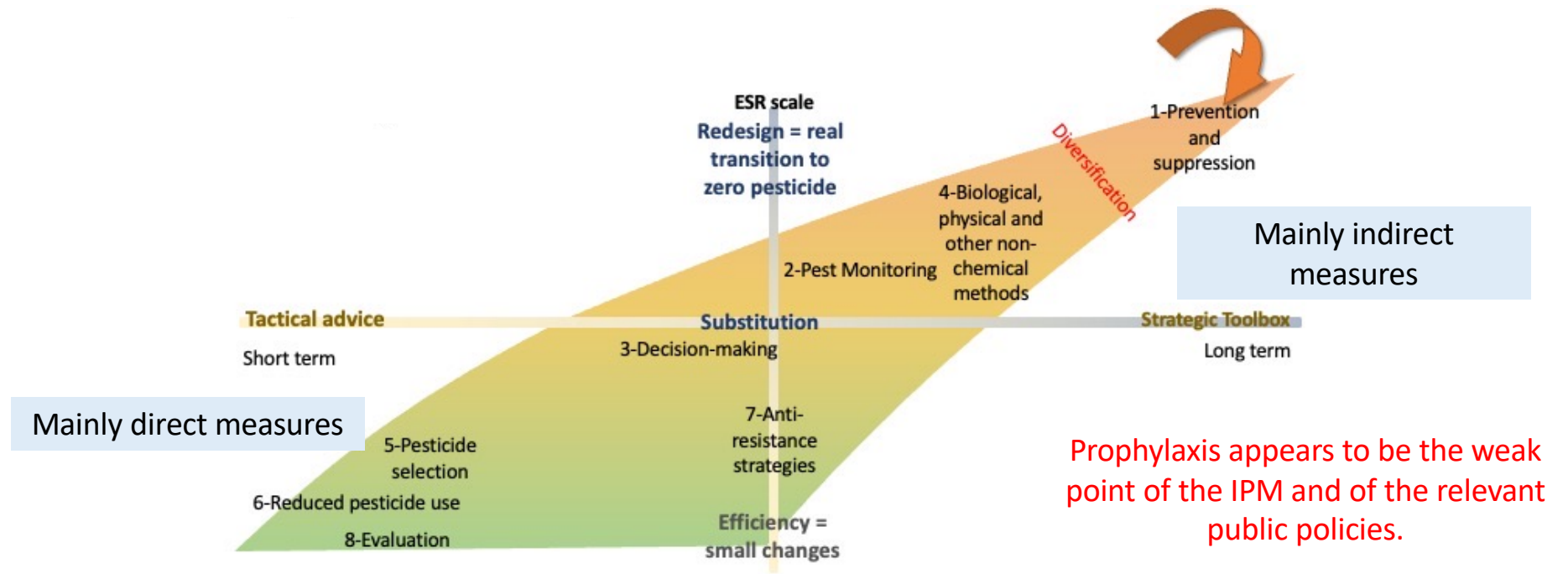


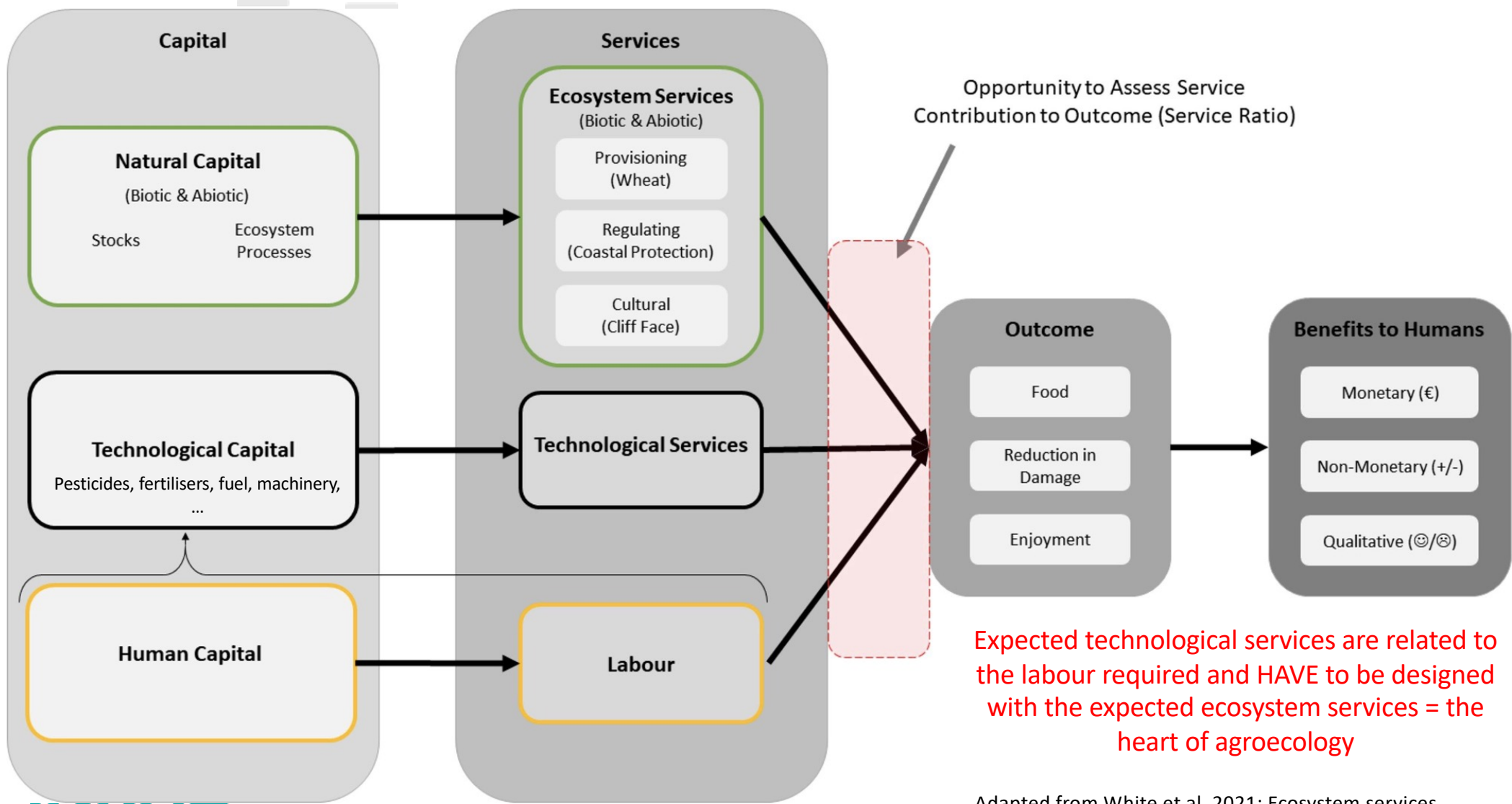
IPM triangle



Triangle in the Wind

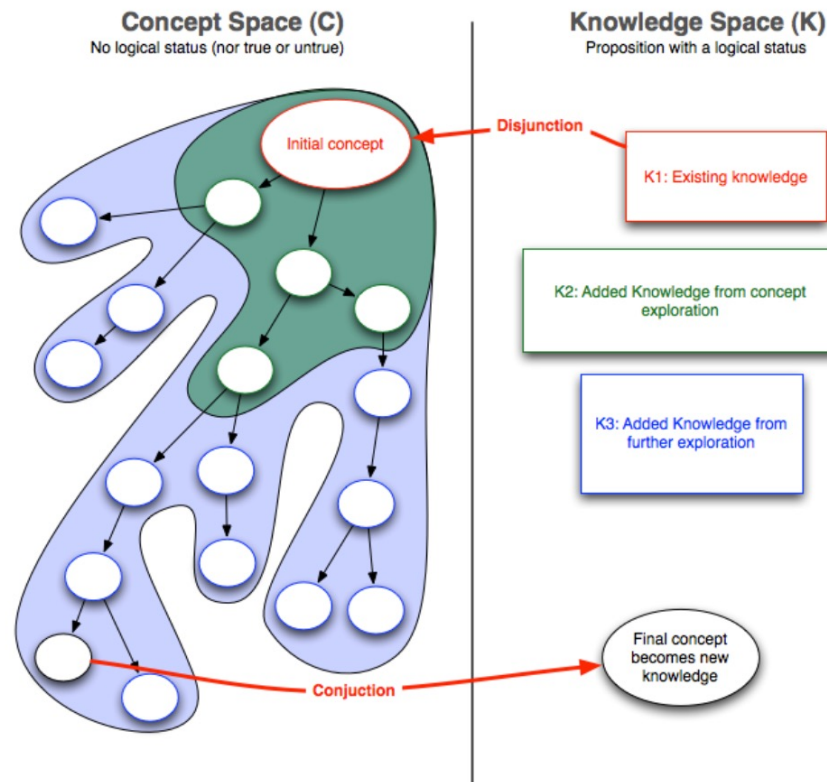
What about the public policies?



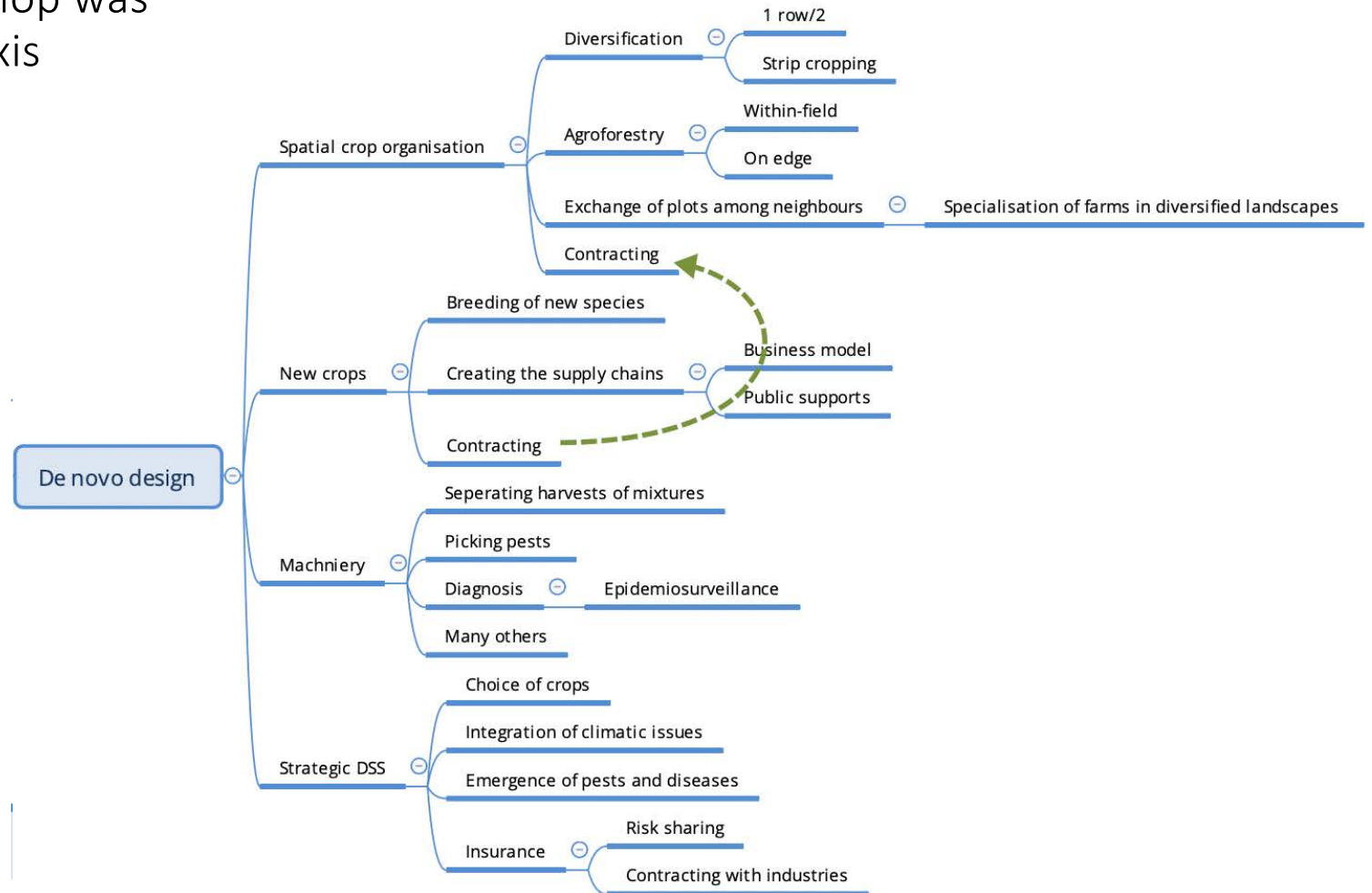


Adapted from White et al, 2021: Ecosystem services

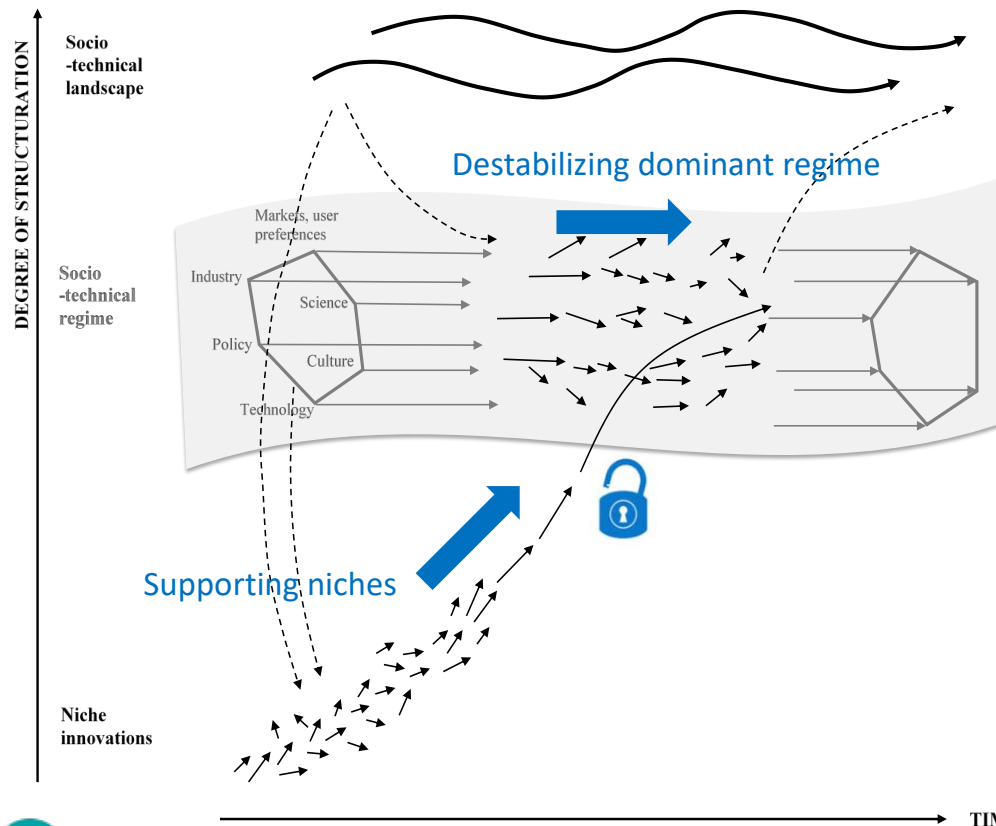
In the COST Action TOP-Agri Network, national C-K workshops are implemented



The French C-K workshop was dedicated to prophylaxis



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)

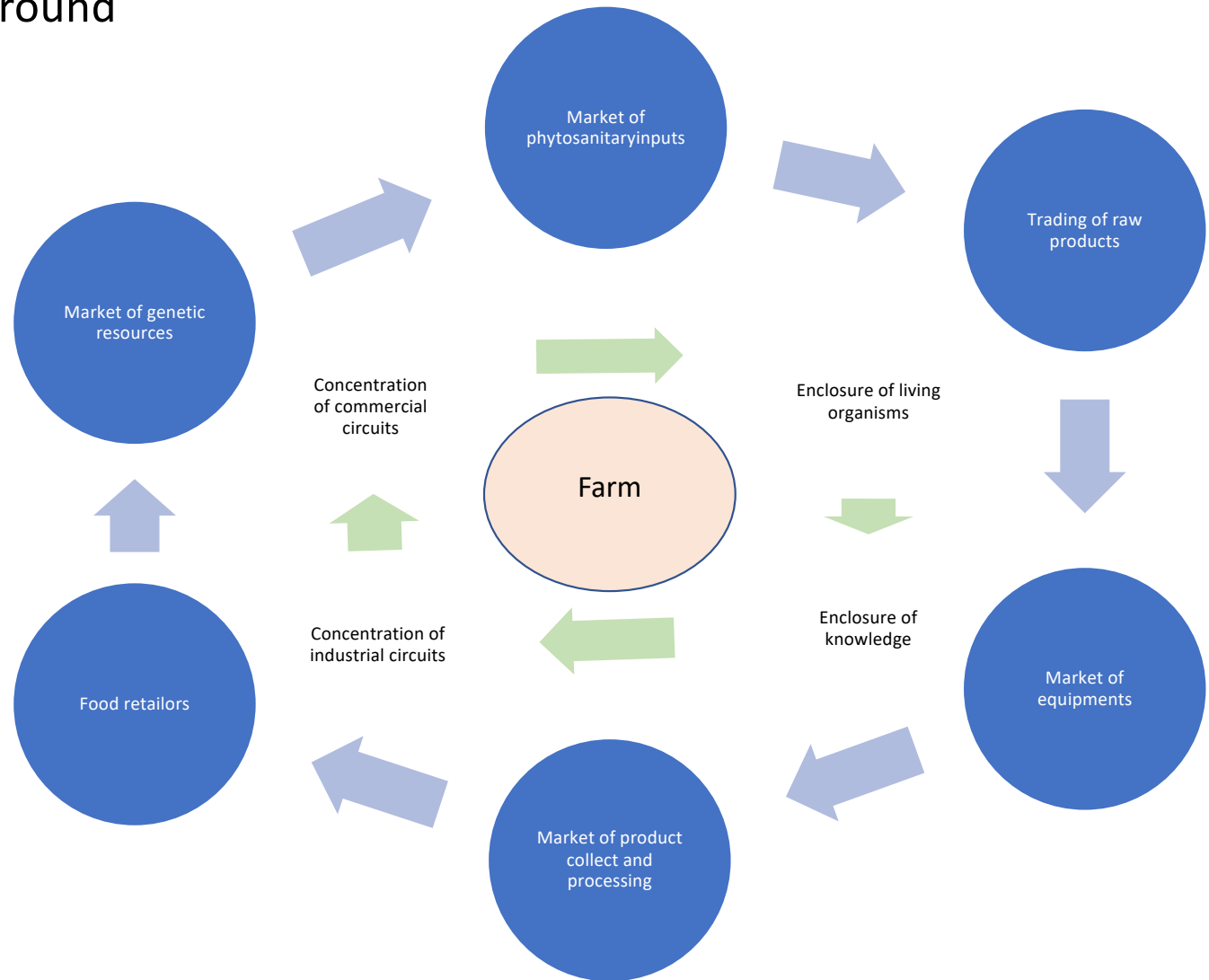
Supporting rupture innovation. R&I is essential

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

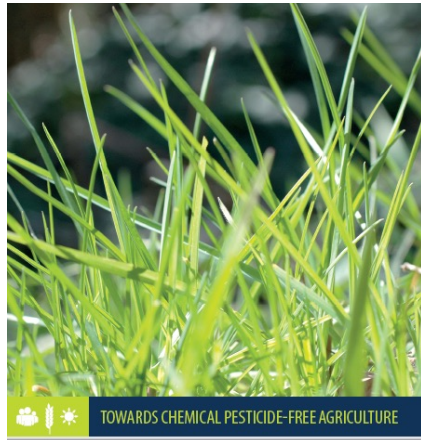
Adapted from Valiorgue (2020)

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



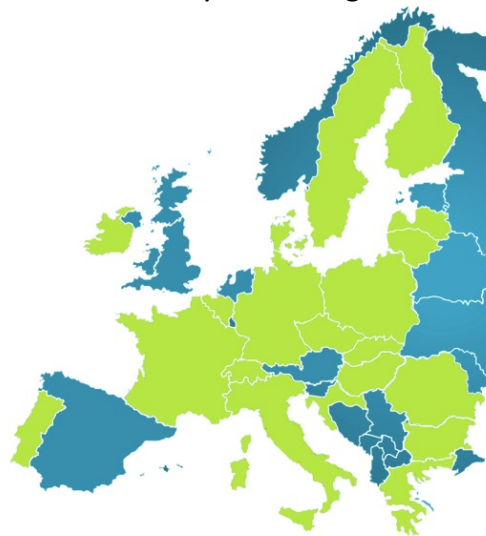
European Research Alliance Towards Chemical Pesticide-free Agriculture



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

- 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: 22 May 2024, Zagreb



Today

- 38 organisations
- 21 countries

Achievements

- An increasing scientific community
- Contribution to a foresight study published in March 2023
- A Cost project approved (CA 21134)
- A CSA approved (Fortuna)
- A Life-PLP approved (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 1st November 2022

Now: 350 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 successful transition:
 - Redesigned cropping systems where prophylaxis is first
 - New varieties
 - Biocontrol and biostimulation
 - Machinery and robotics
 - A commitment of actors all along the supply chains
 - Adapted economics and policies

Thank you for your
attention ...



Laurent Rodriguez

INRAE