GOUVERNEMENT
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ÉCOPHYTO
RÉDUIRE ET AMÉLIORER L'UTILISATION DES PHYTOS

OFB
OFFICE FRANÇAIS DE LA BIODIVERSITÉ

Welcome -Bienvenue !

3rd Workshop ARRUPVICO

Can insurance help farmers to take the risk of phytosanitary losses?

A time for sharing perceptions on existing initiatives and requirements

L'assurance peut-elle sécuriser la prise de risques des agriculteurs face aux pertes sanitaires des cultures ?

Un temps d'échange sur des initiatives en cours et la perception des besoins.

September 24-25th 2025 - Bordeaux

Ce workshop a le soutien financier du Département des Sciences de l'Environnement et du Département CHANGES de l'Université de Bordeaux

IFV · Terres Inovia l'agronomie en mouvement · acta les instituts techniques agricoles · INRAE · université de BORDEAUX · Le Mans Université · Nouvelle-Aquitaine viti REV · FRANCE 2030 · BANQUE des TERRITOIRES · DiagoRisk

Risk Management and Risk Sharing in the vitiREV Program

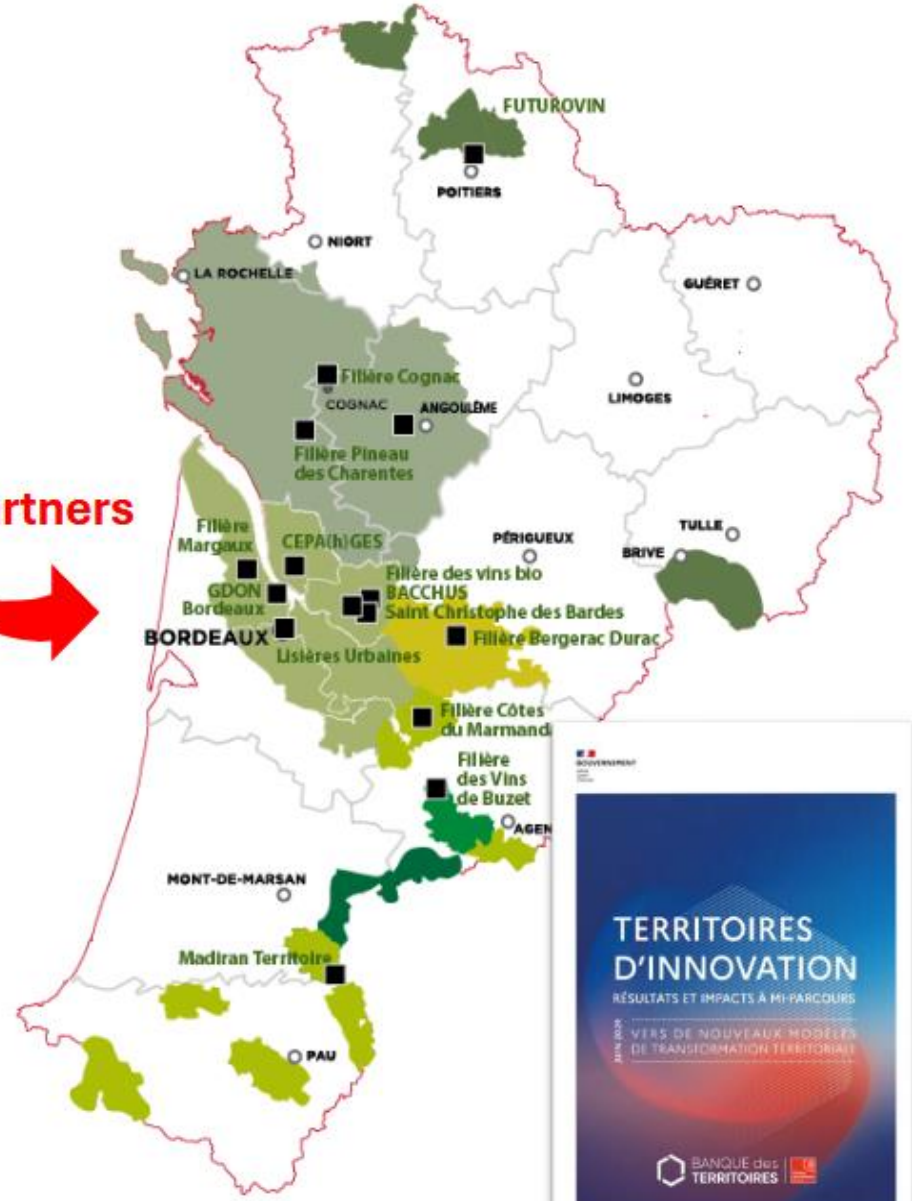
Ambre NELET
Région Nouvelle-Aquitaine

Introduction

Final Workshop– 24-25 Sept 2025

The vitiREV Pact

60 partners



Goals

2018 → **2030**

Certified wine-growing areas BIO, HVE ou ISO 14001

10 % → 85 %

Share of products usable in organic farming

45 % → 80 %

Vineyard areas free from chemical weed control

45 % → 80 %

viti REV

A transition path with vitiREV

Leverage 2
Anticipate climate hazards to better control their effects on the vine

Leverage 3
Support the deployment and growth of climate-resilient plant material

Leverage 9
Support winegrowers in adopting new distribution practices

Leverage 1
Tailor viticultural practices to evolving conditions for increased resilience

Leverage 8
Waste management and energy transition

Leverage 7
Support the cellar master throughout the winemaking process

Leverage 4
Encourage the use and traceability of environmentally and biodiversity-friendly protection solutions

Leverage 5
Adapt to drought events while preserving water resources

Leverage 6
Monitor and optimise harvest practices

viti REV

The issue of synthetic pesticides

"Without treatment, vines only produce one year out of eight"
according to the French Institute of Vine and Wine (IFV)

Phytosanitary protection = **only 2%** of bottle cost

Cutting Treatment Frequency Index by **50% = 1% saving**

But with **~ 50% risk of production loss**

The challenges of giving up pesticides

No alternative is as effective with the same workforce

Consumers are unwilling to pay more

Strong lobbying petrochemical and W&S industry

vitiREV executive summary (after 6 years)

3 insights

- No ecological transition without exports → 
- Agroecological transition requires long implementation times → Nature-based solutions
- A transition without a viable business model can't scale → Paradigm shift: Where does the greatest risk lie in using pesticides?

3 levers for action

- Plant material → Scale-up & Protected Designation of Origin specs
- Data → Evaluation & anticipation
- Risk management & risk sharing → Sharing the added value of transition

viti REV

Thank you for your attention !

Merci pour votre attention !

Contact mail : ambre.nelet@nouvelle-aquitaine.fr

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Few slides of introduction

about the ARRUPVICO project

Luc Boucher DiagoRisk
Marc Raynal IFV, UMT SEVEN

Wooclap ! : to favorize interaction and synthesis !

https://app.wooclap.com/UODJGQ?from=status-bar

Wooclap.com / workshop code : UODJGQ

Computer

Smartphone

ARRUP VICO : Assurabilité des Risques liés à la Réduction d'Usage des Phytosanitaires en Vigne et Colza

1. **Experience sharing and recommendations on climatic and sanitary risks**

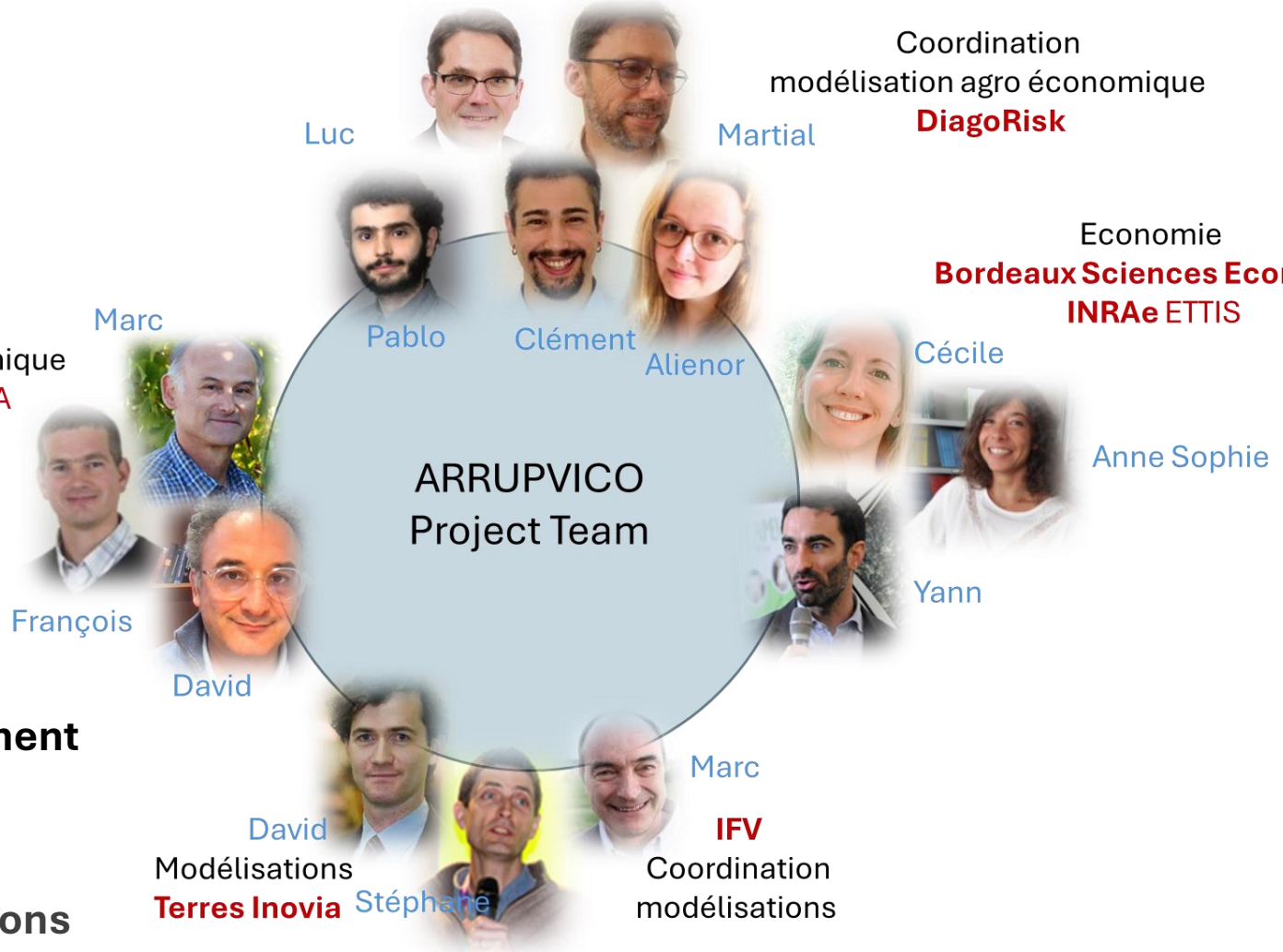
2. **Risk modeling on vine**

3. **Agronomic and Economic approaches**

4. **Digital interface for insurance management**

5. **Risk modeling on rape seed**

6. **Mechanism and process recommendations**



Few slides of introduction ARRUPVICO : the workshop !

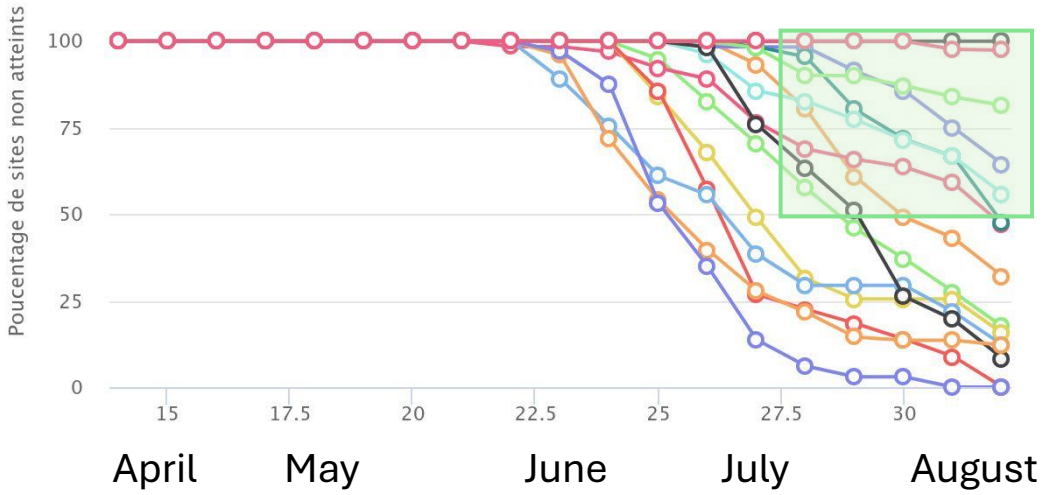
What if a "Green Insurance" could help to reduce the chemical inputs ?

Luc Boucher DiagoRisk
Marc Raynal IFV, UMT SEVEN

Final Workshop– 24-25 Sept 2025

For (French) wine production
Suppression of unnecessary treatments is an ecological necessity !

New Aquitaine Downy Mildew
% of healthy untreated plots (<20% damages)



2025
2022
Low DM destruction

High level of destruction
2024

Untreated plot network - New Aquitaine

Evolution per year (2011-2025)
Of the Frequency of untreated plots
For which harvest destruction due to DM
Is less than a 20% threshold

High variation of the D.M. pressure

Since 2011, Almost 1 year out of 2,
Frequency of untreated plots destroyed more than 20% is less then 50%

Untreated plot destroyed > 20% just 1 year / 4 (?)
(20% = +/- deductible level)

- **Covering the agroecological transition's risk : Utopia or Necessity ?**

S1 : Historical context, nowadays **issues and challenges :**

Christian Huyghe, Julian Roberts, Alexis Patry, ...

vitiREV Insurance Experimentation :

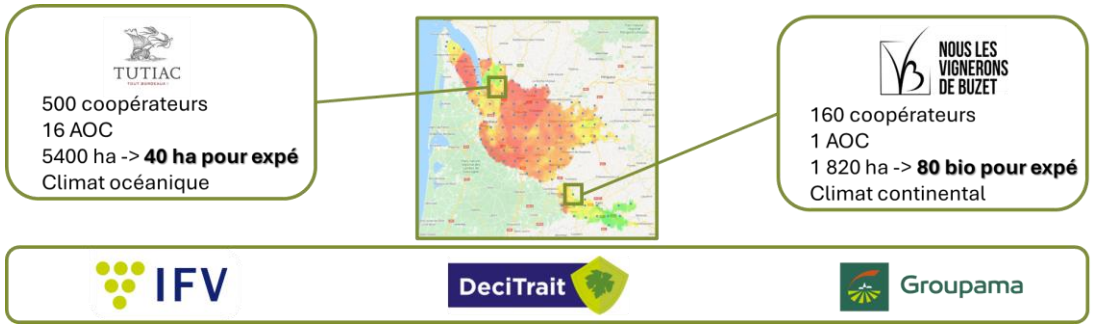
Phytosanitary treatments = 2 to 4 % of the cost of the wine bottle

50% reduction of treatments is less than 2% economy

Harvest loss risk : +/- 50% to 100%

Risk covering ? An economic necessity for the wine grower

Experimental design on 2 wineries from 2019 to 2022 (70 to 110 hectares)



Main result :

Average fungicides reduction = 45 % (30 to 55%)

2022 (low DM pressure) : 20Ha attacked total destruction on 4-5 Ha / 80

=> insurance company withdrawal

Covering the agroecological transition is a paradox … !

- **Covering the agroecological transition's risk : Utopia or Necessity ?**

S1 : Historical context, nowadays **issues and challenges :**

Christian Huyghe, Julian Roberts, Alexis Patry, …

S2 : Two **feedbacks** on risk pooling :

Peter Thorburn and Giuseppe Boatto, …

- **Covering the risk of agroecological transition : Paradox for an insurer ?**

S3 : **Rethink the mutualization** of risks ? New incentive contracts ? :

Mathilde Viennot, Cecile Aubert, Marianne Lefebvre, …

Current European public aid (MAEC, PSE, …)
Systematic expenses but not sustainable resources for growers,
not linked to real losses

- Better knowledge to encourage innovation and risk-taking → favorize agroecology ?

- S4 : modelling the risks and yield losses : François Brun, Clément Bourgade
  Pablo Yepes Llano, Martial P Guinvarc'h….

- **Green or income insurance?** covering **production ? non treatment ?**
  (Effective in the US, why not in Europe?)

- S5 : Insurer's point of view : Antoine Kahn, Mickael Gorecki, Vincent Féraud…

- S6 : work session / 4 groups : Prospects and identification of research areas

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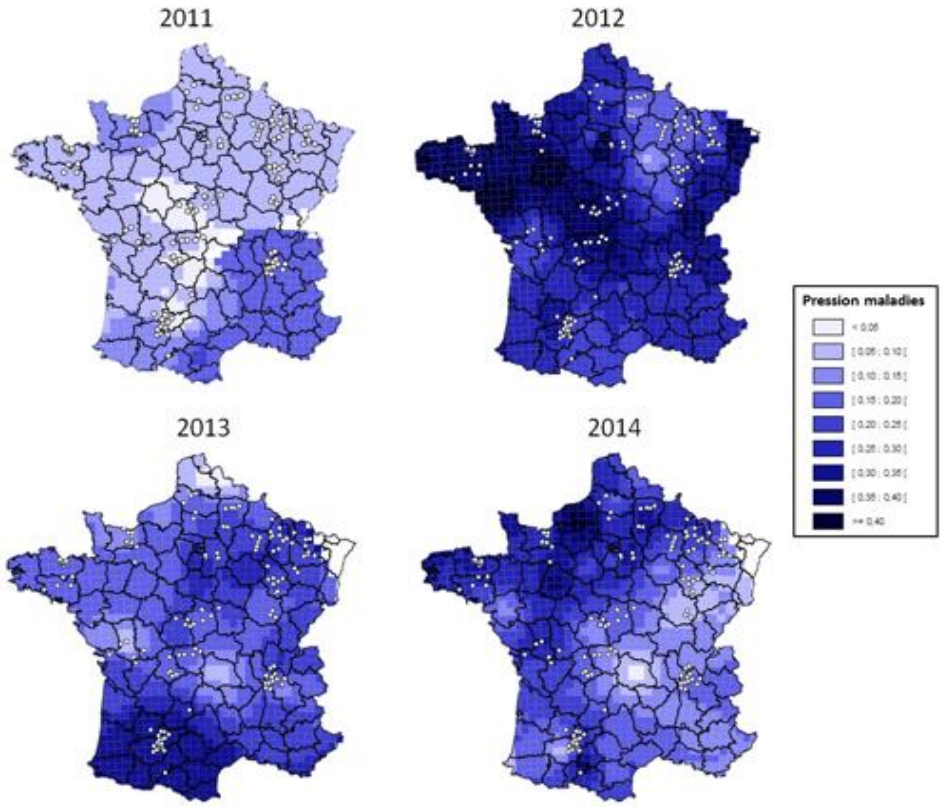
Arrupvico
24 september 2025 - Bordeaux

The stakes of agroecology transition applied to crop protection

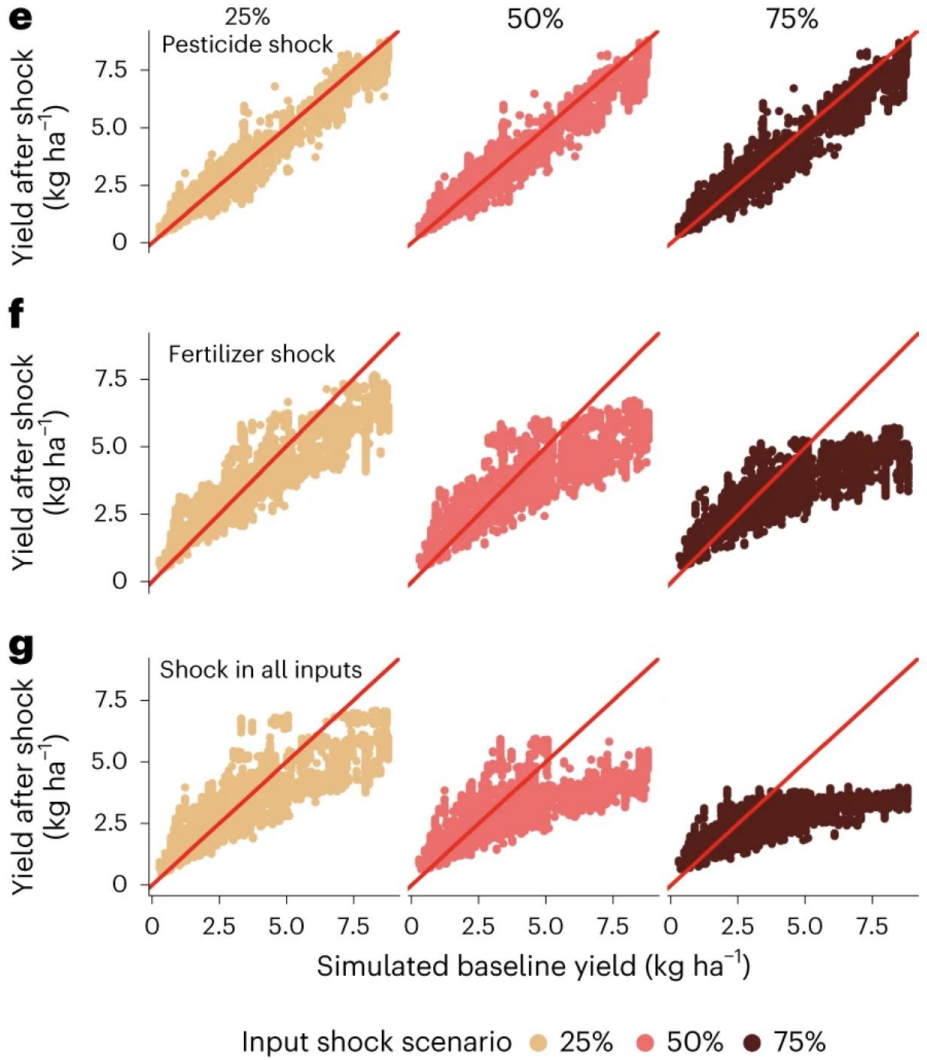
Christian HUYGHE

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



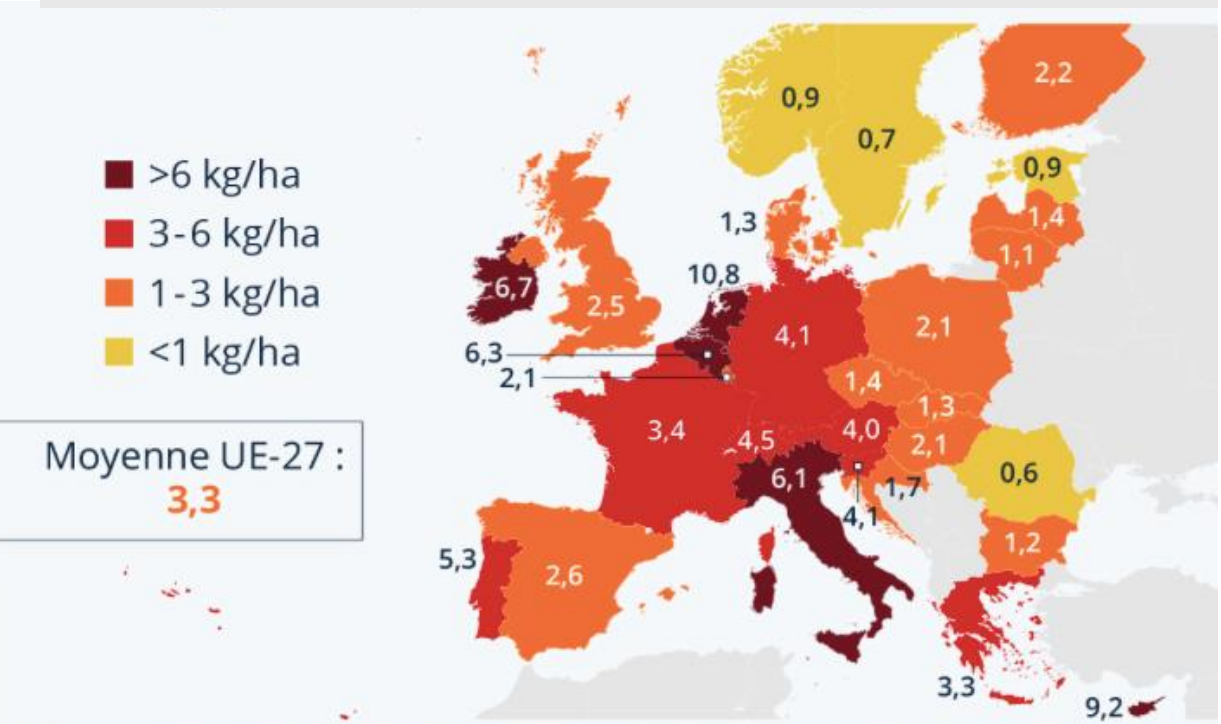
Yield losses due to foliar diseases in bread wheat in absence of any protection
Urruty et al, 2016, ASD



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

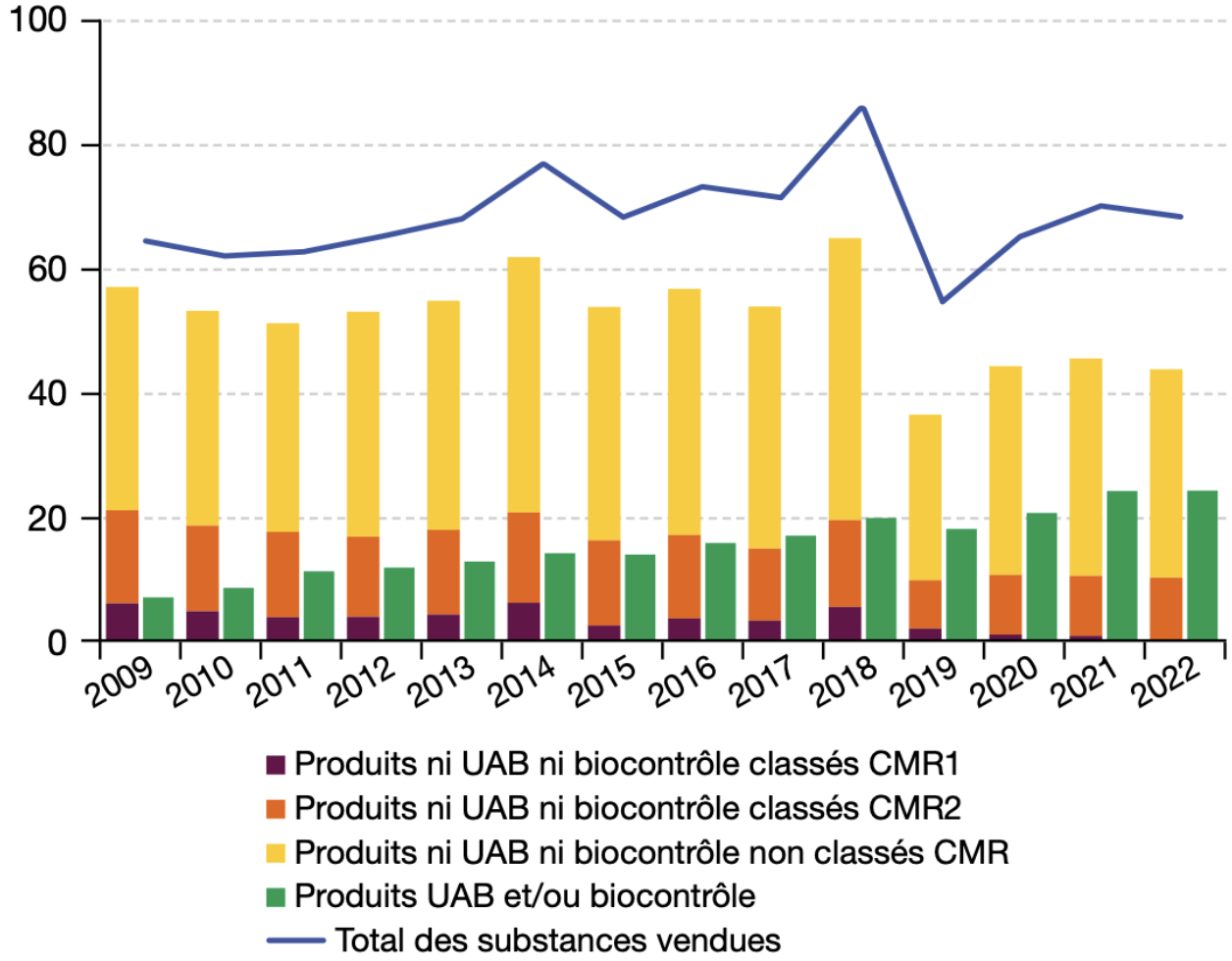
Crop protection is achieved today with massive use of chemical pesticides…

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



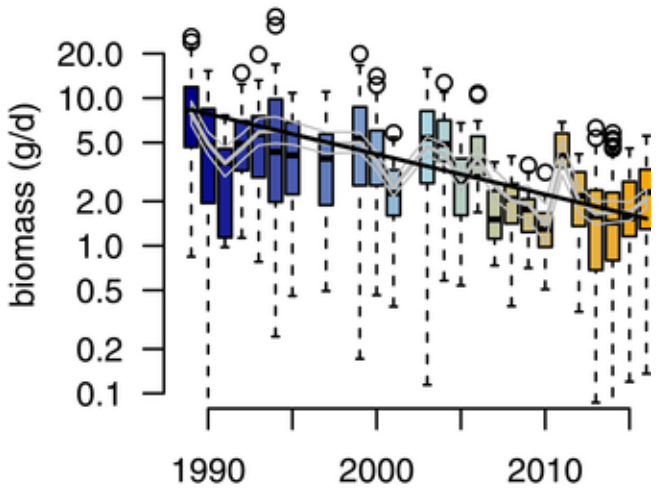
Sélection : pays de l'UE et Suisse, Royaume-Uni, Norvège. Données arrondies.
Source : FAO

X 1000 tons



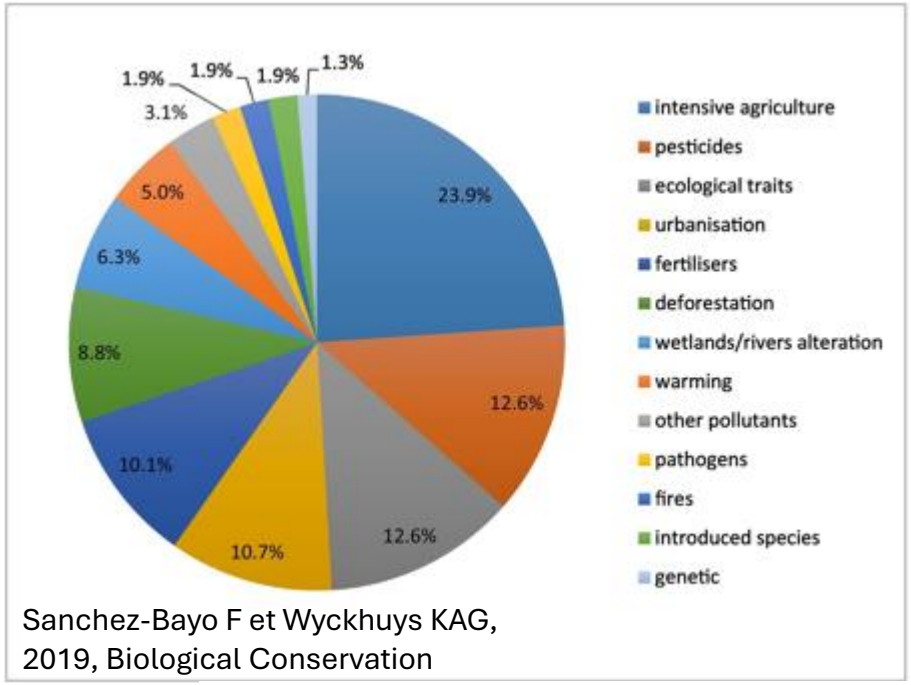
Notes : CMR = substances considérées comme les plus toxiques «cancérogènes, mutagènes et reprotoxiques» avec CMR1 pour «avéré ou présumé» et CMR2 «suspecté». Hors Banole pour la Martinique.
Champ : France entière.
***Source** : BNVD. Traitements : OFB et SDES, 2023*

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



-75% of insects biomass in 26 years

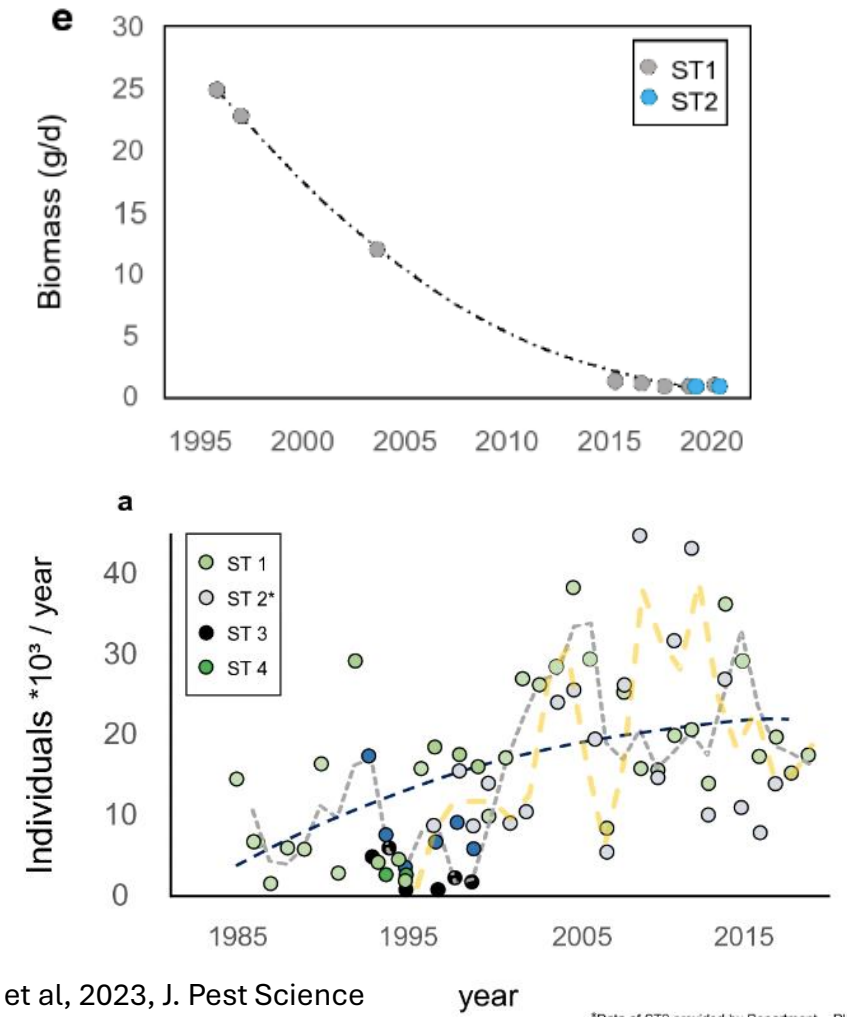
Hallmann CA et al. (2017) PLOS ONE 12(10): e0185809. https://doi.org/10.1371/journal.pone.0185809



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

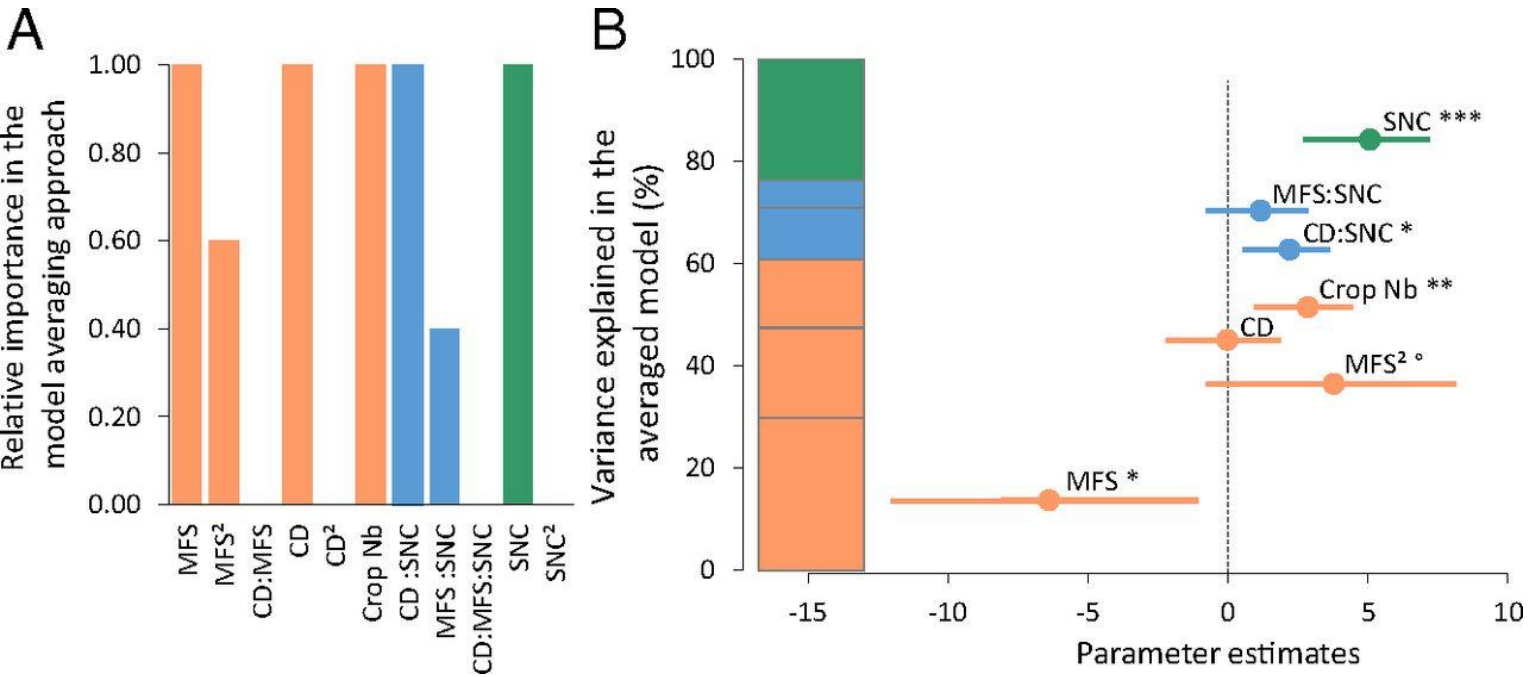
In the areas of arable crops in Germany

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



Ziesche TM et al, 2023, J. Pest Science

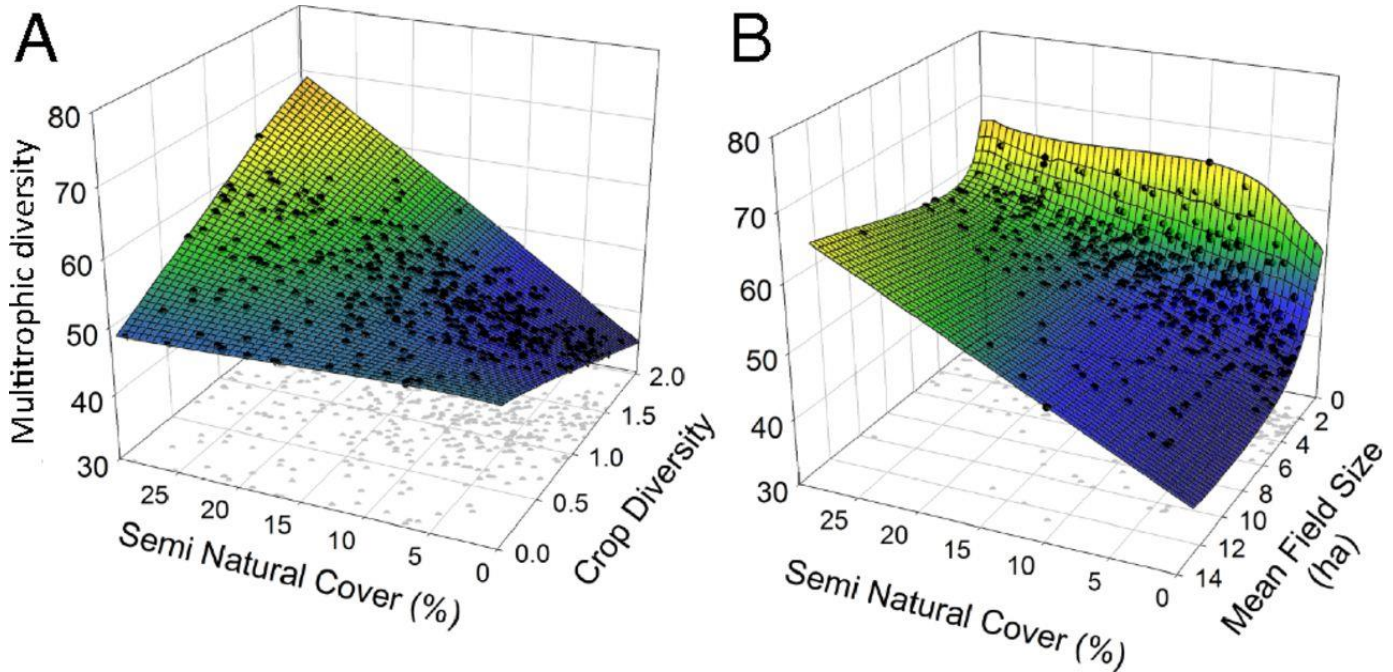
Agricultural practices, pesticide load and land use are the main sources of insect



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?



Human activities lead to break the planetary boundaries (Johan Rockström (2009))

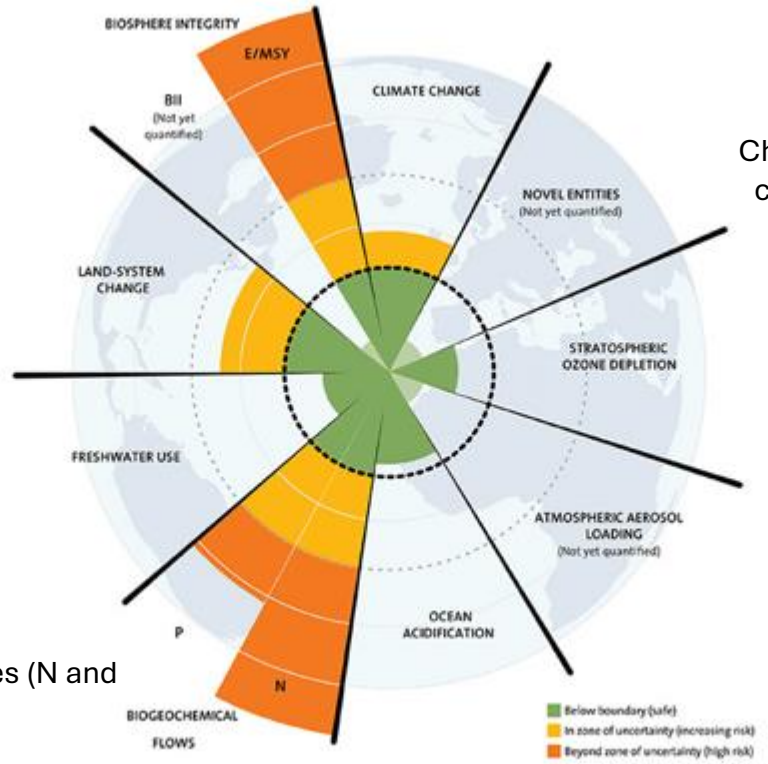
Climate change

Biodiversity

Changement climatique

Land us

Nutrient cycles (N and P)



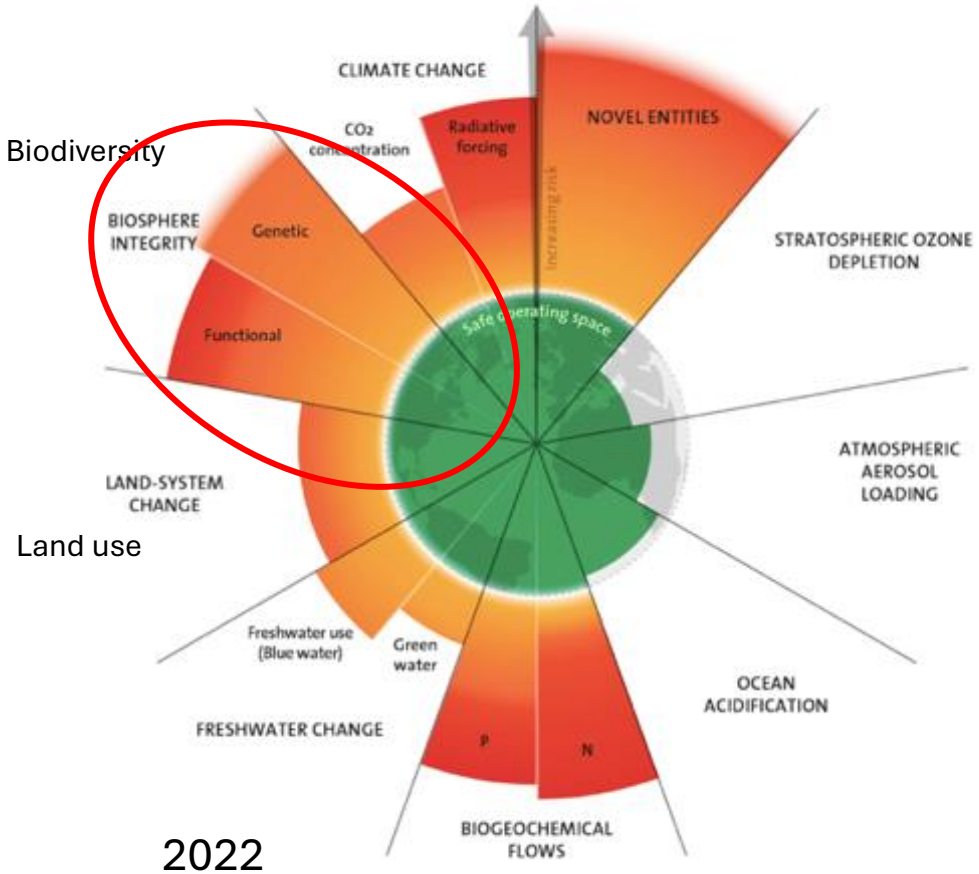
2015

Climate change

Biodiversity

Land use

Nutrient cycles (N and P)

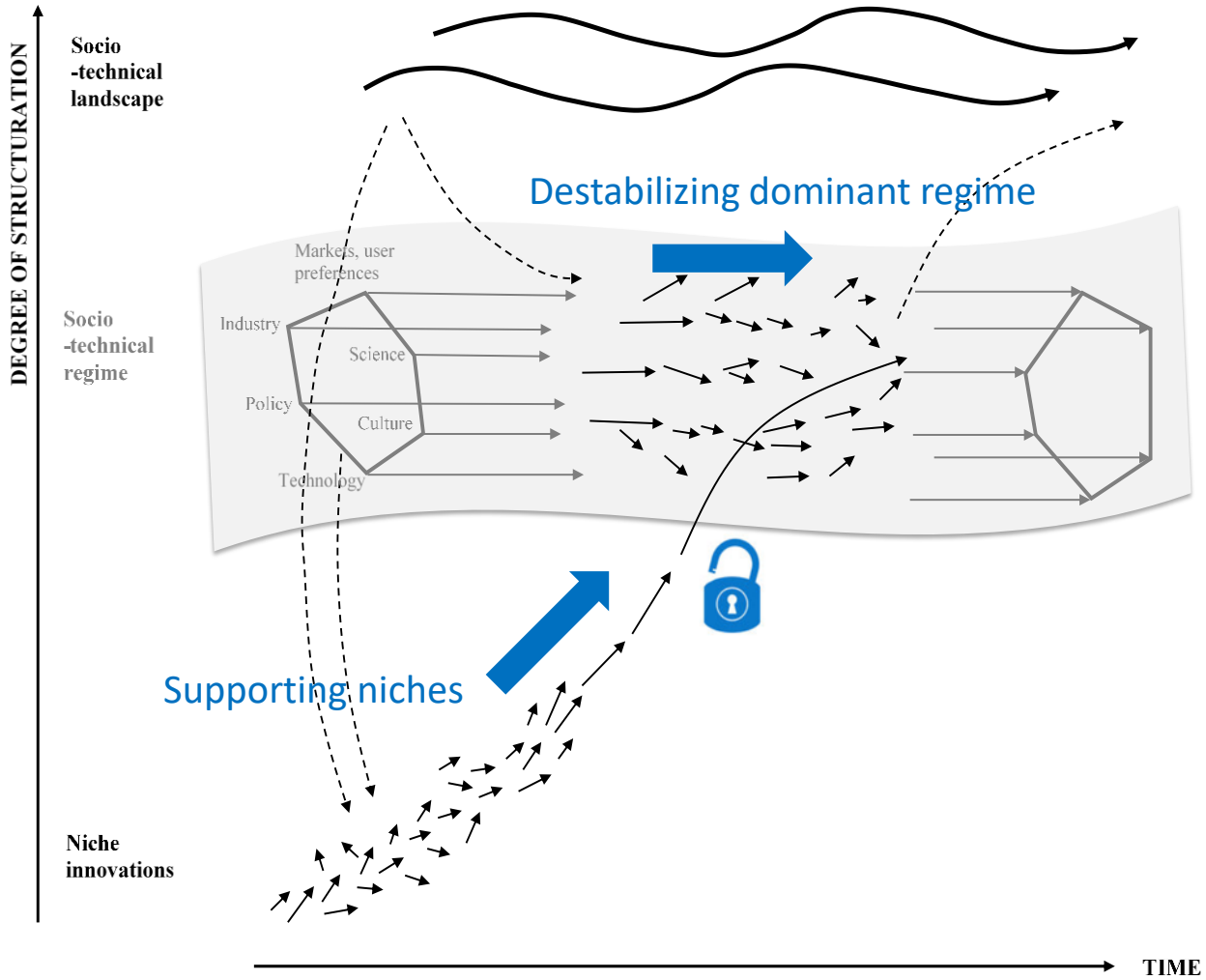


2022

A little humor in these times of PPL Duplomb, also called ‘Obstacles’ or ‘Constraints’

For me, it is rather a PPL ‘immobility’

How to unlock locked-in systems? Innovations and public policies



(adapted from Ollivier et al., 2018 (Ecology and Society) who adapted from Geels, 2002 (Research Policy))

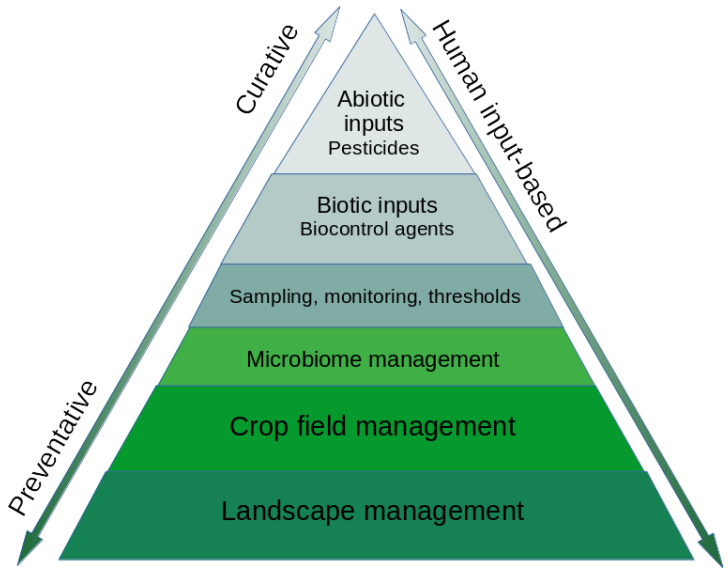
Forcing changes of the socio-technic landscape: public policies including CAP, regulations, listening societal demands

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)

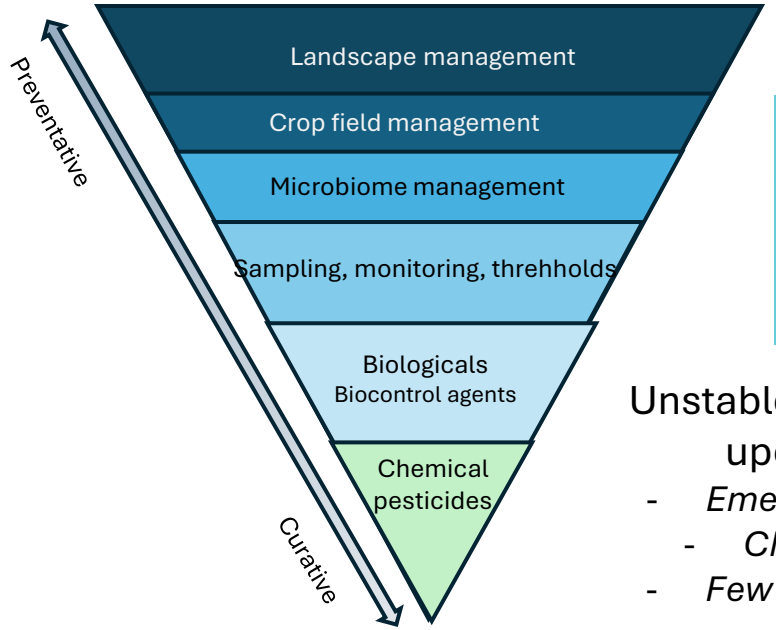
Supporting rupture innovation. R&I is essential

New paradigms for new approaches



IPM triangle

In theory



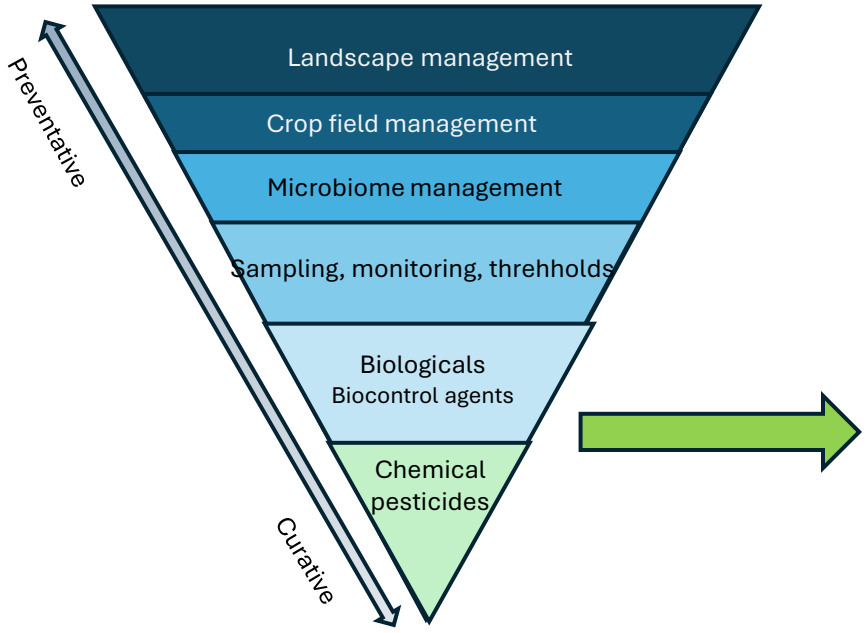
IPM triangle

In practice

Unstable equilibrium based upon chemicals !

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

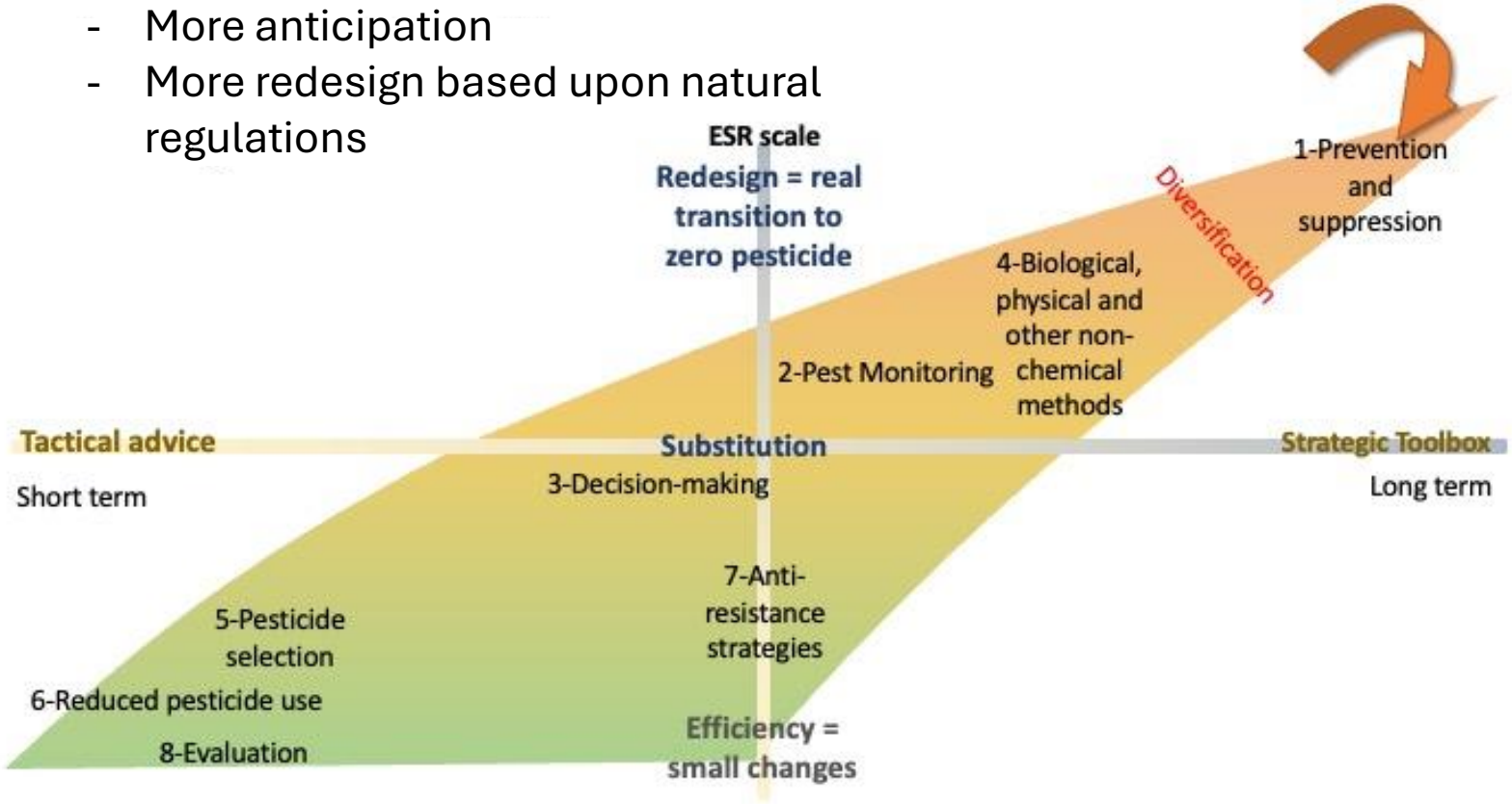
New paradigm for new approaches



IPM triangle

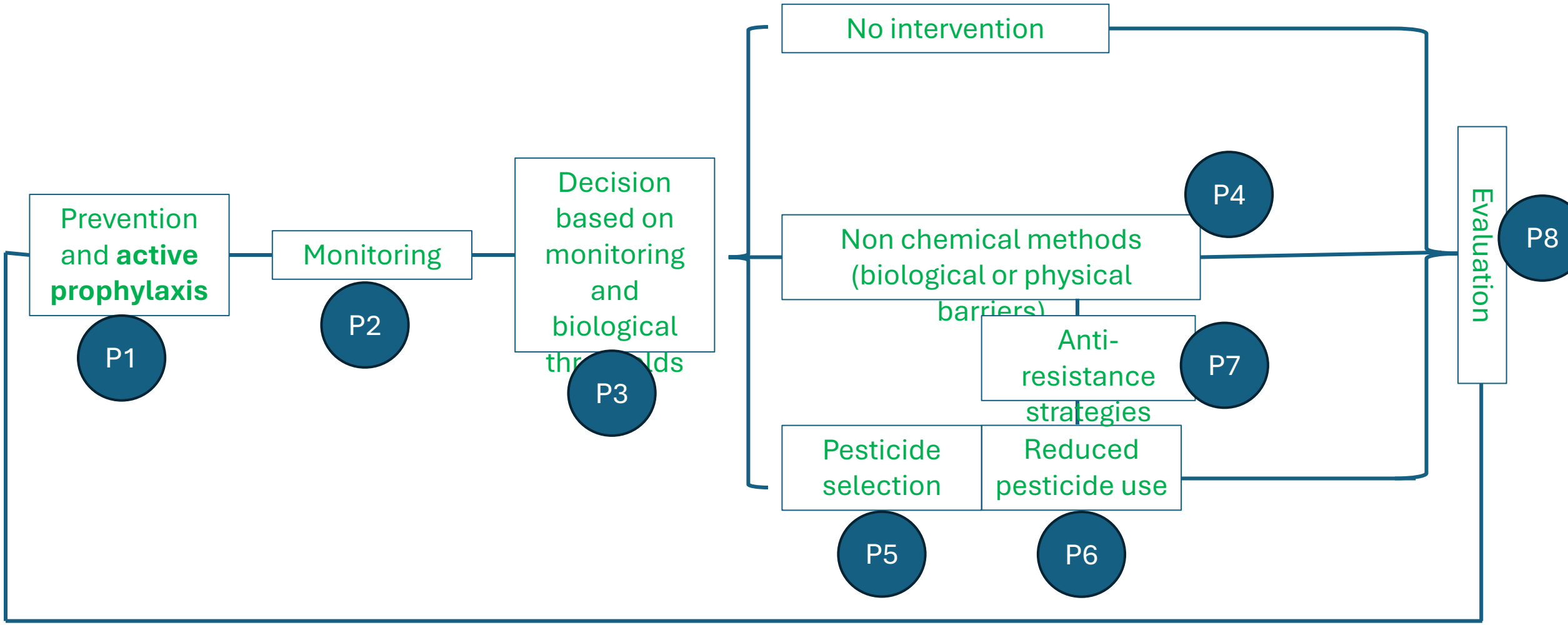
2 dimensions to consider to boost preventative approaches:

- More anticipation
- More redesign based upon natural regulations

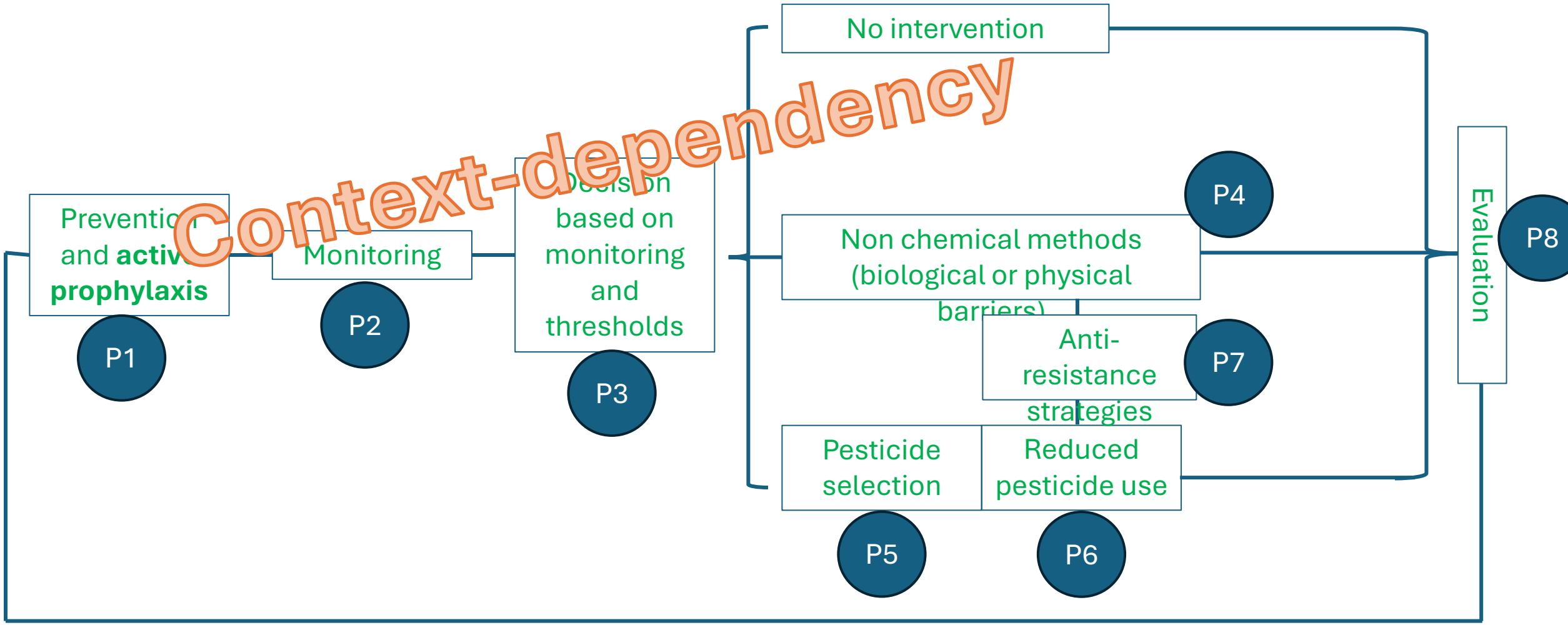


Triangle in the Wind

A new paradigm for Integrated Pest Management

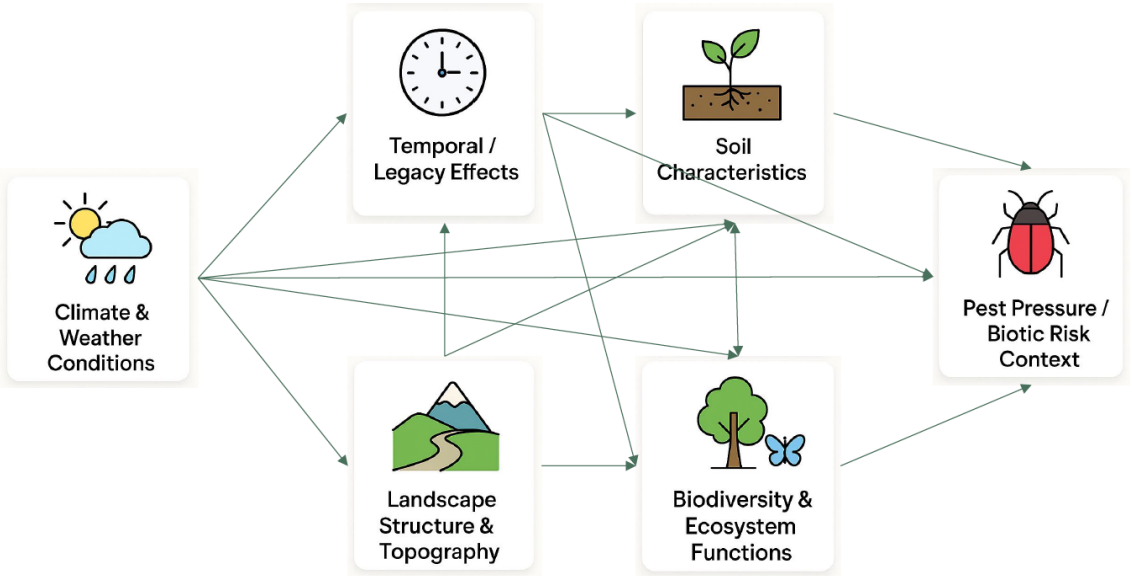


A new paradigm for Integrated Pest Management



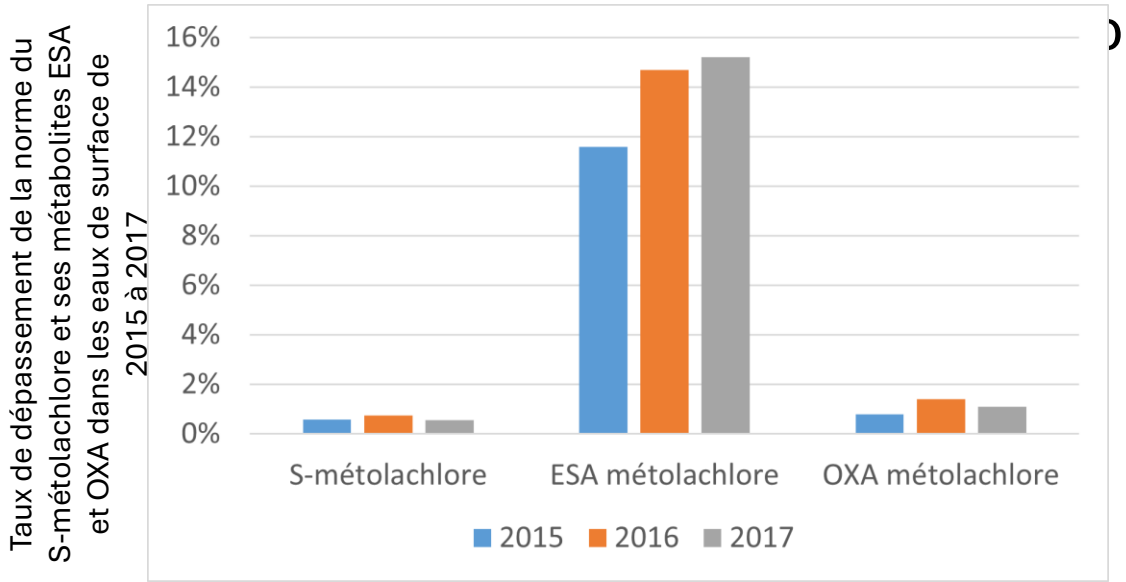
Transition requires to cover risks

- Risk inherent to learning: role of training and advice
- Risk inherent to higher context- dependency
  - Variations of climate among years
  - Biotic pressure and emergences



Economic issues linked to future IPM: hidden costs of crop protection

- Impacts on water quality
  - From of CGDD report in 2011
    - The annual cost of water cleaning in France because of agricultural pollutions (nitrogen, pesticides) > 54 Mrd € (for comparison, the turnover of the French farm in 2024 was 89 Mrd€)
    - Elimination of pesticides in excess = 60 000€/kg of eliminated pesticide
  - According ore (Reboud et al, 2022)



Economic issues linked to future IPM: hidden costs of crop protection

- Impacts on biodiversity
  - Few actions of restoration of biodiversity and natural environment after incidence of pesticide spraying
  - Indirect estimation via loss of ecosystemic services
    - Pollination service
    - Hidden costs = the need to supply hives

Economic issues linked to future IPM: hidden costs of crop protection

- Impacts on biodiversity
  - US example on loss of honeybee hives in 2024-2025 (The Watchers, 01/09/2025)
    - 55,6% of colonies lost at the national level and up to 60% in Texas
    - Why?
      - Effect of pesticides
      - **Damages of varroa (*Varroa destructor*) after emergence of resistance to acaricides**
    - Economic incidence in almond orchards in California
      - More than 2 mllions hives are provided every year. Not yet enough!
      - A yield loss due to lack of pollination up to 428 M€ over the 2024-2025 campaign

Economic issues linked to future IPM: hidden costs of crop protection

- Impacts on human health
  - What impacts?
    - Diseases and cancers
    - Infertility
  - A very difficult estimation: cost of the health care, loss of economic activity, incidences on life quality
  - Very few consolidated data
    - Agrican cohort
    - Works of S. Chamot, CHU of Amiens in consultation « Pediatry and Cancers »
  - *Urgent need to withdraw active substances CMR1, CMR2, endocrine disruptors*
  - *Make Europe Healthy Again!*

The RPD (Redevance pour pollutions diffuses) level does not reflect the alter level of the various active substances

Substance	Santé humaine	Ecotoxicité	Diffusion dans l'environnement	Montant Redevance Pollution Diffuse
Propyzamide				11,5
Aclonifen				9
Sulcotrione				9
Mésotrione				9
Isoxaflutole				9
Chlortoluron				9
Métazachlore				9
Pinoxaden				9
Triflusulfuron				9
Foramsulfuron				9
Pendiméthaline				5,5
Triallate				3
Terbuthylazine				3
Diméthachlore				3
S-métolachlore				3
Métamitrone				3
Flufénacet				3
Phenmédiphame				3
Ethofumésate				3
Nicosulfuron				3
Quinmérac				3
Prosulfocarbe				3
Diméthénamide-P				3
Napropamide				3
Triclopyr				0,9
2,4-D				0,9
Diflufenican				0,9
Dicamba				0,9

Niveau d'alerte faible

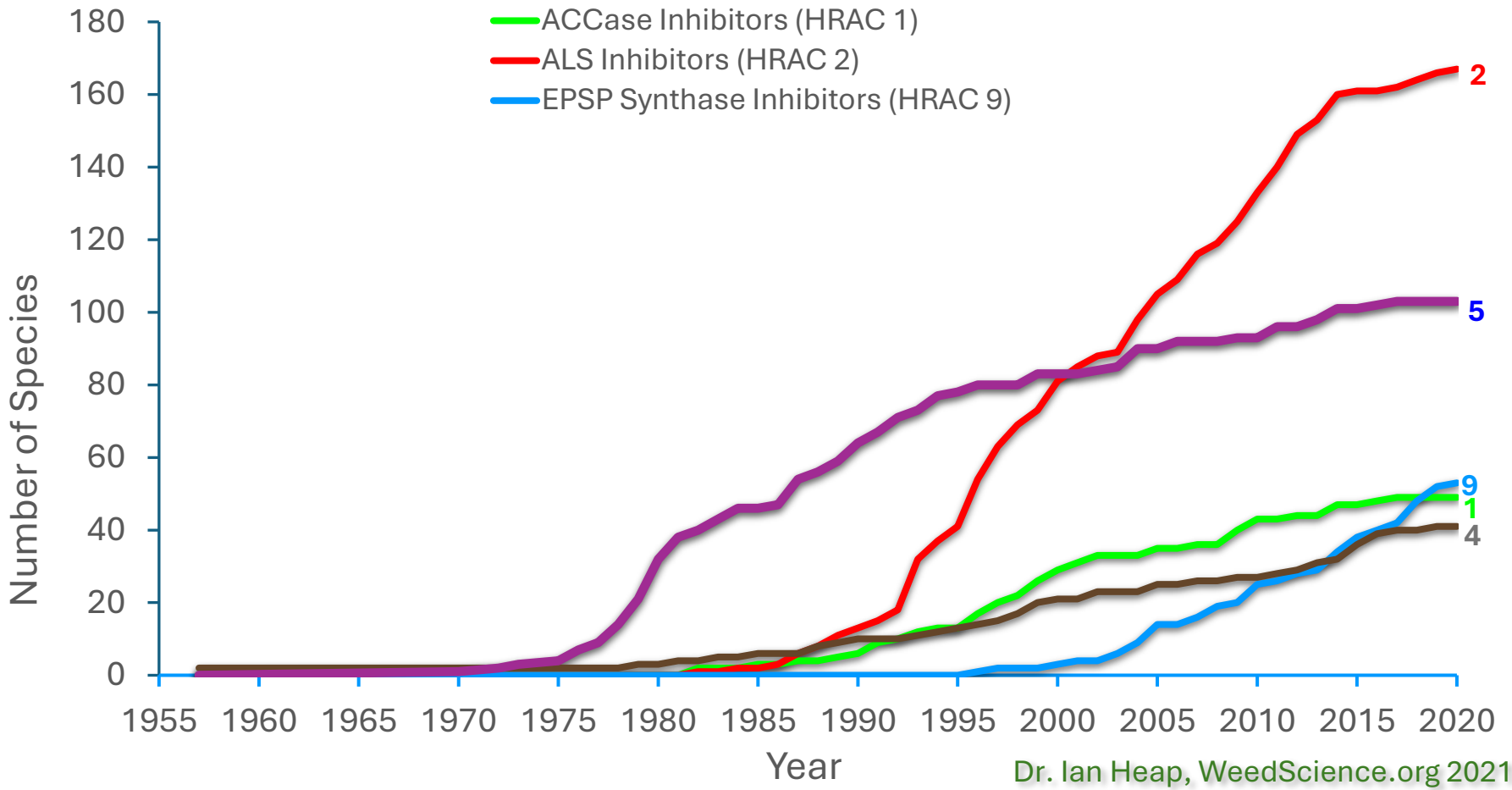
Niveau d'alerte modéré

Niveau d'alerte fort

We could also add

- The agronomic cost due to emergence of resistance

Similar to withdrawal of active substances



Consequences of these elements

- Economic analysis of crop protection must go beyond the only approach of production costs
- Hidden costs are huge but poorly consolidated
- Reduction of hidden costs gives room for maneuver for new support to farmers
- The transition period is delicate
  - Investing for preserving production and reducing hidden costs, including through insurance

  while
  - Paying the hidden costs (large delay effects, especially human health)
- In the analysis of lock-in, **a need to include economic stakeholders involved in hidden costs**: *water supply industries, pharmaceutical industries,…*

Thank you for your attention ...

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Agricultural insurance around the World
Julian Roberts

Willis, London

Session 1 (10:00am -10:30am)

Final Workshop– 24-25 Sept 2025

A brief history of agricultural insurance

The Hammurabi Code

One of the earliest forms of written code by Hammurabi, King of Babylon (c.BC1772).

The code was inscribed on a *stele* (or *stela*, a stone pillar) and placed in public for all to see.

Clause 46 (out of 282) ”*If a man owe a debt and Adad* [the rain God] *inundate his field and carry away the produce, or, through lack of water, grain have not grown in the field, in that year he shall not make any return of grain to his creditor, he shall alter his contract-tablet and he shall not pay the interest for that year*”.

So - a form of crop insurance 3,789 years ago…

How have we been getting on since?

Modern crop insurance

From small beginnings…

Crop hail insurance – hail mutuals were established in Europe ~**200 years ago**.

Not much changed until **1938** when the Federal Crop Insurance Corporation was established in the USA to help the US agricultural sector recover from the combined effects of the Great Depression and the Dust Bowl.

FCIC remained largely experimental until the FCIC Act of **1980** which greatly expanded its remit

Today the US Federal Crop program is the single largest national crop insurance program in the world. In 2024:

- 543 million acres were insured by 1.2 million policies
- total premium was $17bn of government subsidy was $11.75bn (70%)
- penetration (for principal crops) reported at levels of approx 90%

A global perspective

Today agricultural insurance (which includes crops, livestock, forestry and aquaculture) is found globally.

The role of the state/government is a key consideration:

- is insurance considered a part of national agricultural policy
- WTO permits subsidy of crop insurance premiums

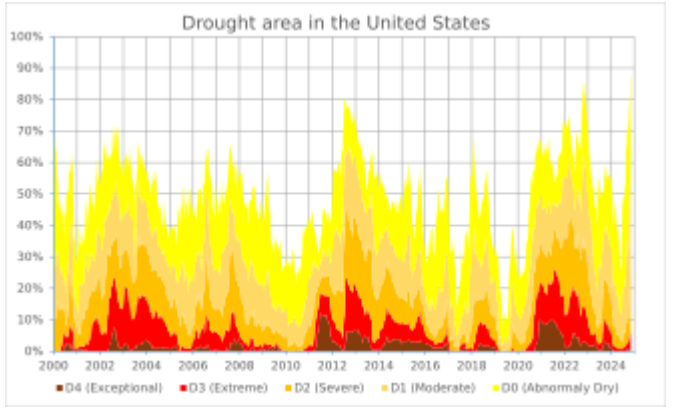
Where the State supports such insurance by means of a material premium subsidy, then widespread adoption is typically found. And *vice versa*…

- big national schemes in US, Canada, India, China, Brazil, EU (various countries)
- notable omissions are Australia, NZ, UK

Global premiums in the segment are hard to state accurately

- best estimate: >US$45 billion
- c.f. estimate of premium in global aviation/airline sector: US$4.5 billion…

Does it work? An example



How did crop insurance perform during the historic 2012 drought in the USA?

- farmers received $17.4 billion in indemnity payments
  - below the $20 billion to $40 billion initially predicted by some analysts and critics.
- farmers retained $12.7 billion in losses as part of their crop insurance policy deductibles
  - an additional $4.1 billion was paid by farmers in premiums
- farmers absorbed nearly $17 billion in uninsured losses and premium expenditures before insurance paid anything.
- private insurers had a $1.3 billion net underwriting loss in 2012
- the US government fulfilled its contractual obligations in its role as a reinsurer under the terms of the Standard Reinsurance Agreement (SRA) and provided premium support to farmers.

No political pressure from farmers for assistance and disaster payments due to the high take up of the Federal Crop Insurance program.

A spectrum of agricultural insurances

There is a range of complexity available:

	Conventional	**More advanced**	**Alternative**
Type/s	Single Peril Named Peril Multi-peril	Revenue protection Margin protection	Weather index Modelled yield Area yield
Underwriting requirements	Farm/field history	Farm/field history Price history	Index history
Claims process	On-site Farm/field measurements	On-site Farm/field measurements	In-season data
Speed of payment	Dependent of availability of loss adjuster	Dependent of availability of loss adjuster… …and availability of reference price data	Shortly after index data becomes available

A focus on phytosanitary risks

Insurance 101

- The Principle of Insurance is to share the losses of the few amongst the fortunes of the many.
  - this can make ‘systematic’ losses difficult to insure
- It is also a requirement that an insured [farmer] should behave as though he/she was uninsured
  - in other words: to continue all risk control and management practices to the same level
- Insured losses are fortuitous - not predictable
  - in this regard, ‘fortuity’ may be strongly linked to the skill and experience of the farmer
- For these reasons, the insurance of pest and disease in agriculture has long been considered to be ~~impossible~~ very difficult…
  - anti-selection…

A focus on phytosanitary risks (cont)

Experiences to date

- In the US federal multi-peril program, losses from pest and diseases to insured crops are typically *included*.
  - the program looks at whole farm yields so, in practice, it would be hard to *exclude*.
  - also, when bundled, with a cocktail of natural perils the year-to-year volatility of loss from these causes tend to be buffered
  - the overall cost of loss is very highly subsidised.
- Where pest/disease is the 'named' peril insured, the underwriting challenge is much greater
  - is there a good 'history' of data against which to assess the risk – and thereby charge the right premium?
  - will the insured continue to manage the risk properly? ["…act as if uninsured"]
  - will only farmers with the highest risk buy the insurance? ["…the fortunes of the many"]
  - No offsetting 'pool' of premium from other insured perils.
- For these reasons, it is very uncommon to find 'named' pest/disease only insurances
- BUT – there's a new kid in town…

Index or ‘parametric’ insurance

Novel but not entirely new…

Parametric insurance provides cover based on the movement of an index not the measurement of actual outcomes

- similar to derivative trading against an index of stock prices (indeed, used to be called ‘weather derivatives’)

The index is made of independent data – i.e. data that are not influenced or even measured by the farmer.

- e.g. rainfall, temperature, windspeed, relative humidity, sunshine etc
- this removes any potential for anti-selection

BUT requires that the index provides a good performance (correlation) with the required risk management outcomes

No insurance policy is 100% accurate but so-called Basis Risk is a potential inherent design challenge of parametrics

Conclusions

Agricultural insurance around the world

Parametric insurance provides cover based on the movement of an index not the measurement of actual outcomes

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No insurance policy is 100% accurate but so-called Basis Risk is a potential inherent design challenge of parametrics

Thank you for your attention !

Merci pour votre attention !

Contact mail : julian.roberts@wtwco.com

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Risk coverage in agriculture
Benefits and challenges for the development of the Income Stabilization Tool (IST)

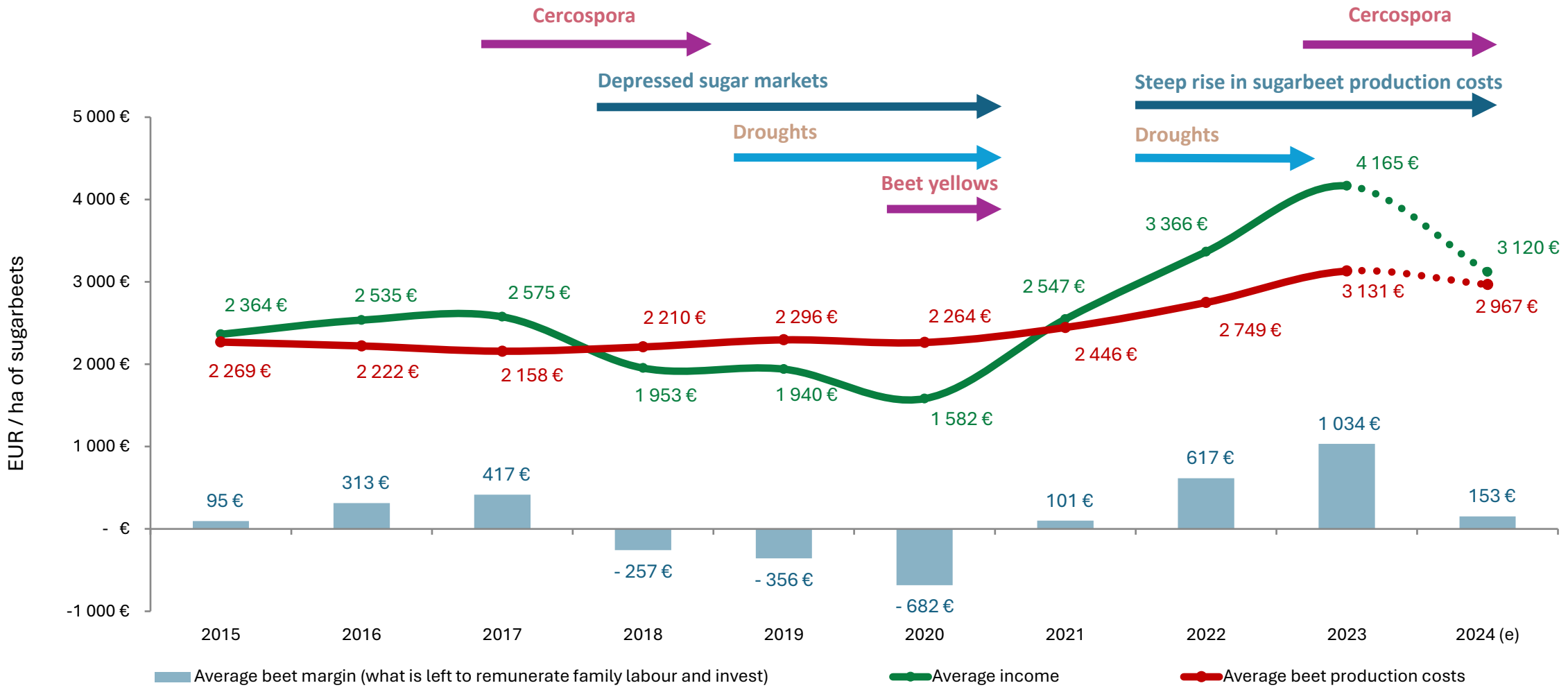
Alexis PATRY – Director of ARTB France

Session 1 – Context, issues : risks of changing / not changing production practices ?

Final Workshop– 24-25 Sept 2025

Why is IST interesting (and inspiring) ?

Increasing risks means increasing variability in sugarbeet revenues and margins



Existing risk management tools available in France ?

"Reasonable" risks

Private tools

Private / public tools

Emergency public systems

"Savage" risks

CLIMATIC RISKS

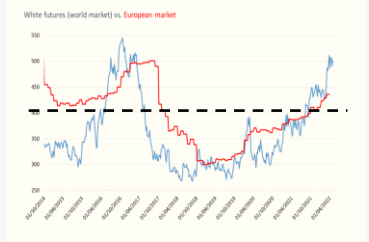
L'ASSURANCE MULTIRISQUE CLIMATIQUE DES RÉCOLTES

- Climate insurance (MRC) covers approximately **35%** of the **French beet acreage**
- Indemnifies **weather-related** yield losses (at a standard price)

REGULATED « SANITARY AND ENVIRONMENTAL » RISKS

FMSE

- « Mandatory » participation to the fund
- Covering costs based on disease control programs
- Indemnifying losses from **"regulated" diseases**



ECONOMIC RISKS (sugar prices, input costs)

NON-REGULATED SANITARY RISKS (beet yellows, weevils)

ISR Betterave-sucre

- Sectorial mutual fund
- Based on a **"gross" margin index**
- Compensates for **significant economic losses** (not covered by already-existing tools such as MRC, FMSE and/or emergency measures when applicable)

The sugarbeet Income Stabilisation Tool (IST) index

“Incomes” rather than yields

- ❑ Yields = Covers only one part of farms’ profitability equation
- ❑ Gross margins (for each crop grown on the farm) = what farmers look at !

The IST indemnifies when a significant loss in gross margin is witnessed against the past 5-year average olympic mean

For sugarbeet, the proposed index is the following :

Sugarbeet IST index = [sugarbeet price x sugarbeet yield] – operating costs + CAP subsidies

gar « futures »
#5)

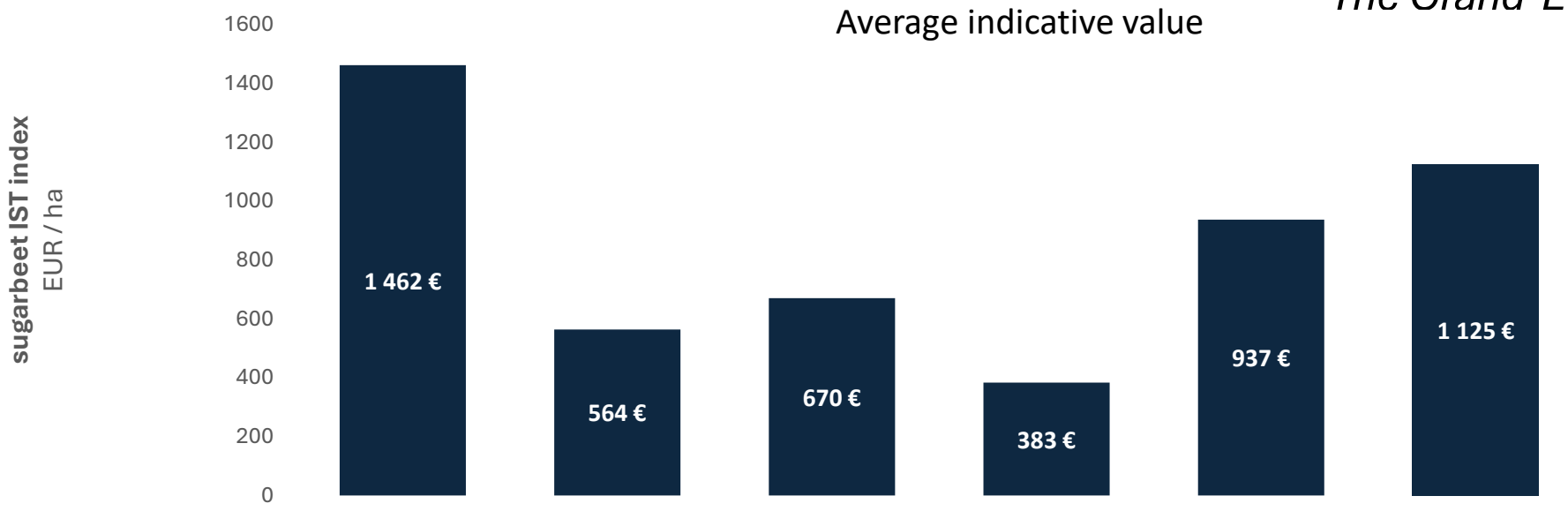
Based on private individual yield from the farmer who subscribed to the sugarbeet IST

Based on public regional operting costs indexes (IPAMPA)

Based on public regional values

The sugarbeet IST index

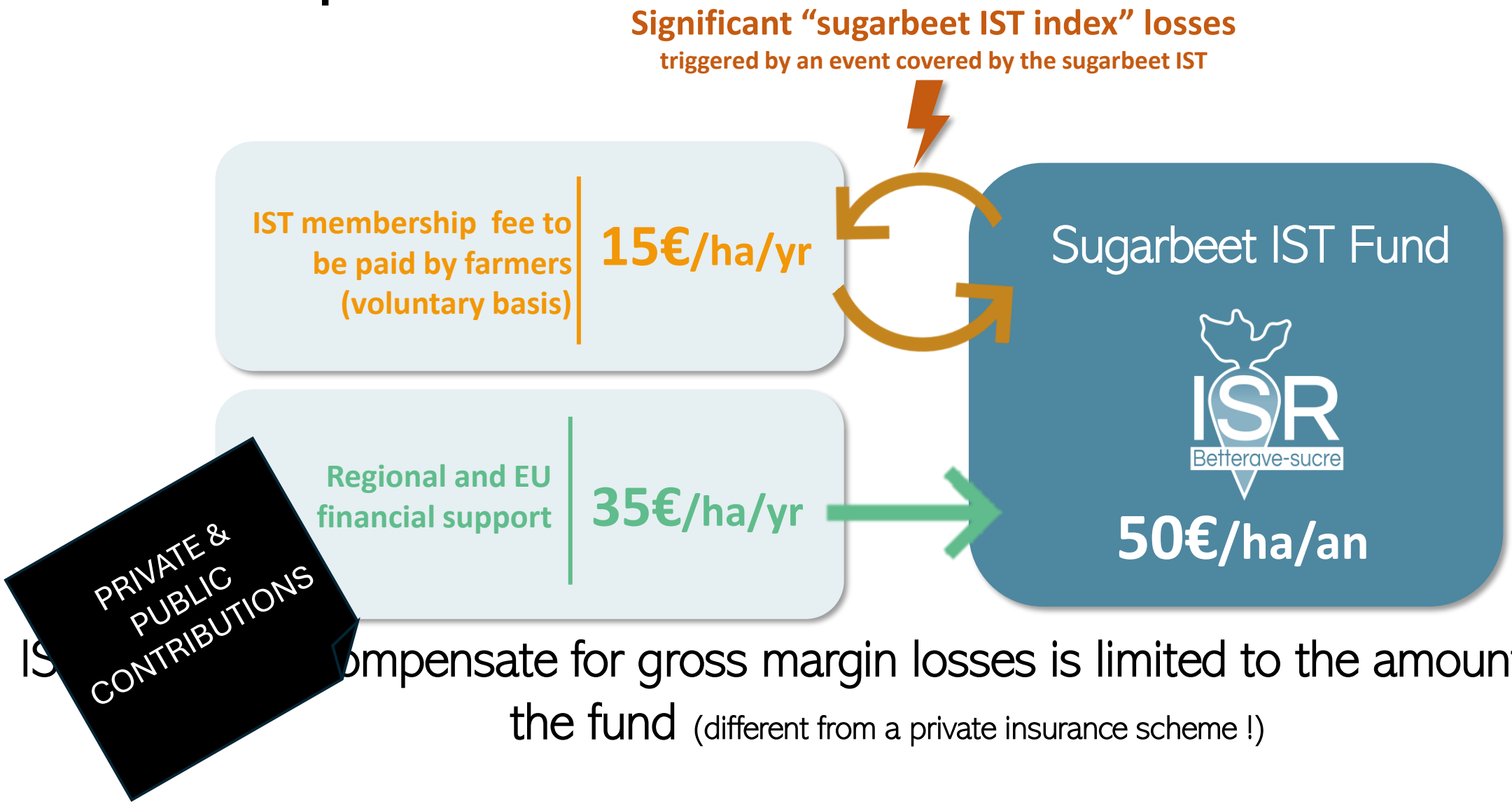
The Grand-Est example



	2017	2018	2019	2020	2021	2022
Average sugarbeet yields in Grand-Est (t/ha)	95,91	79,00	82,04	61,73	79,37	78,00
CAP Subsidies recorded in Grand-Est (€/ha)	341,98	309,60	291,48	255,63	245,18	238,15
Operating costs in Grand-Est (€/ha)	954,91	984,93	991,47	958,87	1052,81	1346,11
Recalculated sugarbeet price (€/t)	21,63	15,69	16,70	17,60	21,98	28,63

How the sugarbeet IST works

Principle



IS ompensate for gross margin losses is limited to the amount available in the fund (different from a private insurance scheme !)

The « two-step » system

<u>Collective</u> activation of the sugarbeet IST
Trigger events

<u>Individual</u> eligibility (due to substantial losses)
20% minimum drop of the Sugarbeet IST index

Effective compensation (for the losses)

- The sugarbeet IST is activated should **trigger events** materialize
  - The list of eligible trigger events is to be defined in IST « rules of proc
    Example :
    - Low sugar **market price**
    - Increase in sugarbeet **operating costs**
  - With a minimum 15% gross margin losses witnessed at regional leve **<u>moral hazard</u>**)

- A farmer may receive a financial compensation from the sugarbeet IST if :
  - farmer's personal sugarbeet IST index drops by minimum 20% when comp ed to his average olympic mean index for the previous 5 years

- The **effective compensation** paid by the IST to eligible farm
  - Deducts non-IST compensations possibly granted to the farmer (MRC,
  - Is adjusted based on a compensation rate (%)
  - Determined by financial availabilities in the fund and/ or by minimum reserve f ST rules of procedure

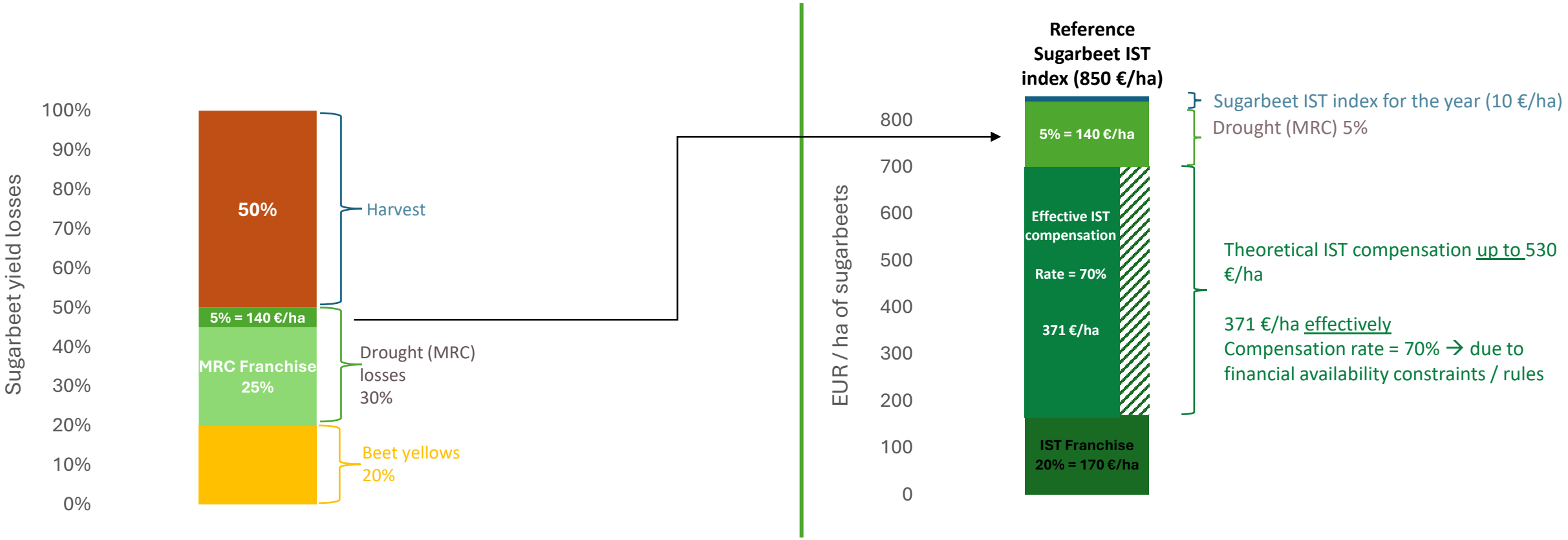
Coordination between IST and existing risk management tools

MRC climate insurance (primary payer)

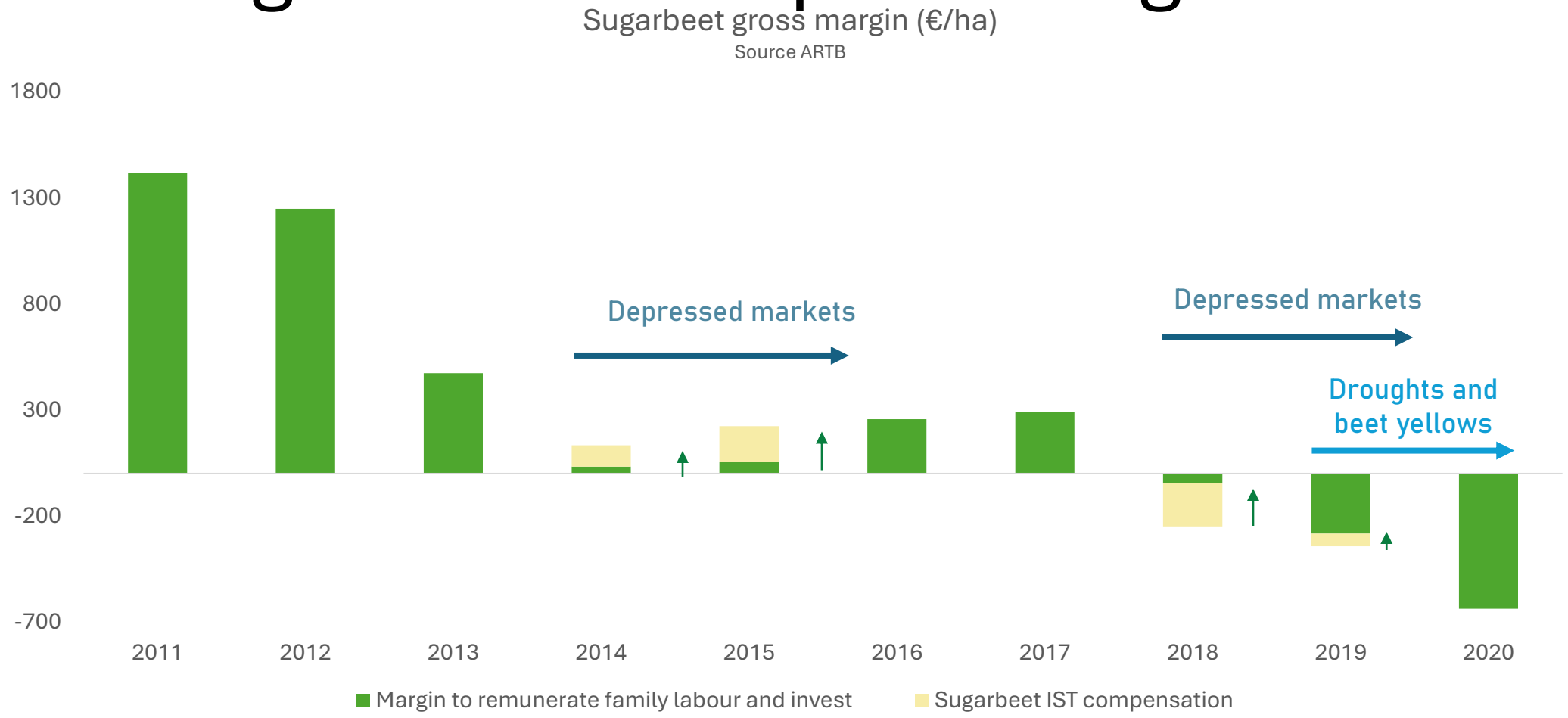
The sugarbeet IST covers additional gross margin losses

The climate insurance (MRC) example

Sugarbeet price drops **5%**
Beet yellows trigger a **20%** sugarbeet yield loss
Drought triggers a **30%** sugarbeet yield loss



The sugarbeet IST impact at a glance



Benefits and challenges

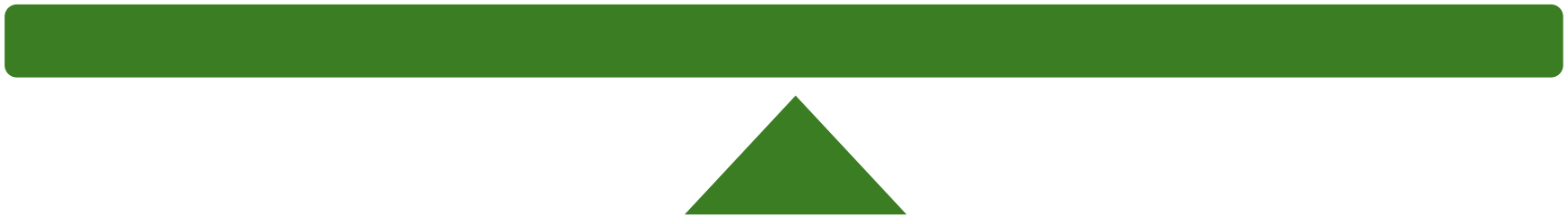
A large number of benefits

Use of index which improves the reactivity of the system (faster compensation timing)

A significant « public support » which mechanically reduces farmers ' membership fees

Can deal with any kind of risks (provided that funds are sufficient to cover for them) : highly adaptable

Income (actually margins) instead of yields



BUT…

some challe

Does not guarantee a full compensation (depends on funds available in the IST)

Requires access to reliable and publicly-available data

Should limit data-input procedures for farmers

Should compensate farmers quickly (a priori funds)

Should limit geographical distorsions between farmers (In France, the IST is currently designed at a regional level)

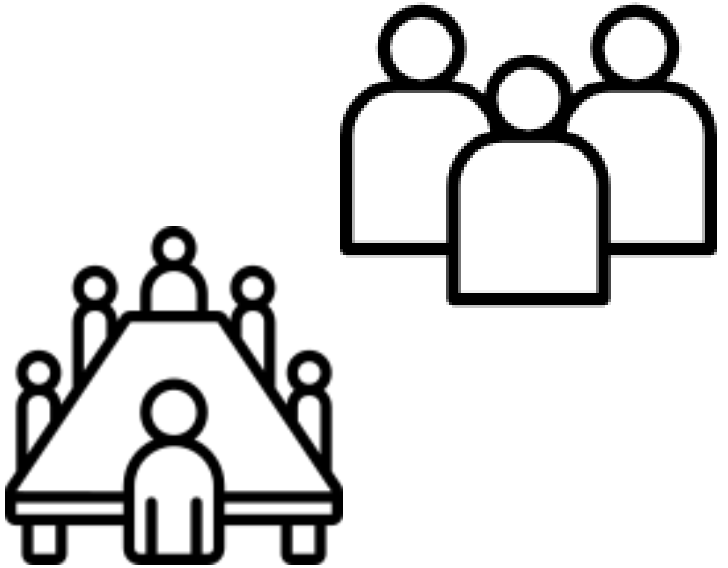
Requires well-designed decision procedures (to activate the IST) as well as a transparent governance system (inclusion of as many automated procedures as possible which will in turn limit fixed costs of the system)

Should get a large number of farmers to join the system in the early years to maximize

Keen to further explore IST and risk management tools in agriculture ?

Recent IST publication

Strategic and technical support



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Using insurance to reduce environmental impacts of cropping:
A case study for the Great Barrier Reef

Peter Thorburn[1], Jody Biggs[1], Tony Webster[1] and Russ Mehmet[2]

[1]CSIRO Agriculture and Food [2]WillisTowersWatson
Brisbane, Australia

Session 2, Beyond climate risk: feedback on risk pooling

Final Workshop– 24-25 Sept 2025

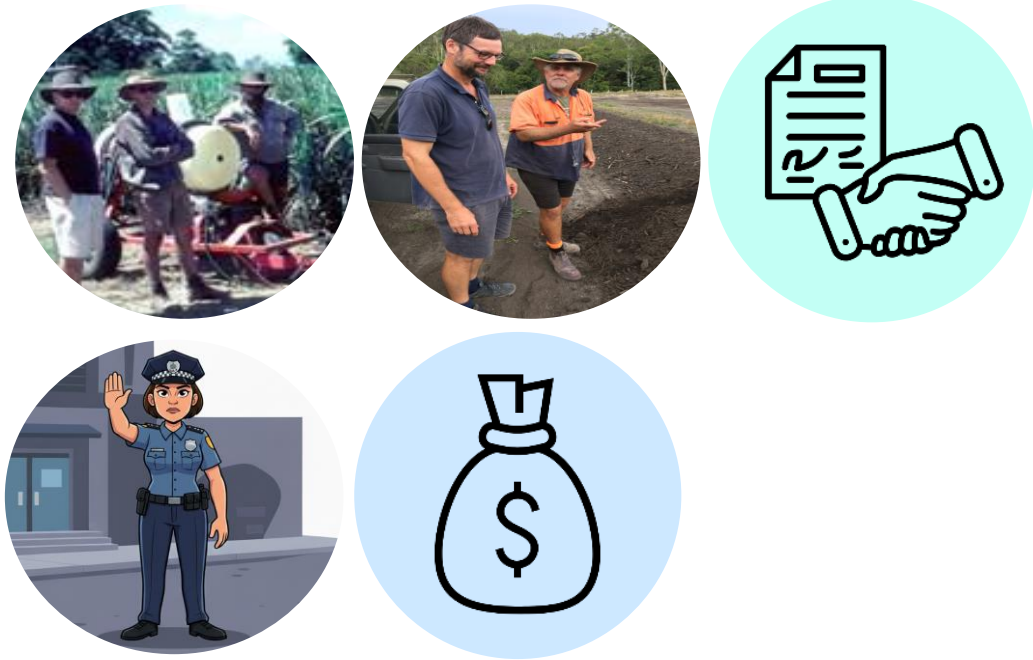
wtw
The leading broker for structuring parametric insurance

Context

Reef health under threat from nitrogen (N) fertiliser applications

Measures to reduce N rates:

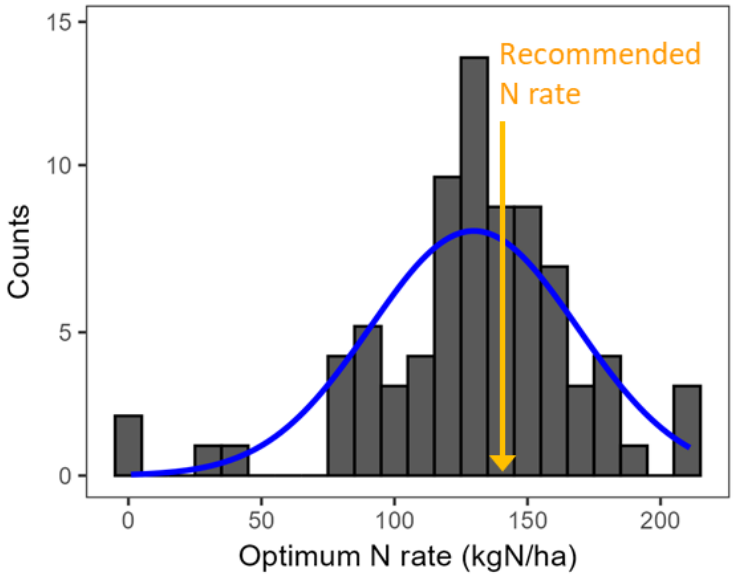
- Extension ✗
- Grants to farmers ✗
- Regulation ✗
- Insurance ?



Why insurance?

- Uncertainty in optimum N fertiliser rate for crops
  - ⇨ Risk that yield is limited by N stress

Economic optimum N rates at 80



- Sugarcane farmer:

". . . why do people put a bit of extra fertilizer on? It's like I said before, they think it's an ***insurance policy****."*[2]

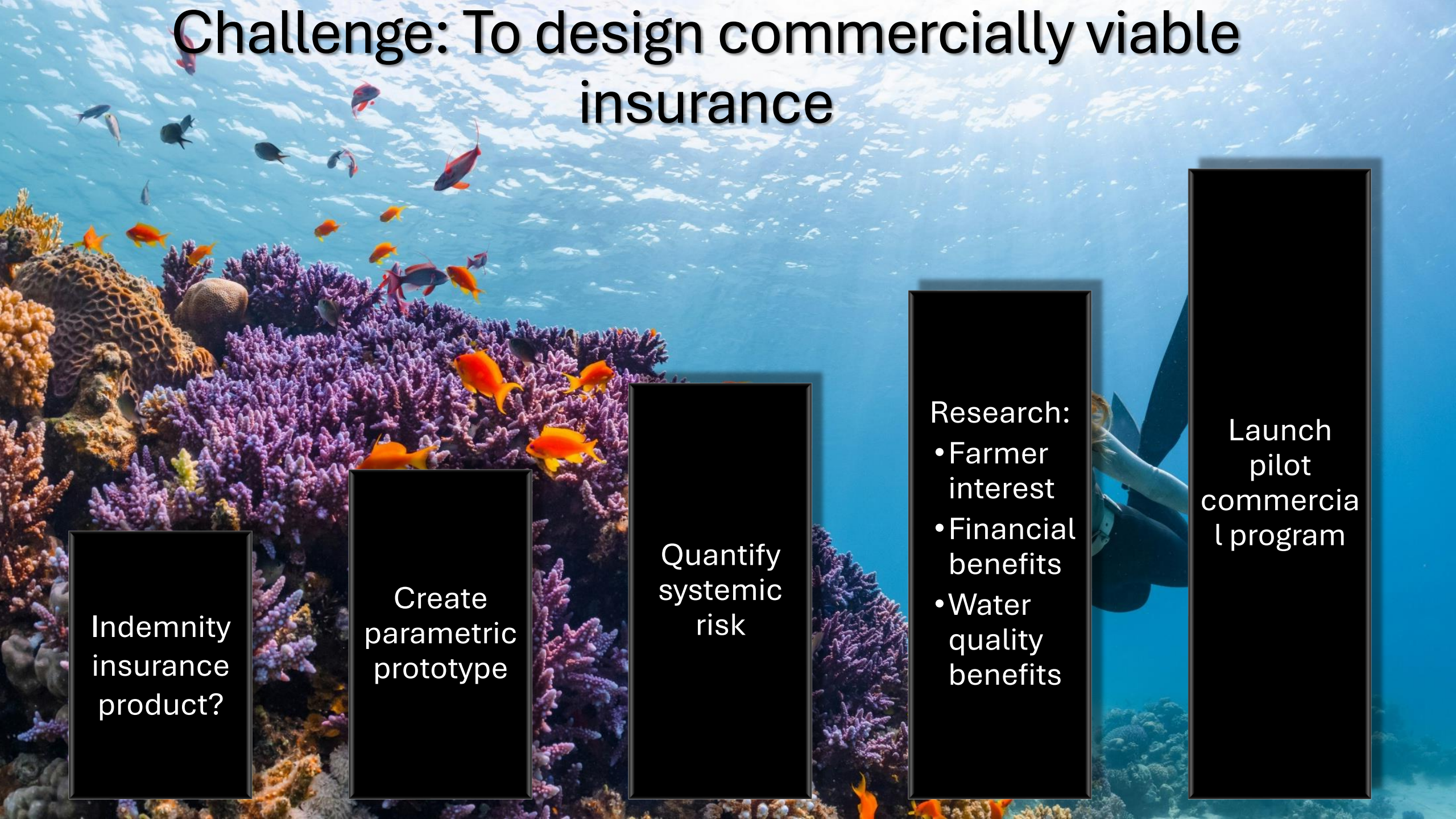
- Replace extra N with commercial insurance?

Photo credit: Peter Thorburn

[1]Replottd from: Thorburn et al 2024. The nitrogen fertilizer conundrum: Why is yield is poor determinant of crop fertilizer requirements? *Agron Sust Dev* 44, 18

[2]Benn et al 2010 The Sugar industry s impact on the landscape of the Australian wet tropical coast. *Landscape Res* 35, 613-632

Challenge: To design commercially viable insurance



Indemnity insurance product? Impracticable

Concept…

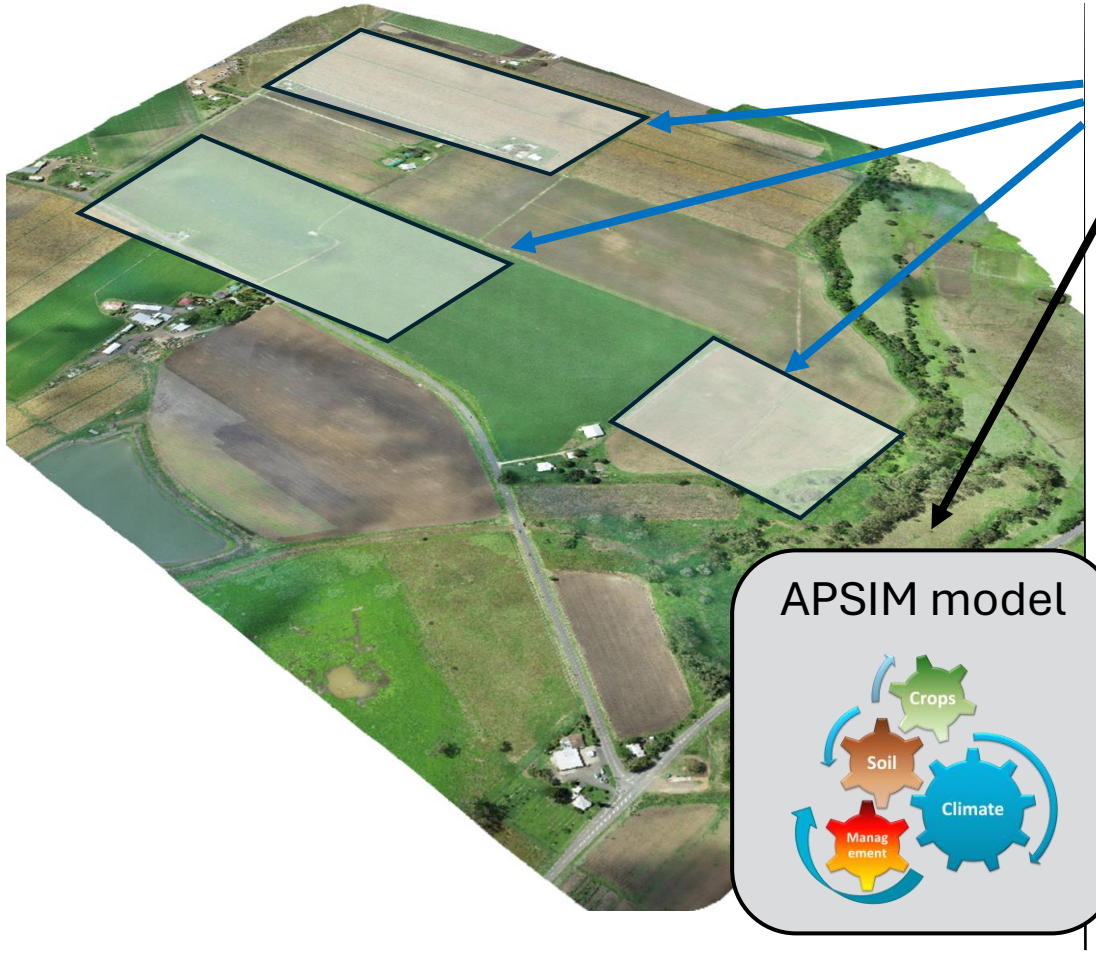
- Yield difference between
  - Insured (lower N)
  - Check plot (original N)

Problems…

- High yield variability due to factors other than N
  - ⇨ 30% reduction to ‘prove’ loss
- Cost of check plots and loss adjustment
- Moral hazard

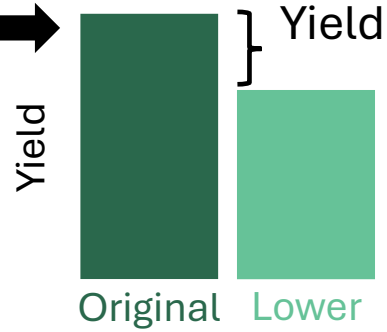
Parametric insurance for N risk – the concept

Evaluation of risk at (quasi) field scale



- Soil type
- Climate
- Timing of crop growth
- Original N rate
- Lower N rate
- *Assumed management practices*

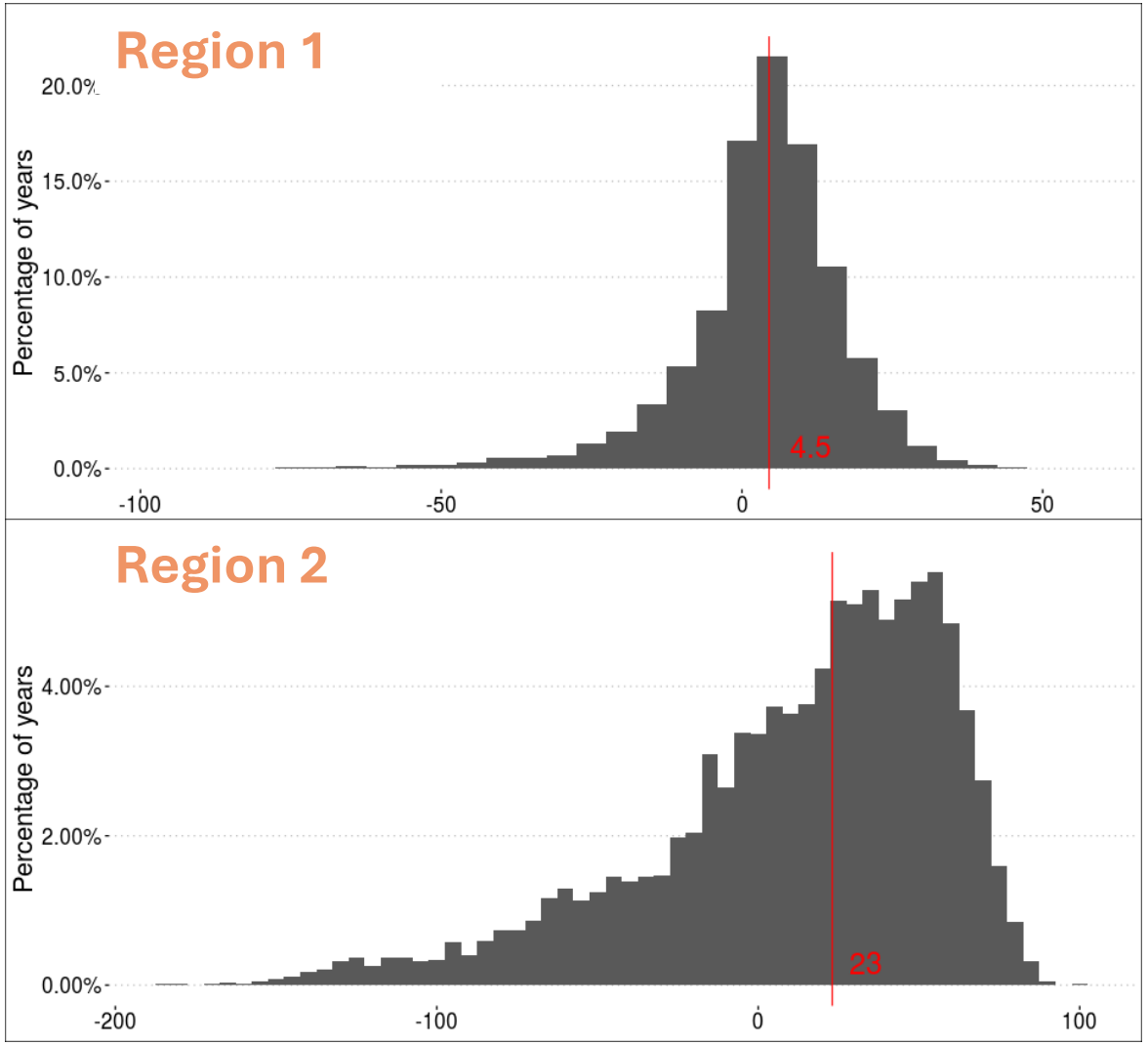
APSIM model



- Historical ⇨ Risk/premium
- Insured year ⇨ Loss/payout

Systemic risk: are losses correlated?

- Create hypothetical portfolios of insurance contracts
  - Contracts based on
    - Soil types
    - Climates
    - Timing of crop growth
    - Original and lower N rates
    - Over multiple years
- Basic cash profit for each contract
  - Premiums - payouts
- Randomly sampled (bootstrapping) contracts to create portfolios
- Distribution of cash profits across years for portfolios



Research: Social, financial and environmental data

1. Field experiments

- Farmers ‘buy’ mock insurance product through *Self Service Portal* 2020-2021

2. Three years commercial experience

- N Risk Insurance sold by WTW since 2022

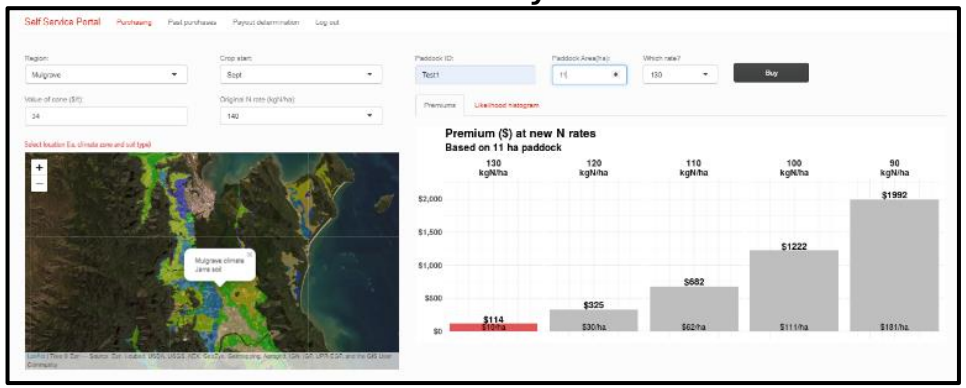
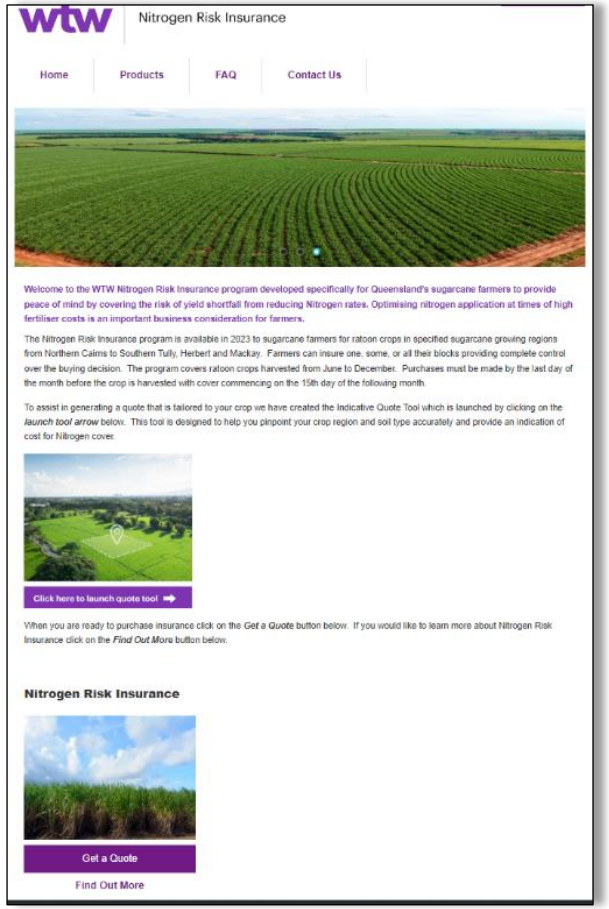



Photo credit: Peter Thorburn



Social - feedback

- **Most farmers and advisors see value**
  - *“This insurance thing could help going forward. This is really innovative…” [Farmer]*
  - *“Yes definitely… If you’re prepared to pay towards cost of N fertiliser, then you can afford to buy insurance and see how that goes.” [Farmer]*
  - *“I reckon it has legs, the conversations around the table in [the region] were good and people were pretty positive about how useful this could be. It’s pretty complex, so takes a bit to get farmers to understand it…” [Advisor]*

Financial outcomes

Averages	**Policies**	
	Mock	***Commercial****
Premium (AUD/ha)	43.43	34.37
Payout (AUD/ha)**	26.09	29.37
N fert cost savings (AUD/ha)	27.67	32.31
Cash flow (AUD/ha)	**+10.34**	**+27.31**
N reduction (kg/ha)	18.4	21.5

* Policies sold in 2022 & 2023, assessed after 12 months

** Mock policies evaluated over 1970-2020

Potential water quality benefits

Totals (per year)	Value	Assumptions
Area insured (ha)	30,000	10% of all cane lands
N fertiliser reduced (t)	600	20 kg/ha
N discharge reduced (t)	120	Delivery ratio = 0.2
Public savings (AUD)	24,000,000	Abatement cost via grants and incentives = AUD200 /kg

Conclusions - N Risk Insurance…

- Successfully designed a new path to reducing
  - N fertiliser over-application
  - Environmental impacts
- No (or little) ongoing cost to:
  - Farmers – implicit subsidy from avoided N fertiliser costs
  - Public – when commercially sustainable
- Flexible – completely farmer's decision, no multi-year lock-in

Photo credit: Peter Thorburn

Where to next?

N Risk Insurance

- Develop distribution network ⇨ commercial sustainability
- Expand footprint

Other crops

- N Risk for cotton (in progress)

Other risks?

- Wheat yield protection (in progress)
- Irrigation
- Pesticides
- Environmental markets

Acknowledgements:

Australian Government

Collaborating farmers and advisors

Julian Roberts and Claire Wilkinson, WTW London

Australia's National Science Agency

This project is funded by the Australian Government's Reef Trust and Natonal Environmental Science Program and the Great Barrier Reef Foundation

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Sharing 5 Years of Experience in Managing Mutual Funds for Plant Diseases

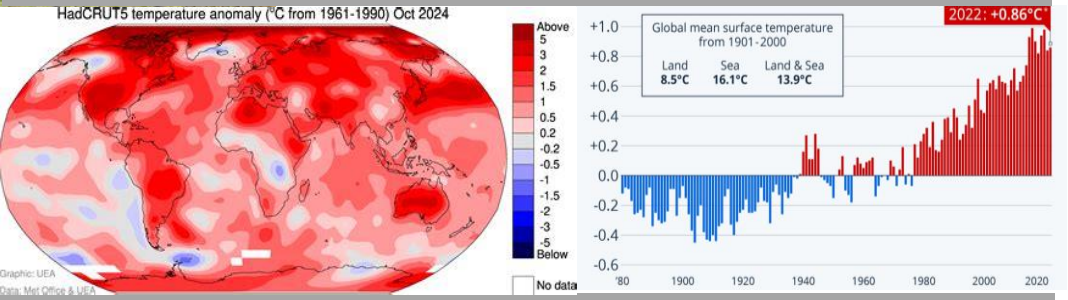
Dott. Agron. Giuseppe Boatto / AGRIFONDO MUTUALISTICO

N° 5 - Feedback on setting up a mutual fund: Agrifondo Mutualistico (Italy)

Final Workshop– 24-25 Sept 2025

Final Workshop– 24-25 Sept 2025 - COMPLICATED SCENARIO FOR FARMERS

CLIMATE CHANGE



DRAMMATIC DAMAGES

COMMUNITY OBJECTIVES

CHEMICAL REDUCTION

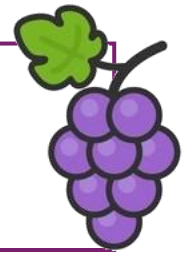
GEOPILITICAL ISSUES

LOWER PROFITS

AGRIFONDO MUTUALISTICO COLLOCATION AND MAIN SECTORS

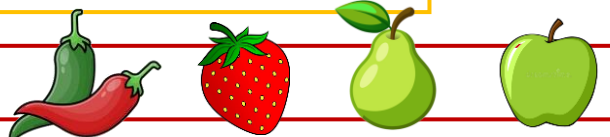
LOCATED IN NORTH EST OF ITALY:
Collected 2 main region:
- **Veneto**
- **Friuli Venezia Giulia**

STRATEGIC AREA FOR:



- <u>WINE SECTOR:</u>
- Prosecco;
- Amarone della Valpolicella;
- Collio Friulano;

- <u>FOOD SECTOR:</u>
- CHEESE:
  - Grana padano;
  - Asiago;
- HAM:
  - Prosciutto Crudo di San Daniele;
  - Prosciutto Crudo di Montagnana;

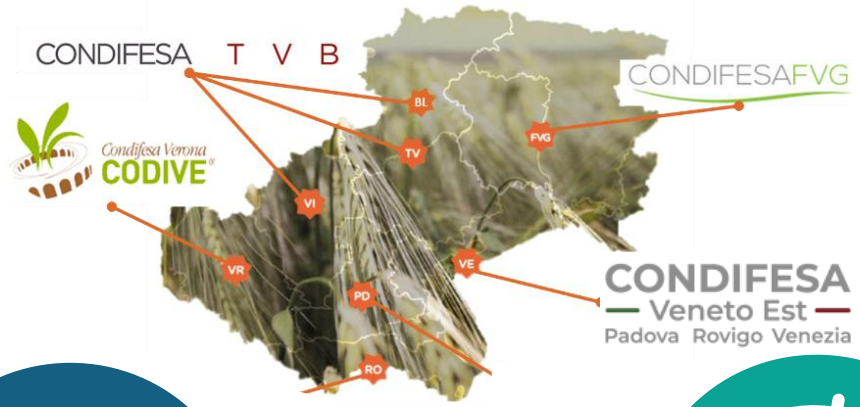


- Others LOCAL D. O. P.

WE ARE:

AGRIFONDO MUTUALISTICO VENETO E FRIULI VENEZIA GIULIA:

Organization Create by «Condifesa» collaboration!



+ 1,1 bn € Protected Value
+ 50 k hectars of wineyards
+ 100 k hectars of cereals

Since 2019 Offical Mutual Fund recognition!
3 funds available:

- **Winegrape fund;**
- **Cereal & soybeen fund;**
- **IST fund for orticolture cooperative.**

+ 10 k Farmer members

OUR JOURNEY in MUTUAL FUND

2010

Our experience start since 2010, created through the collaboration of Condifesa organizations in Veneto and Friuli VG.
Mutual system was created to answer farmer necessity for local damage as:

- Wild Animals;
- Structure of wineyerds by wind storm;
- Reseeding crops afert floading.

- ***2013 EUROPEN UNION BY FEASR ALLOWS SUBSIDIES FOR MUTUAL FUND***
- ***2019 ITALIAN MINISTER RECEPIT IT AND REGULATED***

2020

In 2019, AGRIFONDO MUTUALISTICO integrate PLANT DEASES in the Mutual Fund offer.
We were launched three subsidized funds to compensate for damage caused by plant diseases and income losses.

NEXT FUTURE

The reduction of insurance Companies capacities (portfolio) and guaranties in the futures should be take in charge by mutual fund.

AGRONOMICAL KNOWLEDGE

INSURANCE POLICIES

MUTUAL FUNDS

ACTIVE DEFENSE:

PASSIVE DEFENSE:

SHARED RISKS:

THE KEY IS: SYNERGY BETWEEN THE TOOLS

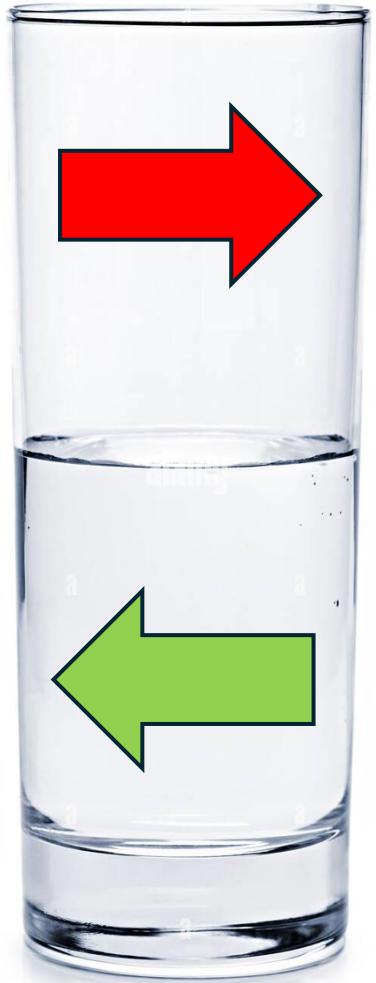
Difference between mutual fund & insurance policie

VS

MUTUAL FUND SYSTEM

PRO

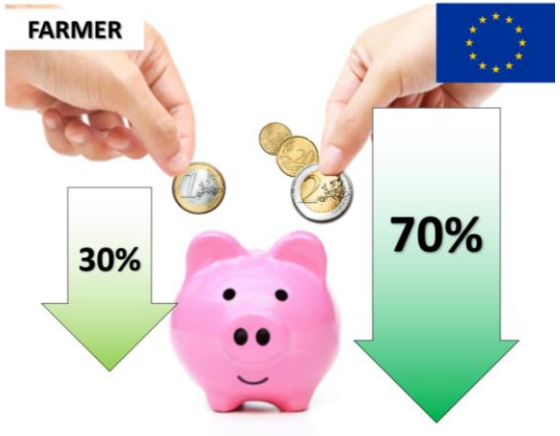
- GUARANTEES FOR RISKS NOT MANAGED BY THE INSURANCE MARKET;
- CREATION OF A PIGGY BANK LINKED TO MEMBERS OF THE FUND/TERRITORY;
- TERRITORIAL MONITORING;



CONS

- COMPENSATION REDUCED/PROPORTIONED IF EXCEEDS FUND AVAILABILITY;
- COMMUNITY REGULATORY CONSTRAINTS/LIMITS;
- NATIONAL DELAY IN COMMUNITY CONTRIBUTION ;

What the contribution in mutual fund means?



Thanks to FEASR, is available an importan contribution in mutual fund with plant disease guarnaties:

- Up to 70% of total cost of the farmer fee;
- No anticipation: Farmer have to cover only 30% of total cost.

To recived these FEASR contribution, therea are restrictive regolation to respect:

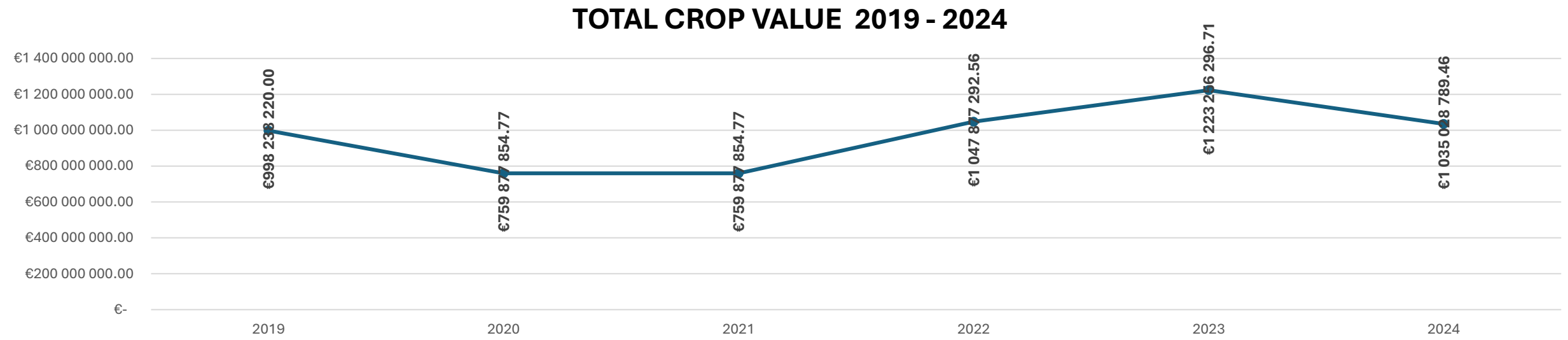
- UE REGULATION;
- NATIONAL REGULATION;
- FUND REGULATION.

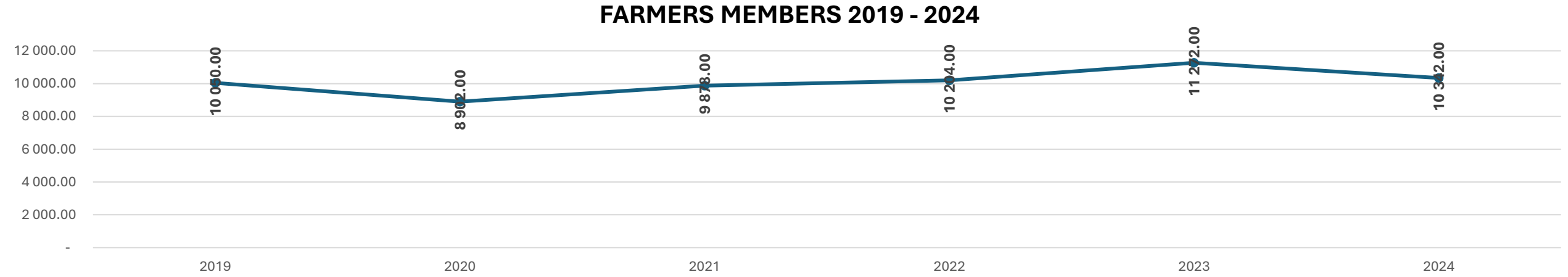
Also the farmers have two improtant rules to respect:

- Perform on GOOD AGRICOLTURAL PRACTIES;
- Damage exceeding the 20% threshold of the common product.

Final Workshop– 24-25 Sept 2025 – THE NUMBERS OF FAMERS TRUST!

GOOD SOWING…. GREAT HARVEST!





Final Workshop– 24-25 Sept 2025 – THE FIRST PERIOD

Since 2010 we started our experience in Mutual Fond to try to respond farmers needs.
CREATE THE BASES FOR FUTURE MUTUAL FUND!

WILD ANIMAL FUND:

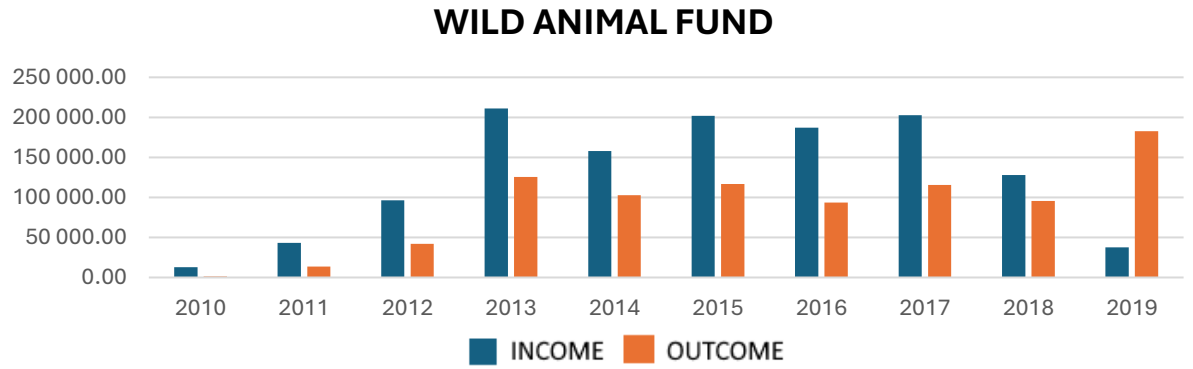
- First established in 2010;
- Consistently stable over the years;

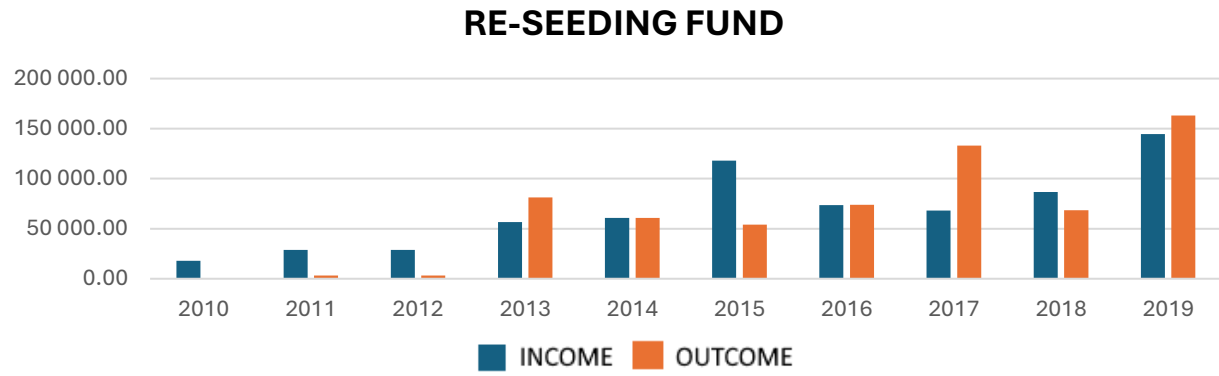
RESEEDING FUND:

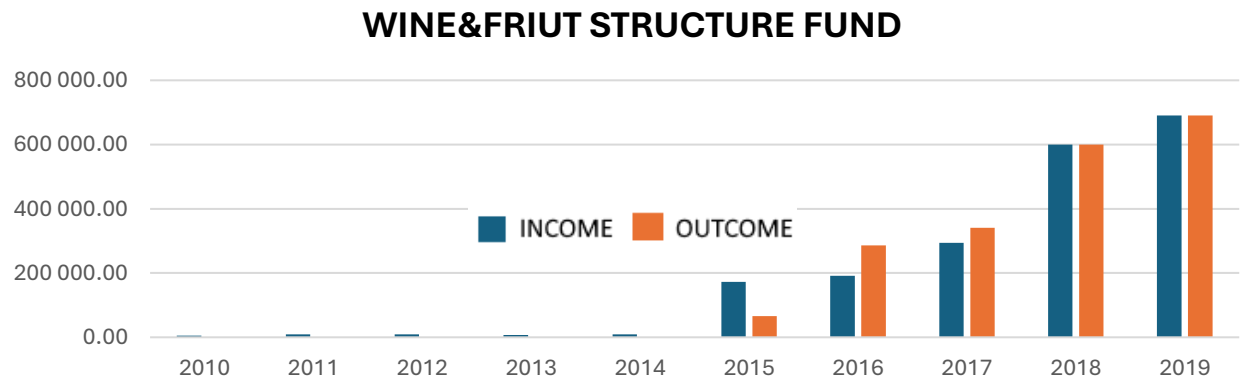
- Involves the very early stages of crop production, starting from sowing;
- Is highly affected by spring weather conditions;

WINE&FRIUT STRUCTURES:

- Compensates for damage caused by strong winds and tornado to the wineyerd and fruit structure;



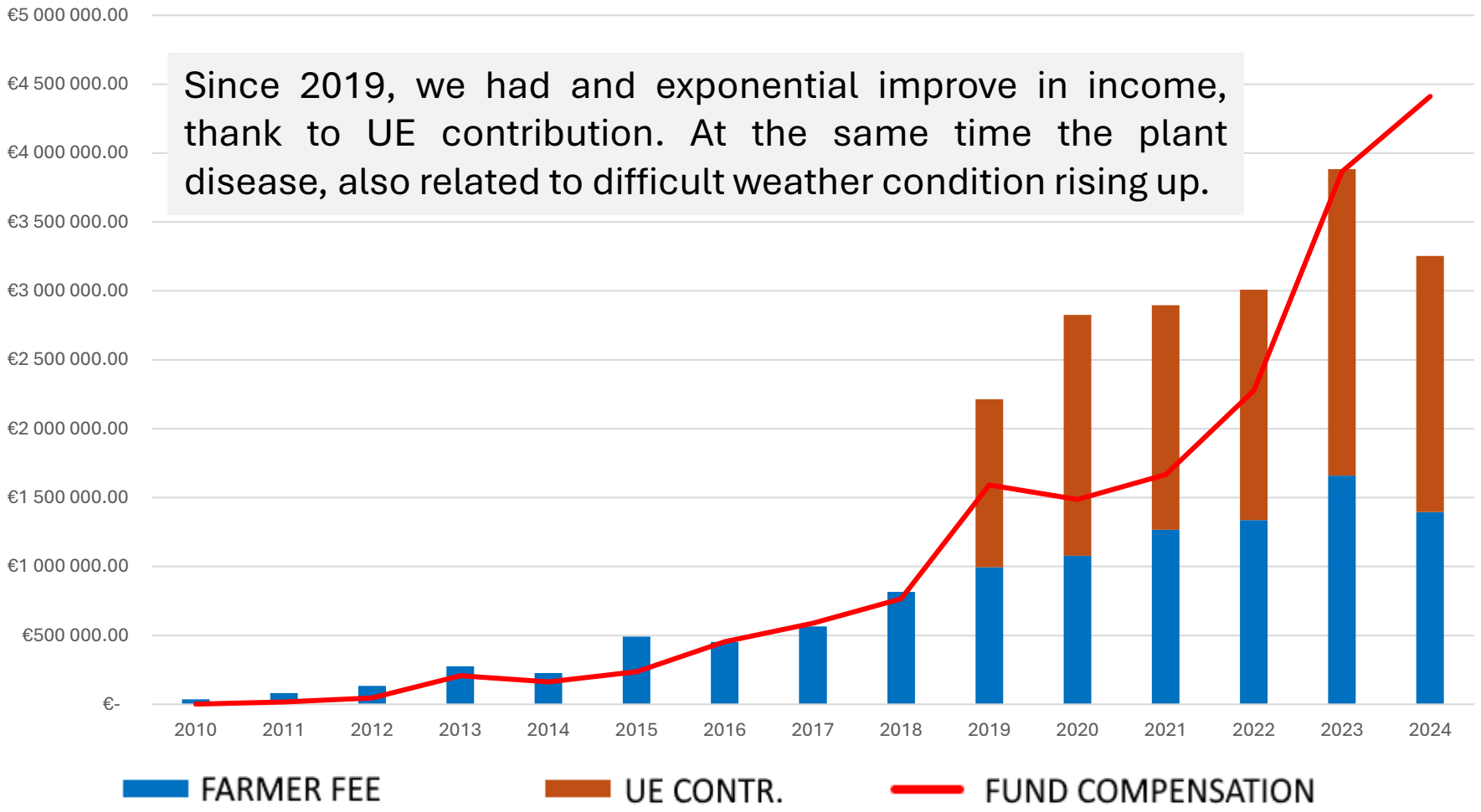




Final Workshop– 24-25 Sept 2025 – THE FIRST PERIOD

THE EFFECTS OF UE CONTRIBUTION IN MUTUAL FUND

AGRIFONDO MUTUALISTICO FINANCIAL STATEMENT 2010 – 2024



Since 2019, we had and exponential improve in income, thank to UE contribution. At the same time the plant disease, also related to difficult weather condition rising up.

CAPITAL STOCK

A key point in Mutual Fund is the creation of Piggy bank. During the good years the fund save money and integrate eventually during the worse years.

WINEGRAPE MUTUAL FUND: HOW IT WORKS?

COVERAGE FOR PLANE DISEASE?

- ✓ **PHITOPATIES:**
- ✓ **INSECT & PARASSITE:**

- **Downy mildew**
- **Powdery mildew**
- **Botrytis**
- **Flavescence Dorée**
- **Esca (grape disease)**

HOW MUCH IT COST?

- **FARMER'S FEE 0,10% OF HARVEST VALUE;**
- *Ex 10.000 € it will cost 10 €*
- **WORKS IN SINERGY WITH INSURANCE POLICIES FOR WEATHER LOSS;**

HOW MUCH IT COMPENSATE?

- Require correct agricolture practies;
- Exceeding the 20% threshold of the common product;
- 20% francise;
- % the value of product loss respect the contract cause the disease.

Final Workshop– 24-25 Sept 2025 - main question!

Can insurance help farmers cover the risk of plant health losses?

2 Main obstacles to overcome:

1) PRICING MODEL:

To quantify the COST OF THE RISK, insurance companies need a statistically significant data set (usually 10 years);

2) MORAL HAZARD:

The damage caused by plant diseases is directly related to the farmer's ability to apply GOOD AGRICULTURAL PRACTICES. Defining the extent of phytosanitary losses without considering the human factor is difficult.

Final Workshop– 24-25 Sept 2025 – RISK MANAGMENT

THE PRICING MODEL FOR CALCULATE THE COST OF RISK

To train the algorithm , you need 2 main datas:

- FREQUENCY OF EVENTS
- INTENSITY OF THE EVENTS

These datas had to be collected during the years (at list 5 years) to achives a valiable indicator.

PROBLEM!

Critical issues for plant diseases database:

- Limited data (usually less 5 years monitoring period);
- Not comparable data: Area/Climate/varietal sensitivity /phenological phase;
- Different active defense strategies (ex. conventional or biologic).

➢ **Our experience focus on main vinegrape's diseases:**

WARM UP PERIOD

EXTERNAL DATAS:

- University (Padova + Verona + Udine)
- Reaserch centre (CREA – Conegliano)
- Tecnical Institute (Cerletti - Conegliano)

SOLVE

RACING PERIOD

+ EXTERNAL DATAS;

+ IN FIELD DATA FEEDBACK:

- In-field expertise;
- Harvest yields analysis;
- Farmers feedback.

Final result : implementation of the system with direct feedback and tailored the "Cost of Risk" through the years.

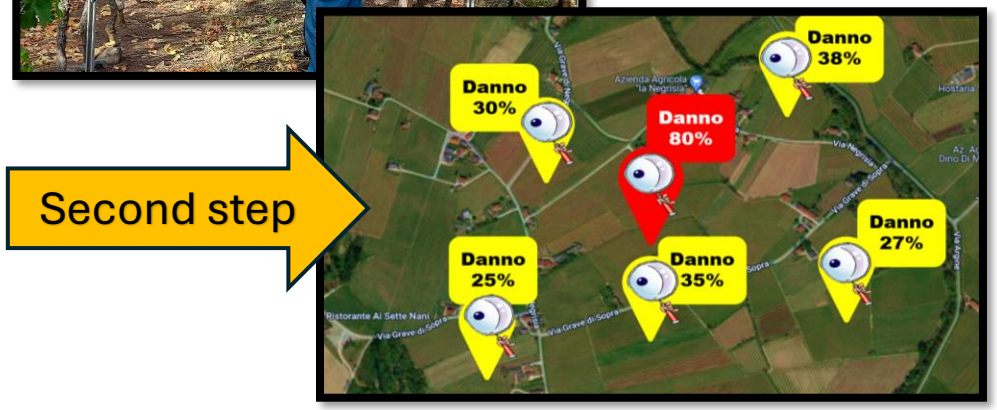
Final Workshop– 24-25 Sept 2025 – MORAL HAZARD

HOW TO REDUCE MORAL HAZARD RISK

The damage caused by plant diseases is directly related to the farmer's ability to apply **Good Agricultural Practices**.
Defining the extent of phytosanitary losses without considering the human factor is difficult.
To reconcile the damage recorded by an individual farm with a comparable figure for the region, we at Agrifondo Mutualistico have implemented a **two-phase verification system:**

1) A specialized technician verifies:
   - the correct application of "Good Agricultural Practices"
   - Estimate of the damage present at the time of harvest;

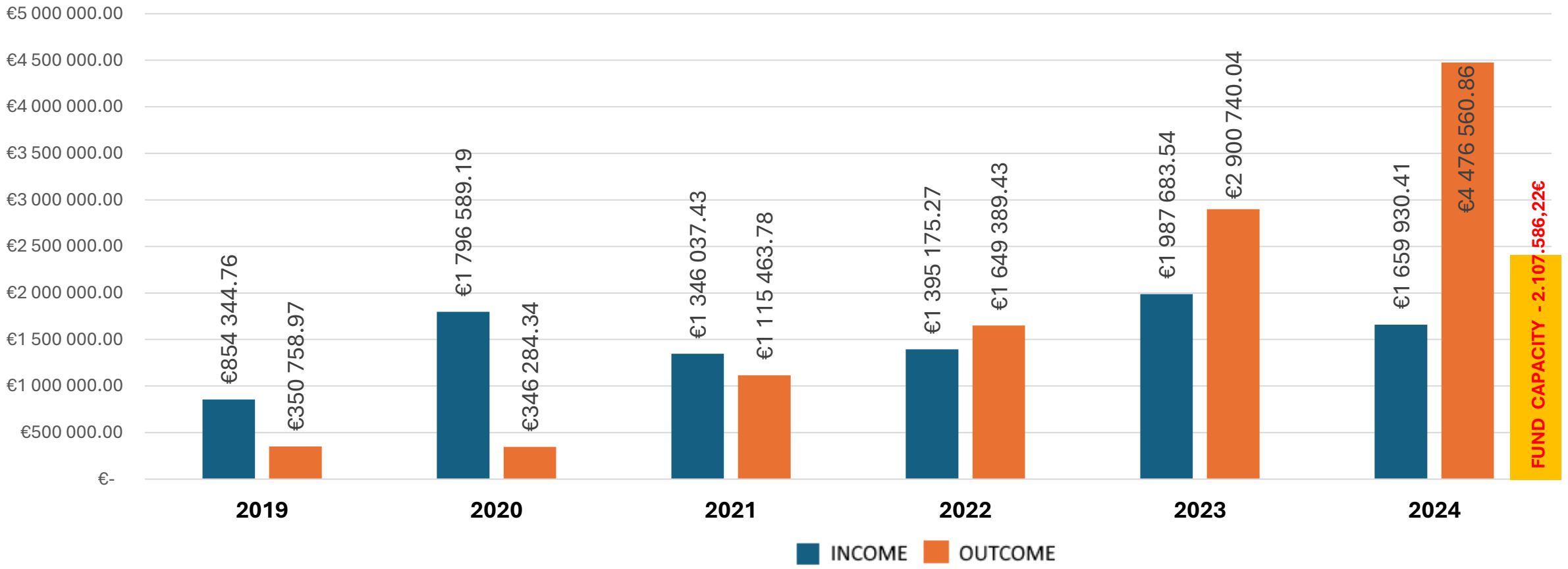
2) Identification of average damage over a homogeneous area:
   - Monitoring the territory by in-field experties;
   - Collecting data by public amministration on harvest yeild per municipalities.



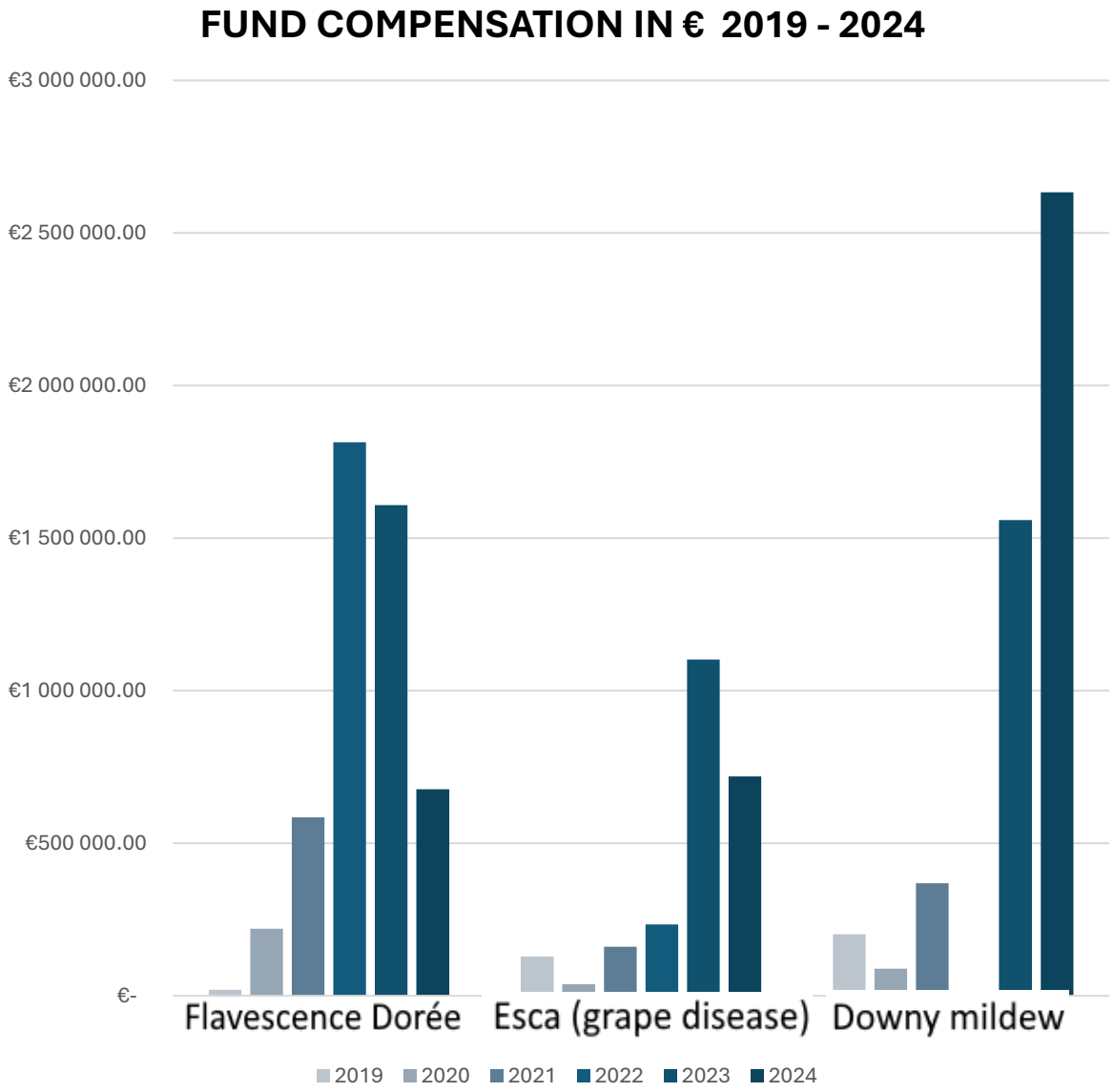
WIN-WIN METHOD:
1) AVOID/REDUCE COMPENSATION FOR HUMAN ERROR;
2) CORRECT READING OF REAL DAMAGE IN FIELD BY INSPECTOR;
3) KNOWLEDGE TRANSFER TO HELP FARM TO AVOID FUTURE DAMAGE;

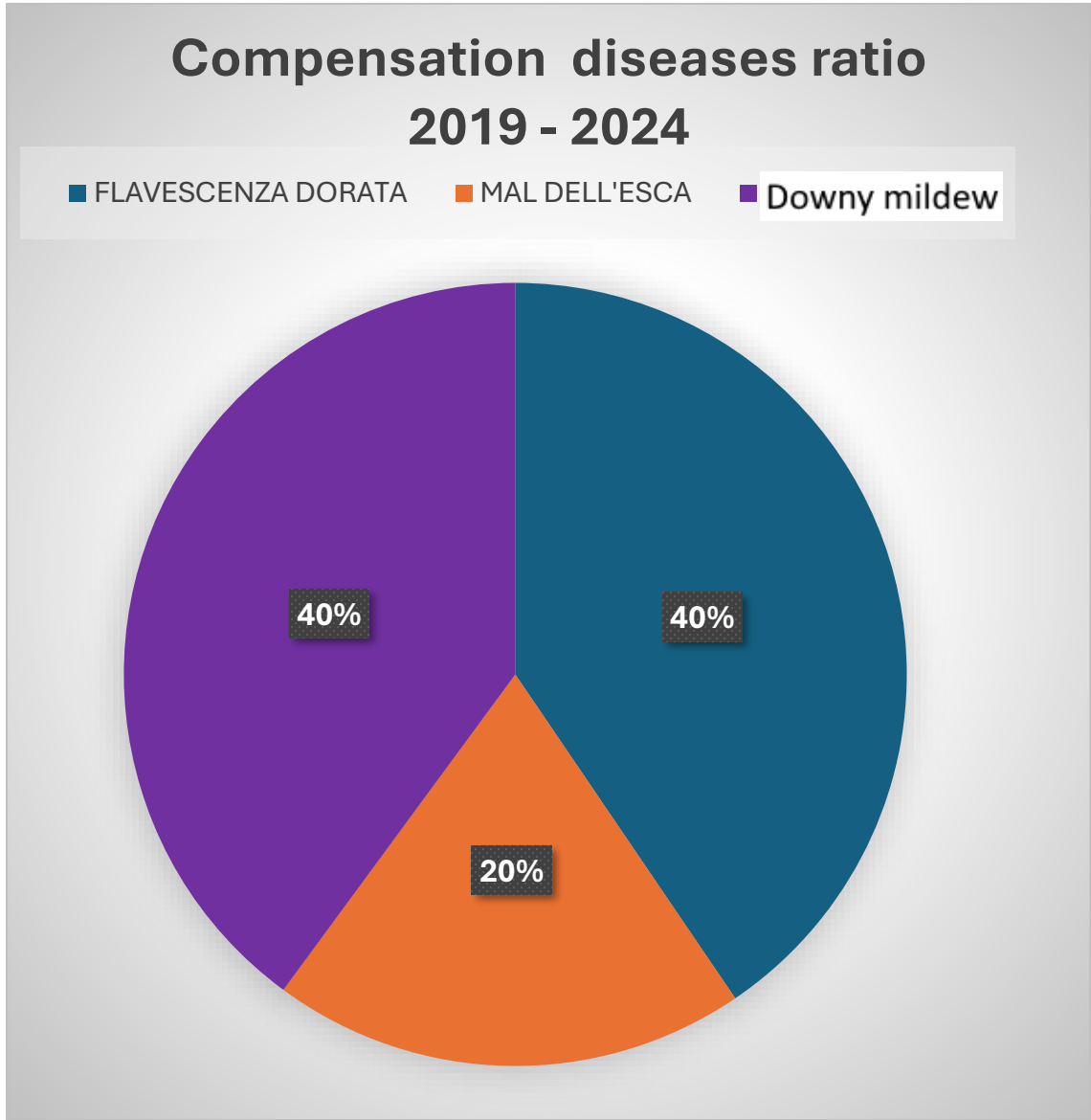
THE WINEGRAPE MUTUAL FUND TREND

INCOME STATEMENT 2019-2024

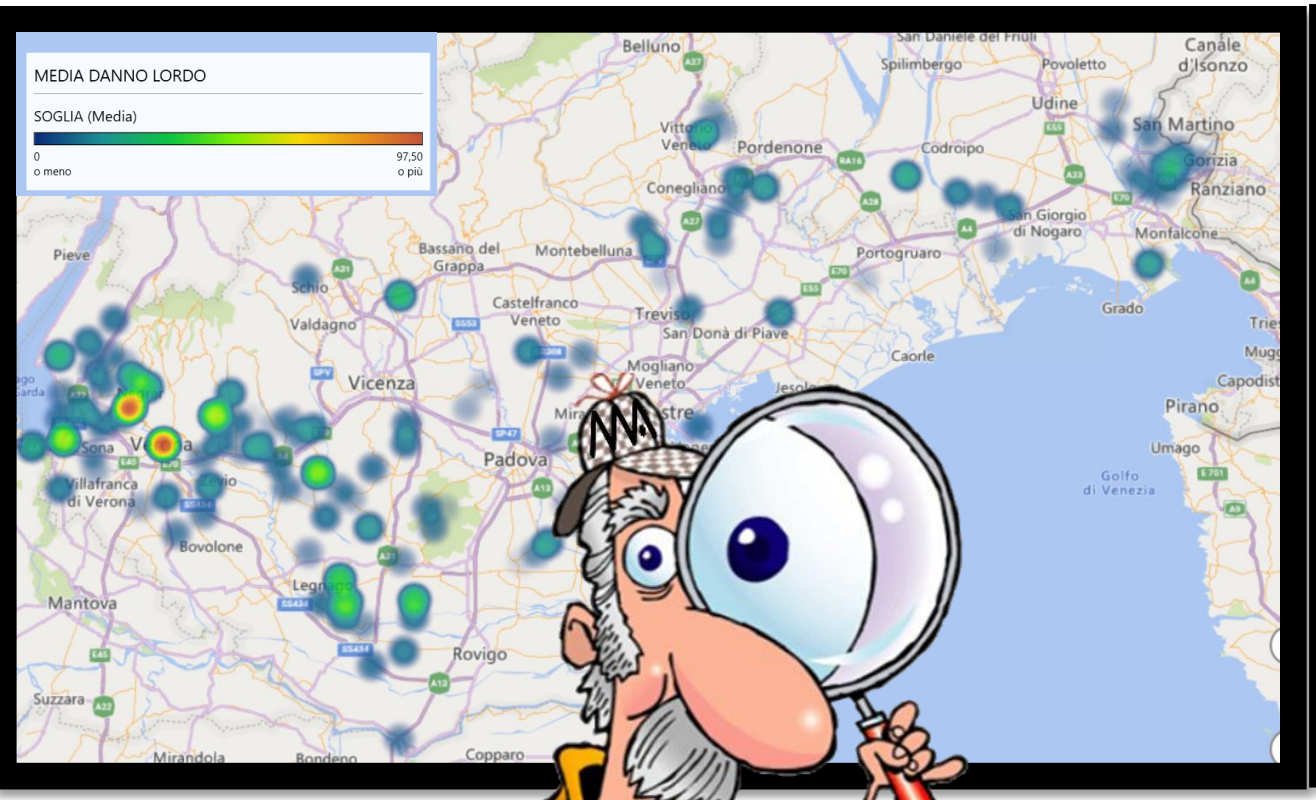


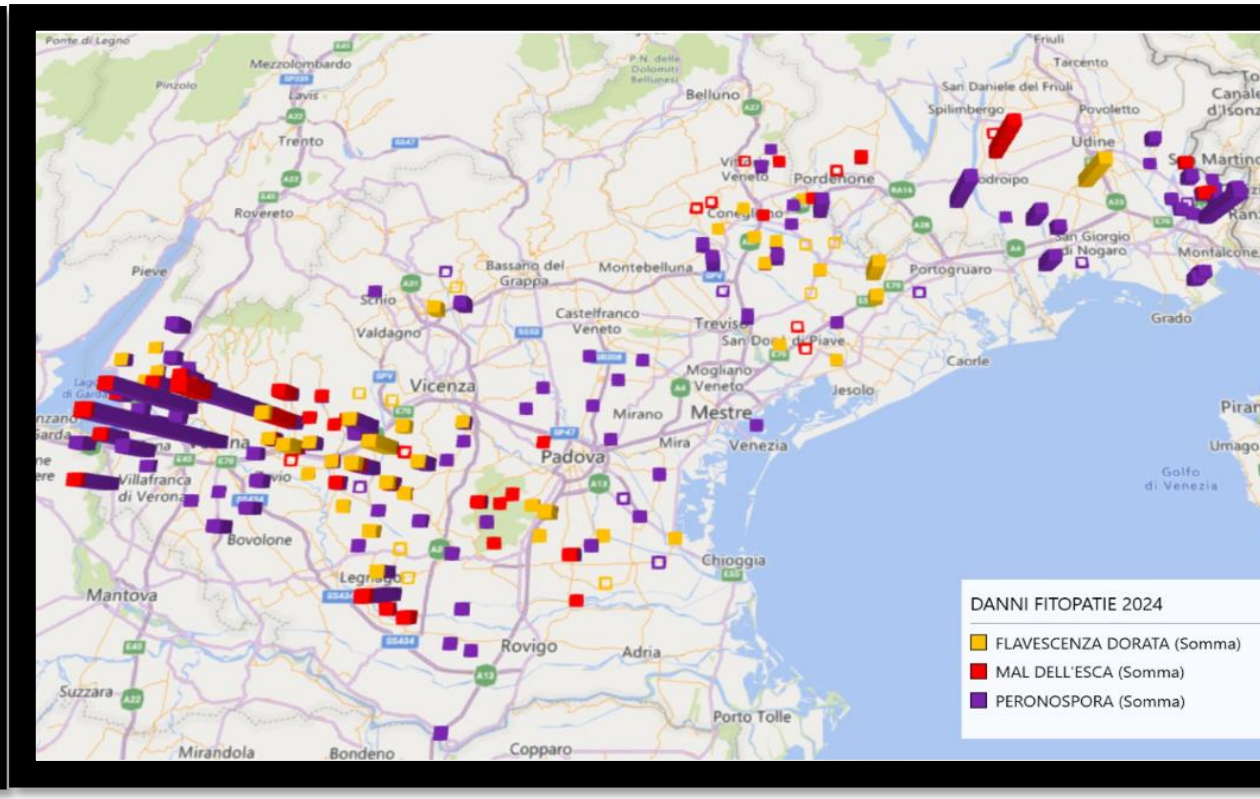
Final Workshop– 24-25 Sept 2025 – WINEGRAPE FUND TREND





Disease distribution during 2024





+ 2500 FIELD EXPERTIES PER YEAR;
+ 300 FARMER'S COMPENSATION PER YEAR;
+ 100 MONITORING POINTS PER YEAR.

Final Workshop– 24-25 Sept 2025 – RISK ASSESSMENT

INTRODUCE RISK ASSESSMENT'S CONCEPT IN FARMS BUSINESS

In addition to these technical aspects related to RISK MANAGEMENT, it is also important to evaluate RISK ASSESSMENT aspects, more focus on the perception of risks within the farm.

The correct valutation of the risk is not always easy, expecially for agricoltural business:

- Weather condition are hystorically the most important to face off;
- Plant diseases are less noticeable but can cause very significant damage;

- There are several factors that lead the farmer to underestimate but the risk is rising:
  - Climate change;
  - Alien insect and new disease;
  - Reduction in chemical molecules;
  - increasing costs;

Improve the knowledge for a correct Risk Assessment is the winning strategies for empowering farmers. The Mutual funds are based the knowledge of the risks and the conscious sharing through the farmers.

Final Workshop– 24-25 Sept 2025 – SHARING KNOWLED AND INNOVATION

AGRIFONDO & CONDIFESA FOLLOW AKIS

RESEARCH & INNOVATIVE TOOLS:

The need to manage uncovered risks has presented Agrifondo with new challenges in DEVELOPS NEW SYSTEM:

- **RADAR METEO;**
- **FENOMETEO;**
- **DSS (BODY).**

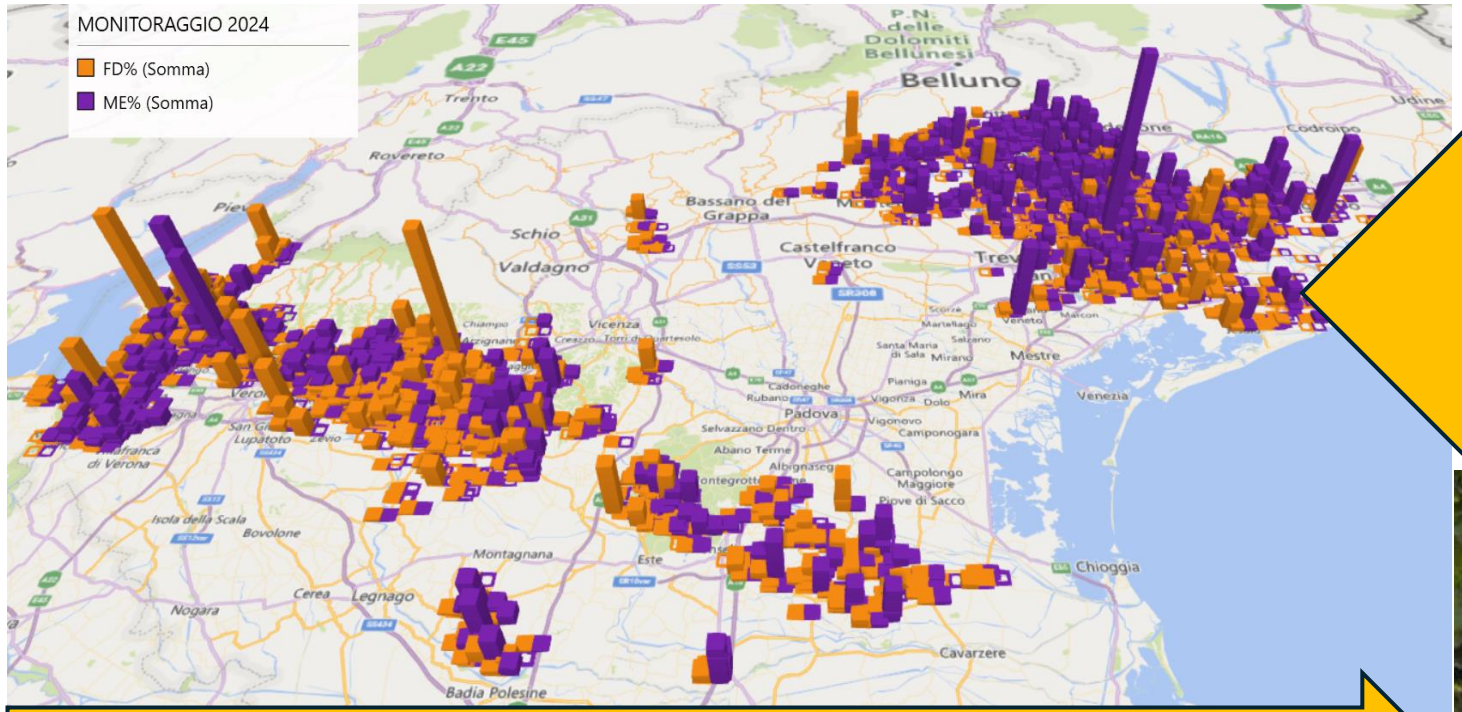
BUILD THE FUNDATION OF MUTUALITY:

In mutual funds, risk is shared among members. The co-responsibility of farmers in complying with Good Agricultural Practices is fundamental.

SHARE TERRITORIAL CONSULTING:

Through the mutual funds' expert team, we have been able to train farmers in the correct application of GOOD AGRICULTURAL PRACTICES.

AGRIFONDO: NOT ONLY FUND!



MONITORING GRAPEVINE YELLOWS

REGIONAL MONITORING WITH GIPS DATAS FOR REGIONAL DATABASE AND TEMPESTIVE DECISIONS.

REGIONAL ASSIGNMENT FOR:

- EXPERTIES FOR VALUTATE WILD ANIMAL DAMEGE.

Final Workshop– 24-25 Sept 2025 – OUR TEAM OF EXPERTIES

TRAINING KNOLEDGE AND CONSULTANCY IN THE TERRITORY

Currently, the Agrifondo Mutualistico Expert Corps comprises over 12 technicians distributed across the two regions. During the agricultural campaign, the technicians participate in refresher and collegial training courses to ensure both a correct assessment of the damage suffered by the farmer and technical advice aimed at addressing any shortcomings in compliance with Good Agricultural Practices.

Thank you for your attention !

Merci pour votre attention !

Contact mail : segreteria@agrifondomutualistico.it

Ce workshop a le soutien financier du Département des Sciences de l'Environnement et du Département CHANGES de l'Université de Bordeaux

3rd Workshop ARRUPVICO

Can insurance help farmers to take the risk of phytosanitary losses?

A time for sharing perceptions on existing initiatives and requirements

L'assurance peut-elle sécuriser la prise de risques des agriculteurs face aux pertes sanitaires des cultures ?

Un temps d'échange sur des initiatives en cours et la perception des besoins.

September 24h 2025 - Bordeaux

Ce workshop a le soutien financier du Département des Sciences de l'Environnement et du Département CHANGES de l'Université de Bordeaux

Rethinking the mutualization of climate risks: how to reinvent collective solidarity in the face of natural hazards

Mathilde Viennot

Haut-commissariat à la Stratégie et au Plan

Session 3 – How can we secure farming practices and mobilize the insurance industry?

Final Workshop– 24-25 Sept 2025

A cross-disciplinary approach to protecting homes from climate change

Numerous reports on the financial challenges and reforms of the Cat Nat system, the rise of climate risks, the lack of adaptation of housing, etc.

Our original approach :

- An analysis of the **climatic and social challenges** posed by global warming to the insurability of housing
- A parallel with the **creation of social security** and how the State covered social risks
- Three scenarios prepared with the support of a **working group** made up of insurers, actuaries, insurance researchers, social protection practitioners, legal experts, social security historians, geographers and others.

→ How could these considerations and models could be applied to other areas affected by global warming and ecological transition, such as agroecology?

A solidarity-based system with major limitations

Difference with agroecology: an insurance system already exists

A system that covers a wide range of risks while keeping premiums quite low

- A **public-private system**, with an insurance-based approach and a state guarantee
  - based on comprehensive home insurance, which is compulsory for tenants
  - two main systems: "Cat Nat" cover, introduced in 1982, and "TGN" cover (Storm, Hail, Snow).
- **Prevention** is **mainly collective**, relying on a multitude of players (mainly public)
- A system that appears particularly **mutualised and supportive** in international comparison

But there are limits for households:

- **Inequalities between contracts and between territories** :
  - incomplete compensation for damage
  - non-insurance in certain territories
  - risks not covered (retreat of the coastline)
  - uncertain cover for other risks (drought)
- **Increased vulnerability** for some households

Climate change, a source of vulnerability for the insurance system

All regions are affected by global warming

- **Growing exposure** to extreme events, rising claims costs (+10 to 20% over the last 40 years)
- **Difficulty in assessing the overall cost of inaction**: variable and uncertain projections to 2050

  Cat Nat: €2.5 - 4 billion / year; TGN: €1 - 1.7 billion / year

Climate change, amplifying the flaws in the insurance market

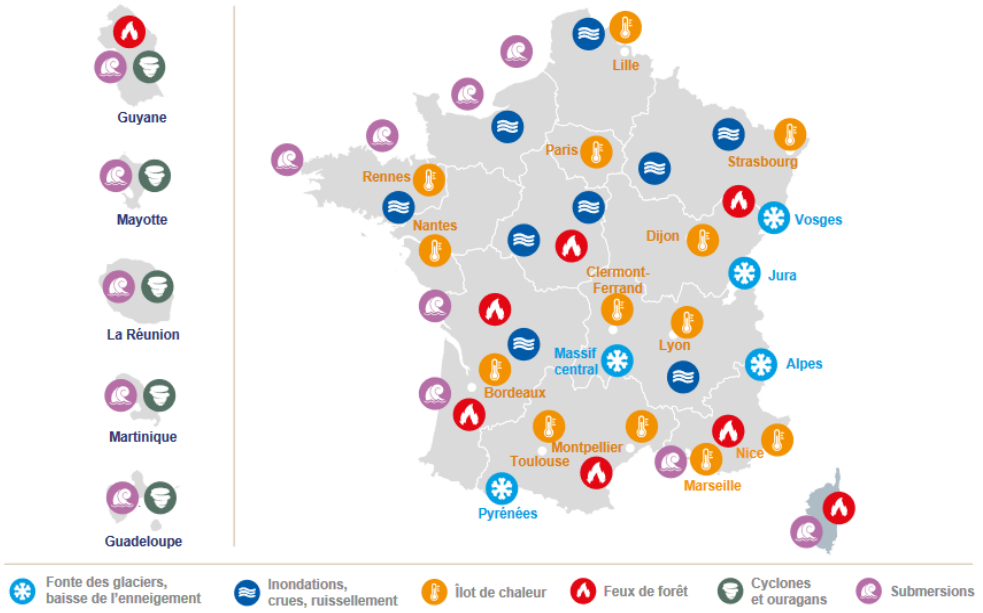
- The risk of **insurers withdrawing from** the market, **premiums rising** and the **quality of** insurance **falling**.

Territorial resilience needs to be questioned

- A **prevention** policy that is **uneven** across regions and risks, and **separate from compensation**

Agroecology:

- **Growing exposure**
- **Market withdraw or incapacity to insure?**
- **Territorial resilience**



Source: Climate Action Network, 2024

A historical parallel with the gradual development of social insurance

Industrialisation and collective responsibility

- Long-standing debates on **responsibility, solidarity and the role of the State** in protection
- **1945 marked** the turning point for **social security**: public, universal and compulsory cover for risks that had previously been left to private initiative.

Are climate risks social risks? The need for a structured public response

- Systemic, unevenly distributed, largely beyond individual control
- **Structural flaws of the insurance market**: uncertainty, long-term horizon, exclusion issues

Towards a "Social Security system for climate risks"? A fundamental political choice

- How can the State intervene?
- Thinking about a **new climate solidarity system**: what we make insurable, how we share the burden of adaptation, what role we give to the State, local authorities and citizens, etc.

Social protection: inspiration for mechanisms (tools, redistribution, contribution, etc.)

How can we invent new forms of mutualization and insurance? A method

Inventing new forms of mutualization and formalizing them in scenarios

- **The objectives of a risk mutualization system**
  - Provide coverage for risks that are uninsurable by the market, either due to the absence of risk or the high cost of insurance.
  - Respond to a principle of solidarity.
  - Contribute to reducing overall risk by integrating prevention, which can define the division between the state and the private insurance market.
  - Defining what constitutes an acceptable risk for the community, beyond which the system is no longer sufficient to provide protection and therefore other areas of public policy must be mobilized.
- **Reflect on the components of mutualization systems**
  - What risks and damages should be covered?
  - What coverage and types of benefits should be provided?
  - Who should be the beneficiaries of the system?
  - Who are the taxpayers and how is the system financed?
  - Who should manage and govern the system?

Remodelling climate risk mutualization: three scenarios

The **first scenario "State regulation of the insurance market":** basic insurance, additional protection against climate hazards, mitigates risks between the private and public insurance markets. The government intervenes in regulating the insurance market and guarantees the insurability of climate risks.

The second scenario **"a climate risks State guarantee" :** extends public reinsurance to every climate risk, erases their exceptional nature. It fully entrusts the State with insuring risks that become uninsurable.

The third scenario **"State insurance of climate risks"**: calls for a complete nationalization (i.e. universal and unified coverage) of climate risks, restorative dimension (introducing an indemnity branch), reinforces prevention (creating a risk prevention circuit and adapting housing to climate risks). Climate-related contributions would replace insurance premiums.

→ **Your turn!**

Thank you for your attention !

Merci pour votre attention !

Contact mail : mathilde.viennot@strategie-plan.gouv.fr

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Contract terms and conditions: what do policyholders prefer?

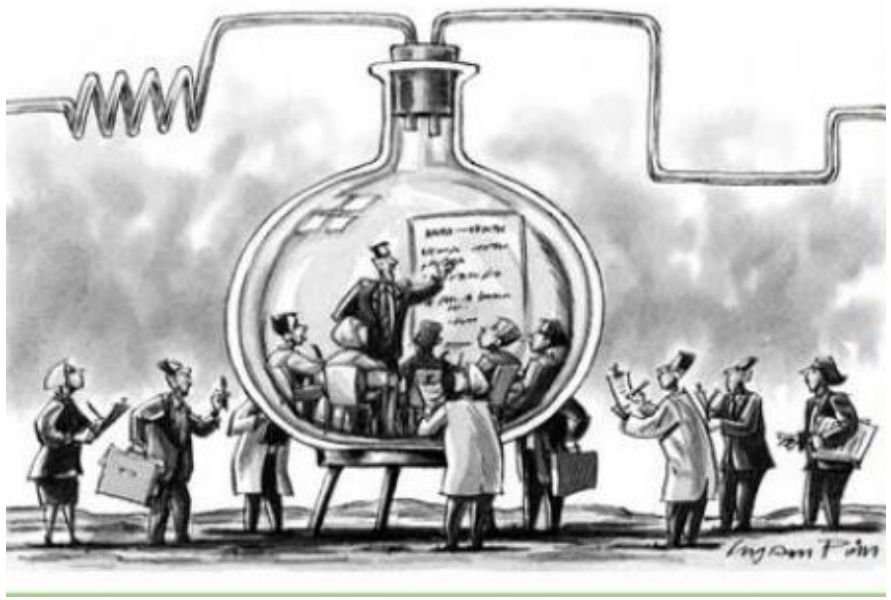
Marianne Lefebvre
Yann Raineau & Cécile Aubert

Session 3: How can we secure farming practices and mobilize the insurance industry?

ARRUPVICO Final Workshop– 24-25 Sept 2025

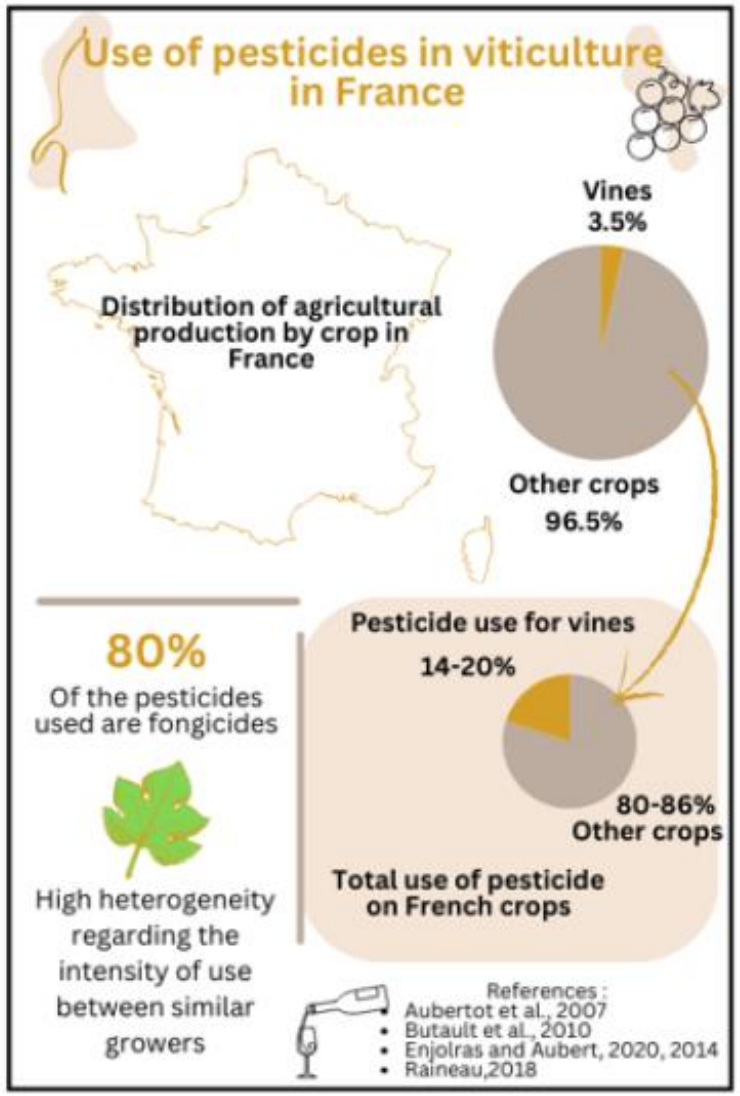
Contract terms and conditions: what do policyholders prefer?

The economist as plumber (Duflo, 2017)



Context

- Ambitious pesticide reduction goals at EU and French level
- Low uptake of alternative pest management strategies
  e.g. Decision Support Systems -DSS- to optimize pesticide use
- Green insurance may be more cost-effective than green payments
  (DeVuyst and Ipe 1999, Baerenklau 2005)



Program under evaluation

- Program aiming at reducing financial risks due to a change in practices against fungal diseases (DSS) in vine growing

- Akin to Best Management Practice insurance

- Currently tested at small scale in a living lab context

We investigate ex-ante the determinants of the uptake at ***larger scale, varying contract features***

Model + Discrete Choice Experiment

Multiple experimental research processes for socio-economic innovations

Living Lab

Intuition & Concept generation
Proximity of real interests and constraints

Experiments conducted

Conditions	Context	Nature of work
Real	Uncontrolled	Partnership, participation

Multiple experimental research processes for socio-economic innovations

Living Lab

Intuition & Concept generation
Proximity of real interests and constraints

Large-scale survey (e.g. Discrete Choice Experiment)

Diversification of modalities
Robustness based on a larger sample

Experiments conducted

Conditions	Context	Nature of work
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Conditions	Context	Nature of work
Hypothetical	Controlled	Research-driven

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Conditions	Context	Nature of work
Hypothetical	Controlled	Research-driven

The VitiREV project

VitiREV: living lab-based project, aiming at environmentally-friendly vineyard

Challenges:

- pesticides, human health & residential proximity
- attractiveness of wine-growing regions
- new varieties resistant to diseases (e.g. mildew), new tastes & impact on consumer demand
- high yield risk related to the adoption of BMPs
- collective organization of production (cooperatives, unions…), routines & behavioral lock-in

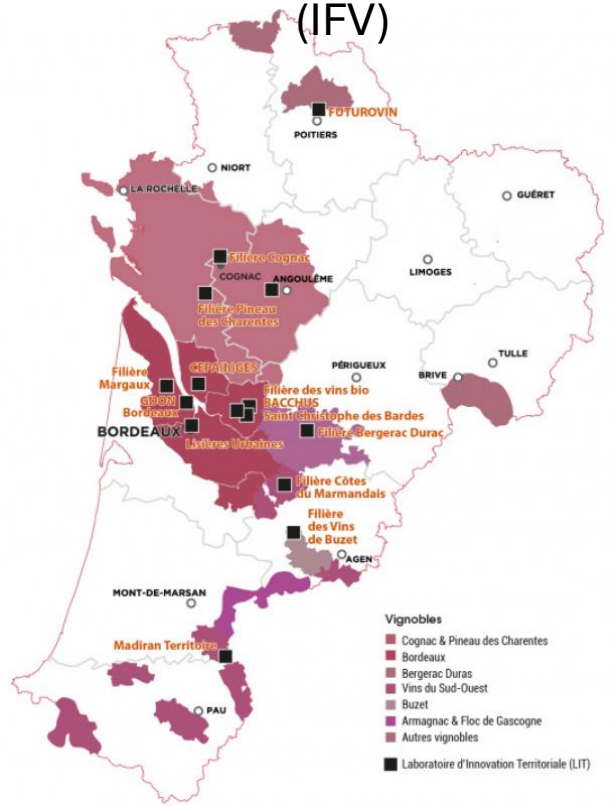
Association between Residential Proximity to Viticultural Areas and Childhood Acute Leukemia Risk in Mainland France: GEOCAP Case-Control Study, 2006–2013

Authors: Matthieu Mancini, Denis Hémon, Perrine de Crouy-Chanel, Laurence Guldner, Laure Faure, Jacqueline Clavel, and Stéphanie Goujon | AUTHORS INFO & AFFILIATIONS

Publication: Environmental Health Perspectives • Volume 131, Issue 10 • CID: 107008 • https://doi.org/10.1289/EHP12634

TREATED UNTREATED

Downy mildew on vine (IFV)

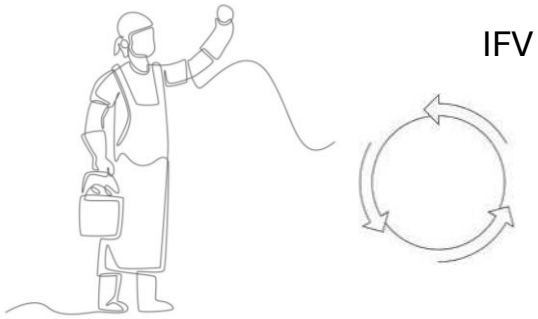


A regional network of 15 Living labs

Living Lab

Intuition & Concept generation
Proximity of real interests and constraints

IFV - R&D Technical Institute



Buzet, Tutiac - 2 Wine Cooperatives

Groupama - Insurance Group

Experiments conducted

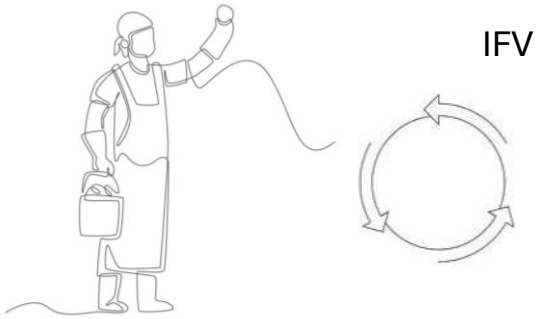
Conditions	Context	Nature of work
Real	Uncontrolled	Partnership, participation

- **Real-condition testing of a combination of an insurable treatment protocol and an insurance contract**, to overcome farmers' lack of confidence in modelling tools

Living Lab

Intuition & Concept generation
Proximity of real interests and constraints

IFV - R&D Technical Institute



Buzet, Tutiac - 2 Wine Cooperatives

Groupama - Insurance Group

Experiments conducted

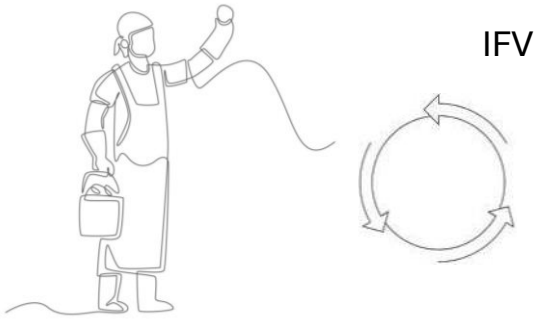
Conditions	Context	Nature of work
Real	Uncontrolled	Partnership, participation

- **Real-condition testing of a combination of an insurable treatment protocol and an insurance contract**, to overcome farmers' lack of confidence in modelling tools
- If producers have biased perceptions regarding the effects of new practices on profits (Feather and Amacher, 1994), green insurance could help them revise them by trying these practices risk-free (Mitchell and Hennessy, 2003; Aubert et al., 2020).
- Compared to agri-environmental schemes (AES), subsidizing green insurance can be more cost-effective since public support is triggered only for actual losses (Baerenklau, 2005).

Living Lab

Intuition & Concept generation
Proximity of real interests and constraints

IFV - R&D Technical Institute



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Conditions	Context	Nature of work
Real	Uncontrolled	Partnership, participation

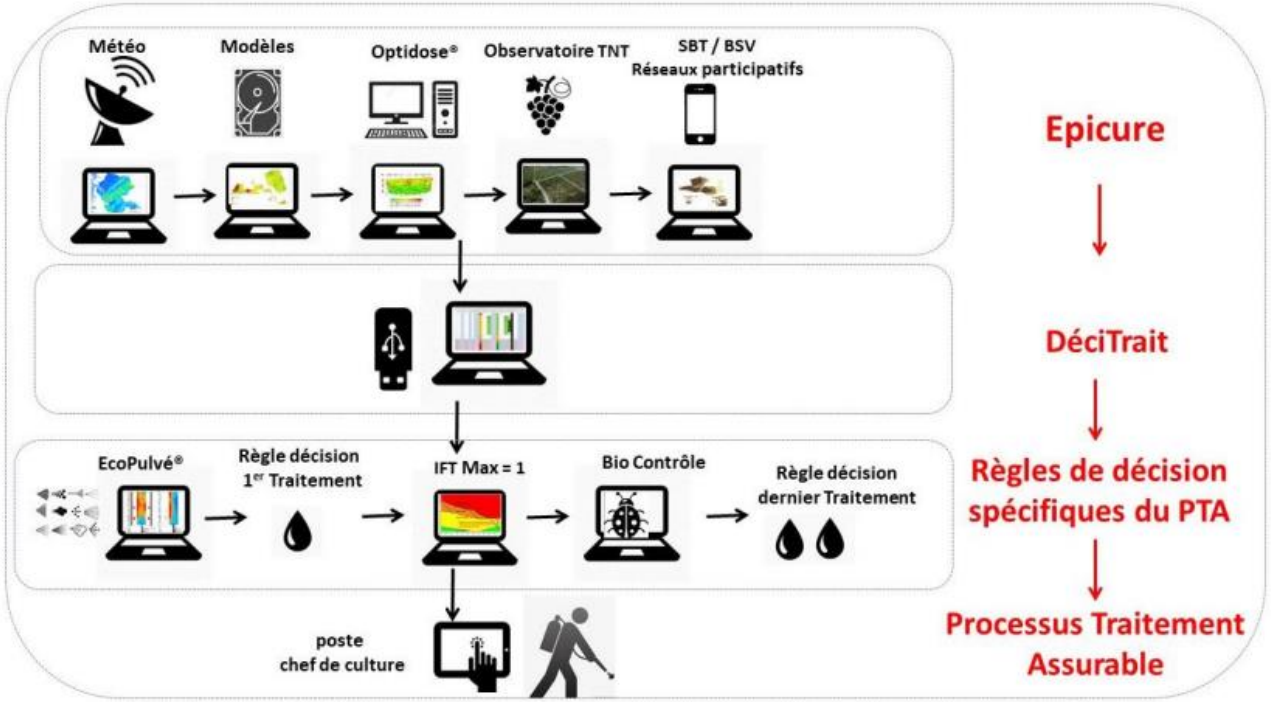
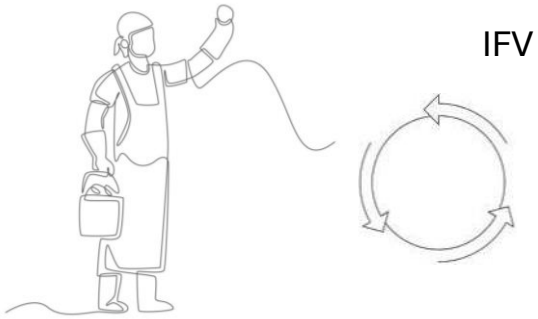


Figure 1 : Architecture du Processus de Traitement Assurable (PTA)

Living Lab

Intuition & Concept generation
Proximity of real interests and constraints

IFV - R&D Technical Institute



Buzet, Tutiac - 2 Wine Cooperatives

Groupama - Insurance Group

Experiments conducted

Conditions	Context	Nature of work
Real	Uncontrolled	Partnership, participation

- Enabling a 30-55% reduction in fungicides between 2019 and 2022

Tableau 3 : Distribution des IFT fongicides en viticulture en Gironde et Lot-et-Garonne en 2019, relevés dans les enquêtes Pratiques culturales

	VITICULTURE CONVENTIONNELLE		VITICULTURE BIOLOGIQUE
	IFT fongicides en Gironde	IFT fongicides en Lot-et-Garonne	IFT fongicides en Lot-et-Garonne
1ER DECILE	**8.8**	**8.2**	3.8
2E DECILE	10.1	8.8	4.8
3E DECILE	11.2	9.3	5.5
4E DECILE	12.2	10.0	**6.3**

Raynal, Marc, Christian Debord, Loïc Davadan, Cécile Aubert, and Yann Raineau. 2024. "Recommend and guarantee: Testing an insurable treatment protocol for reducing pesticide use in vineyards." *Innovations Agronomiques* 96:74-87. https://dx.doi.org/10.17180/ciag-2024-vol96-art06

Aubert, Cécile, Yann Raineau, and Marc Raynal. "Learning about best management practices: Theory and experimentation under the umbrella of crop insurance". *Working Paper*.

Living Lab

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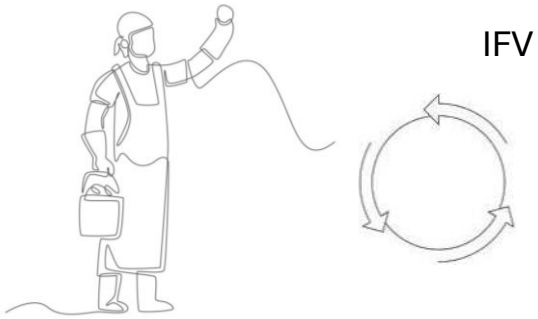

Buzet, Tutiac - 2 Wine Cooperatives

Groupama - Insurance Group

Experiments conducted

Conditions	Context	Nature of work
Real	Uncontrolled	Partnership, participation

- And finally generating learning for all parties (and a reduction in costs) – more acres engaged, and organic conversion

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Experiments conducted

Living Lab

Intuition & Concept generation
Proximity of real interests and constraints

Conditions	Context	Nature of work
Real	Uncontrolled	Partnership, participation

Large-scale survey (e.g. Discrete Choice Experiment)

Diversification of modalities
Robustness based on a larger sample

Conditions	Context	Nature of work
Hypothetical	Controlled	Research-driven

European Review of Agricultural Economics Vol **51 (5)** (2025) pp. 1201–1272
doi:https://doi.org/10.1093/erae/jbaf002
Advance Access Publication 12 February 2025

Green Insurance for Pesticide Reduction: Acceptability and Impact for French Viticulture

Marianne Lefebvre[†,*], **Yann Raineau**[‡,§], **Cécile Aubert**[§,††,‡‡], **Niklas Möhring**[§§], **Pauline Pedehour**[†], **Marc Raynal**[†††]

[†]*Univ Angers, GRANEM, SFR CONFLUENCES, F-49,000 Angers, France;* [‡]*INRAE, ETTIS, F-33,612 Cestas, France;* [§]*Univ. Bordeaux, CNRS, BSE, UMR 6060, F-33,600 Pessac, France;* [††]*Toulouse School of Economics (TSE);* [‡‡]*GAEL, U. Grenoble Alpes;* [§§]*Production Economics Group, University of Bonn;* [†††]*Institut Français de la Vigne et du Vin (IFV), UMT SEVEN*

Abstract

Green insurance can help producers manage the risks of transitioning to more environmentally friendly practices. We investigate the uptake determinant and potential pesticide reduction in the viticulture sector, a major pesticide user, using a choice experiment with 412 French growers. Correcting for sampling bias, we find that between 48 per cent and 60 per cent (depending on contract features) are likely to take up green insurance. The insurance offers compensation for yield losses caused by the failure to contain diseases of a Decision Support System targeting pesticide reduction. We find an average 45 per cent reduction in fungicide use for adopters and conclude that green insurance can be a cost-effective tool for achieving the EU's ambitious pesticide objectives.

Keywords: choice experiment, pesticides, viticulture, insurance, decision support system, integrated pest management, index, mutual fund

JEL codes: Q18, Q14, D81, C99

Living Lab

Large-scale survey (e.g. Discrete Choice Experiment)

- Survey administered online to 20,000 winegrowers (on some 59,000 winegrowing farms in France)
- 412 complete answers (2%)

Table 4. Sample characteristics

Variable	Description	Sample mean	Population
Vine growers characteristics			
Age	Years old	49.46	46.50
Gender	1 = male, 0 = female	0.876	0.781
Seniority	Years of work in vines	23.3	
Education in viticulture	1 = Yes, 0 = No	0.767	0.92
Vineyards characteristics			
Land size (vineyard)	Hectares	45.8	22.1
Ownership of the vineyard	1= Yes, 0 = No	0.752	
Protected indication (see Note 1)			
Protected denomination of origin (AOP/AOC)	1 = Yes, 0 = No	0.90	0.46
Protected geographic indication (IGP)	1 = Yes, 0 = No	0.37	0.28
Other	1 = Yes, 0 = No	0.20	0.08
Collective implication			
Member of a cooperative	1 = Yes, 0 = No	0.422	0.58
Collective score (see Note 2)	between 1 and 5	1.11	
Certification (see Note 3)			
Organic farming	1 = Yes, 0 = No	0.269	0.17
In conversion towards organic farming	1 = Yes, 0 = No	0.061	
Other (High Environmental Value, Terra Vitis)	1 = Yes, 0 = No	0.517	0.3
None of these certifications	1 = Yes, 0 = No	0.153	

Living Lab

Large-scale survey
(e.g. Discrete Choice Experiment)

Decisions

Decision to **subscribe to a green insurance contract** (before April)

For all the vine area on the farm

A DSS included into the scheme provides treatment recommendations

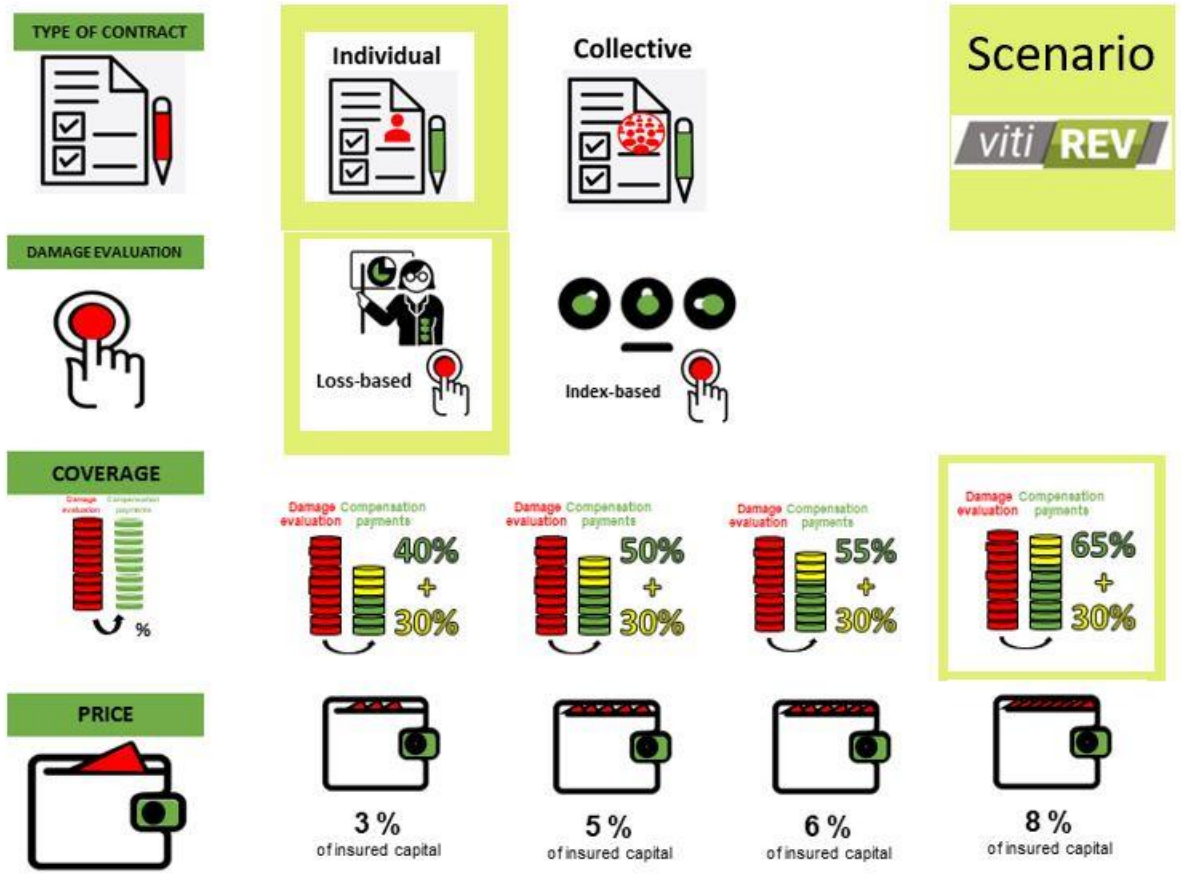
Decision to follow (or not) DSS recommendations throughout the year

Harvest time: in case of yield losses due to fungal disease, **a payment is triggered**

The amount depends on the insured capital, damages compared to the guaranteed yield **and the compliance with DSS (subsidized bonus) – NEW!**

Living Lab

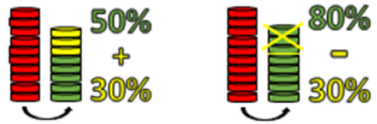
Large-scale survey
(e.g. Discrete Choice Experiment)

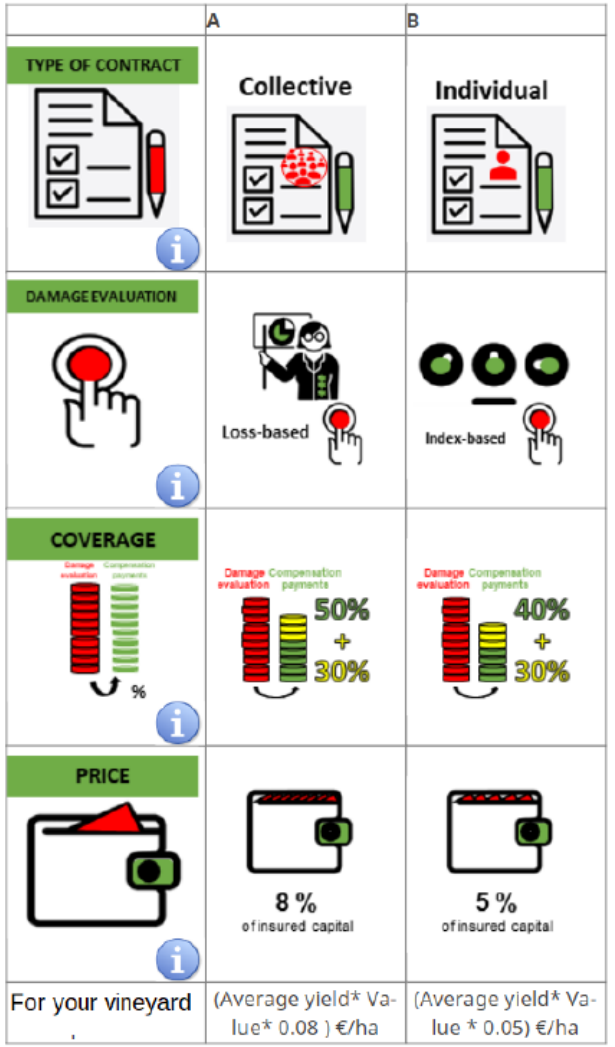


Living Lab

Large-scale survey (e.g. Discrete Choice Experiment)

- Bayesian D-efficient design
  4 choices per respondent x 6 blocks
- 2 Between-subject treatments Bonus/Malus

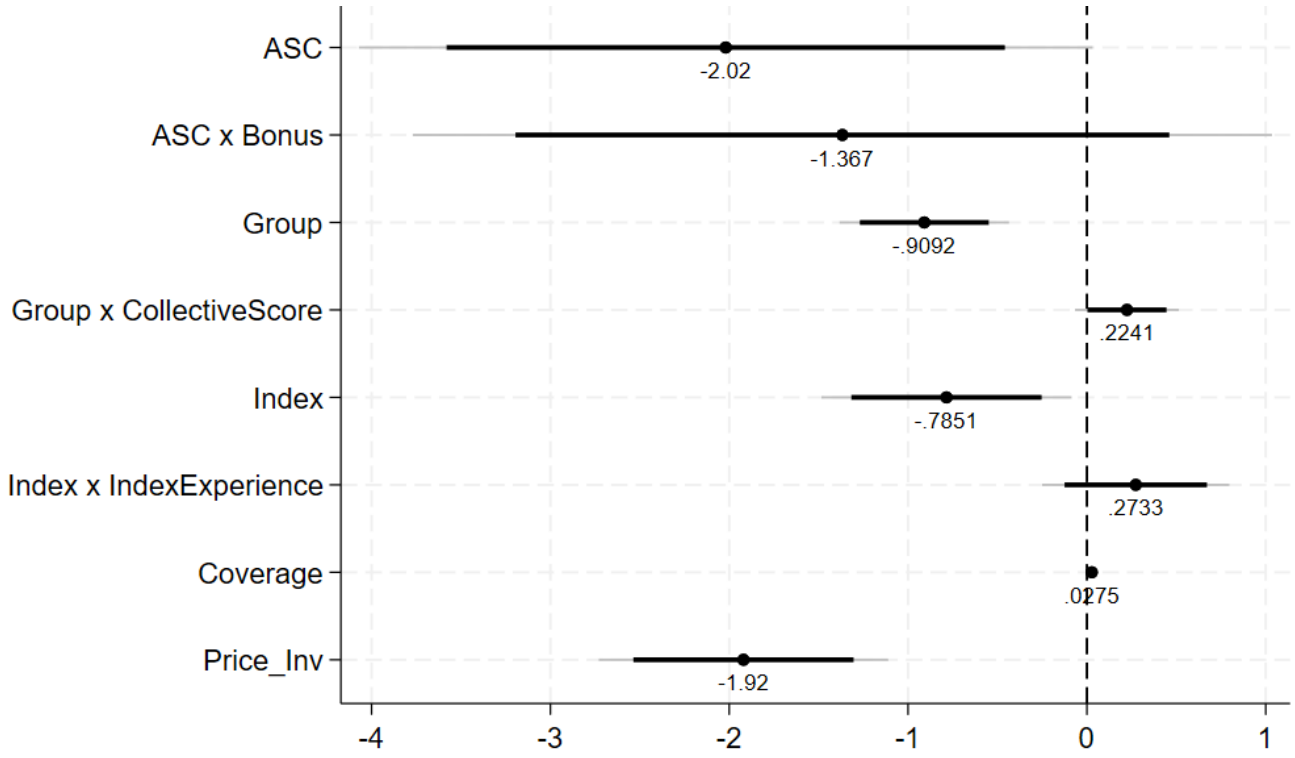




	A	B	None
My choice	o	o	o

Living Lab

Large-scale survey (e.g. Discrete Choice Experiment)



Living Lab

Large-scale survey (e.g. Discrete Choice Experiment)

Table 4: Latent class: Probability to subscribe to green insurance

	Class 1 (60%)	Class 2 (40%)
ASC	-1.587***	0.631
	(-5.64)	(0.62)
Group	-0.430***	-0.151
	(-5.69)	(-0.34)
Index	-0.294***	-0.430
	(-4.17)	(-1.03)
Coverage	0.0192***	0.00203
	(3.79)	(0.10)
Price	-0.0982***	-0.535***
	(-3.96)	(-3.83)
Probability to belong to class 1		
Organic	0.929**	
	(2.74)	
Organic_transition	2.293***	
	(3.38)	
Other certification	0.911**	
	(2.95)	
Sanitary strategy	0.348**	
	(2.77)	
Constant	-1.354**	
	(-3.03)	
N	4944	

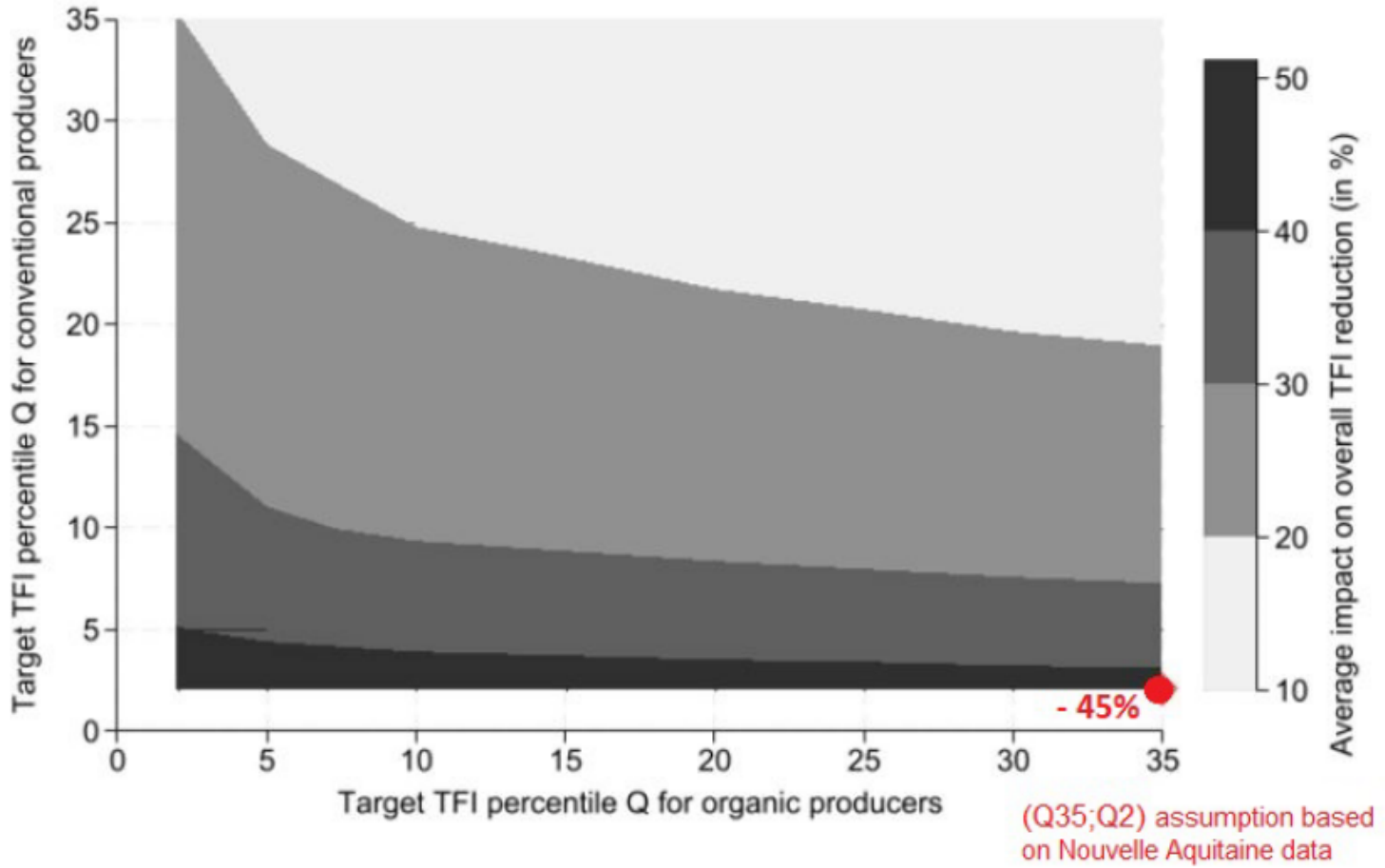
t statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

Living Lab

Large-scale survey
(e.g. Discrete Choice Experiment)

A.4: Sensitivity analysis: Impact of green insurance on TFI reduction at the population level, according to DSS environmental performance



In brief

Living Lab

Large-scale survey (e.g. Discrete Choice Experiment)

- 48-60% of the vine growers are likely to subscribe to green insurance (depending on contract design and prices)
- Low interest of growers for index and group contracts, despite interest of insurers
- Limited windfall effects: 23% of the adopters have null TFI reduction potential, not more than non-adopters
- Producers transitioning to organic certification are more interested in green insurance
- Non-marginal contribution to pesticide reduction objectives

- **...But also some fundamental opposition by some!**

Lefebvre, Marianne, Yann Raineau, Cécile Aubert, Niklas Möhring, Pauline Pedehour, Marc Raynal, "Green Insurance for Pesticide Reduction: Acceptability and Impact for French Viticulture", *European Review of Agricultural Economics*, https://doi.org/10.1093/erae/jbaf002

Pedehour, Pauline, Cécile Aubert, Marianne Lefebvre, Juliette Morel, Yann Raineau. Organizational innovation for the reduction of phytosanitary products: feedback from French winegrowers. *Working Paper*.

Multiple experimental research processes for socio-economic innovations

Experiments conducted

Living Lab

Intuition & Concept generation
Proximity of real interests and constraints

Conditions	Context	Nature of work
Real	Uncontrolled	Partnership, participation

Large-scale survey (e.g. Discrete Choice Experiment)

Diversification of modalities
Robustness based on a larger sample

Conditions	Context	Nature of work
Hypothetical	Controlled	Research-driven

Next step?...

Experimentation in a controlled context (e.g. Randomized Controlled Trial)

Real impact assessment
Public policy perspective

Conditions	Context	Nature of work
Real	Controlled	Research-driven

Conclusion

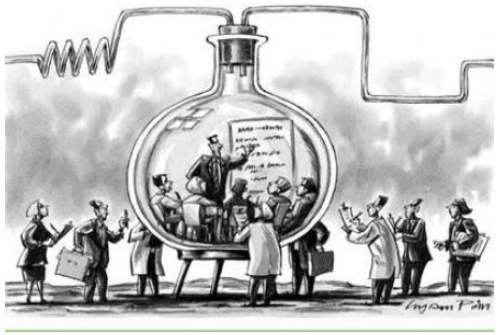
Multiple experimental research processes for socio-economic innovations

- “Agro Living labs”:
  - Identification of key parameters of existing socio-technical systems
  - Preliminary discussions with stakeholders to better define contract modalities to be tested through large-scale experiments/surveys
  - Development of the trust necessary for interdisciplinary experimental approaches
  - A network to facilitate fieldwork, pilot projects, and close ties with local authorities

- For social sciences in general, analysis of new forms of governance, participation, and (re)negotiation between territorial actors.

Thank you for your attention !

The economist as plumber (Duflo, 2017)



Contact mail : marianne.lefebvre@univ-angers.fr

Ce workshop a le soutien financier du Département des Sciences de l'Environnement et du Département CHANGES de l'Université de Bordeaux

3rd Workshop ARRUPVICO

Can insurance help farmers to take the risk of phytosanitary losses?

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September 24th 2025 - Bordeaux

Ce workshop a le soutien financier du Département des Sciences de l'Environnement et du Département CHANGES de l'Université de Bordeaux

Incentive insurance contracts to foster the ecological transition

Cécile Aubert

Bordeaux School of Economics, U. Bordeaux

Session 3. How can we secure farming practices and mobilize the insurance industry?

Final Workshop– 24-25 Sept 2025

Main argument

Partly based on ‘Learning about best management practices: Theory and experimentation under the umbrella of green insurance’, with Yann Raineau and Marc Raynal (forthcoming ERAE).

- Among the obstacles to the ecological transition: Many agroecological innovations and Best Management Practices (BMP) are validated by experts as effective...

… Yet farmers do not adopt them.

- Financial, technical, behavioral barriers to innovation adoption. Here focus on uncertainty: New tools and practices involve risk.
- ‘Green’ decision-support systems (DSS) are built to minimize this risk.

But their ‘quality’ (especially in terms of adequacy to a specific context) is unknown.

⇒ New source of risk.

⇒ Potential role for insurance.

⇒ Study benefits and limits of insurance to foster experimentation.

Main argument

- We study a *theoretical model* of experimentation and learning about the quality of a DSS that reduces spraying but involves a risk of losses due to pests and diseases.
- BMPs require more adjustments to conditions than conventional agriculture ⇒ Value of data-based advice (Decision Support System, DSS), but one cannot assess the quality of the recommendations without trying them.

- *Insurance can be a facilitator*, allowing farmers to experiment and assess the suitability of new practices and tools in their specific case.
- However, agricultural timelines ⇒ Learning can be very slow: over a cultivation period ⇒ No law of large numbers. No reason for beliefs to converge quickly towards the actual underlying distribution.
- Due to this, order effects matter.

Different types of data and information

Climatic data: Largely public and verifiable (reliable sources) ⇒ It can be used to condition a contract. Some features are common to many farms, others are more local (idiosyncratic risk, e.g., hail).

Pest-related data: Pest pressure, attacks, losses. Much more difficult to evaluate. Control plots provide measures of general pest pressure, but losses come from multidimensional contexts and may be difficult to assess even for experts ⇒ If used in a contract, judicial uncertainty may add to the inherent ecological uncertainty.

Expert recommendations (humans or digital tools): can be made verifiable and used in a contract. Farmer's compliance is partly verifiable (moral hazard?). Consequences of recommendations are unknown at first ⇒ Model uncertainty.

General structure

DSS-processing implies new risk
(≠ Plain data)

Data related to **θ**
(farming environment, climate)

DSS-processing, quality ***q***(*F*)

Recommendations σ

Farmer

Do not follow

No learning

Follow / Experimentation

Learning on *q*
Feedback *F* on model

- A farmer can either
- - cultivate ‘as usual’ (‘conventional’),
- - or follow DSS recommendations (reduced spraying).
- The source of risk and need for learning: the DSS can fail (= miss situations where spraying is needed). This happens with unknown probability 1 – q.
- Learning about q is slow:

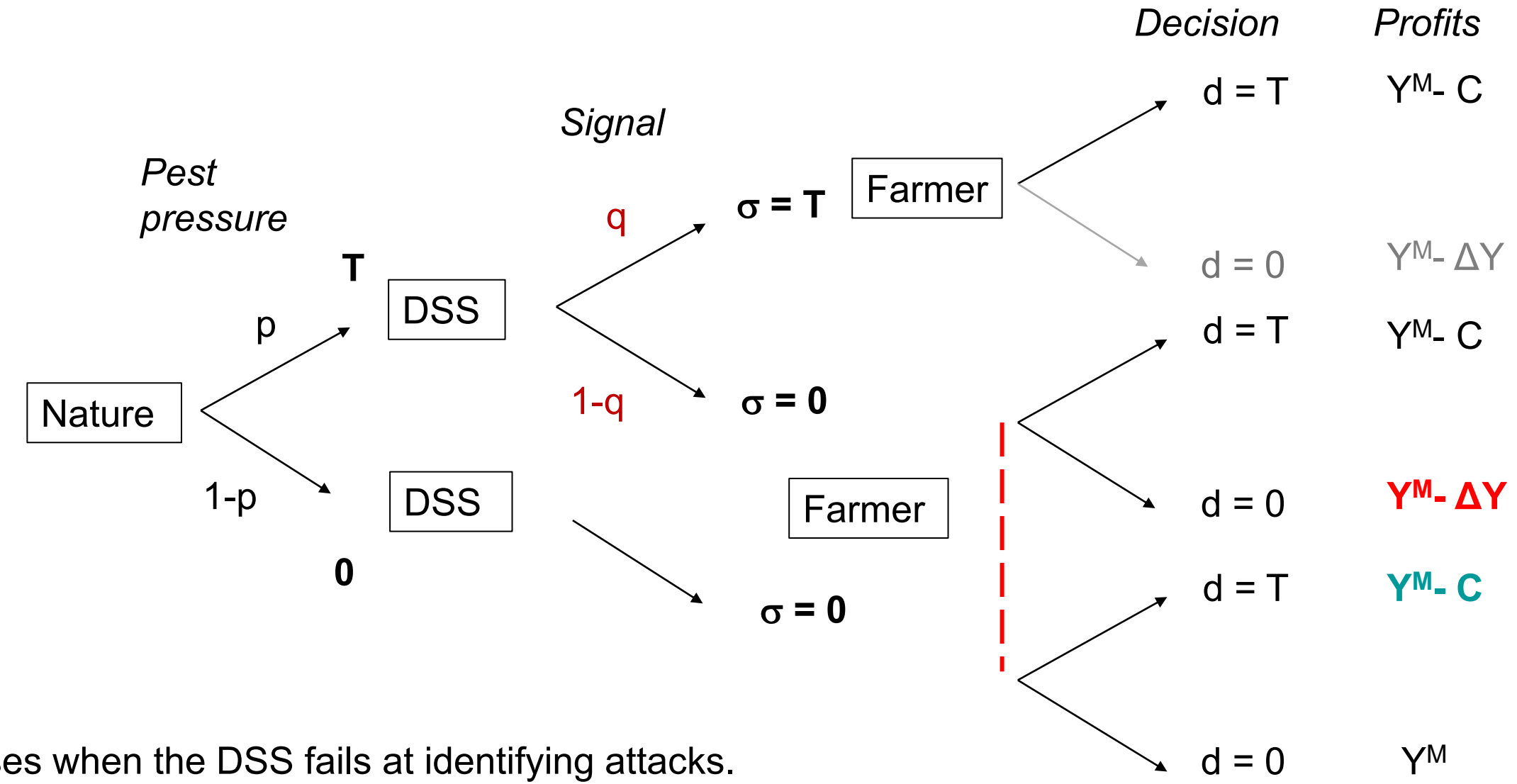
- Pest management: impossible to experiment on small area (contrary to new seeds)

- Fixed cost of DSS (including labor): idem.

⇒ Learning along the timeline of cultivation

+ Experimentation is necessarily discrete.

The informational structure



Risk of losses when the DSS fails at identifying attacks.

The model

Precision q is either

$\overline{q}$ (high) with proba. ν

or $\underline{q} = \overline{q} - \Delta q$ (low).

Expected quality $\mathbb{E}_\nu q = \nu\overline{q} + (1-\nu)\underline{q}$.

- Bayesian updating, once per cultivation period.
- Low-pest pressure situations are uninformative. Learning occurs with proba. p.

Result (Equilibrium)

Follow DSS if and only if expected q high enough:

$$\mathbb{E}_\nu q \geq \hat{q}(\nu) \equiv 1 - \frac{(1-p)C}{p(\mathcal{L}(\Delta Y) - C)}$$

where $\mathcal{L}(.)$ measures the utility loss from crop losses.

The facilitating role of insurance

- Consider a green insurance that pays indemnities I in case of losses, only if the farmer has followed the DSS (premium ωI).
- Then the farmer experiments (= follows the DSS) if

$$\mathbb{E}_\nu q \geq \hat{q}^I(\nu) \equiv 1 - \frac{C - w^I}{p(\mathcal{L}(\Delta Y - I) - C)} \quad \text{where} \quad \hat{q}^I(\nu) \leq \hat{q}(\nu)$$

$\Rightarrow$ Insurance allows experimentation for more pessimistic beliefs.

- It may enable the continuation of experimentation even after relatively bad first results.
- However order effects are crucial, as beliefs do not quickly converge towards the true value of q.

The dynamics of learning

No law of large numbers.

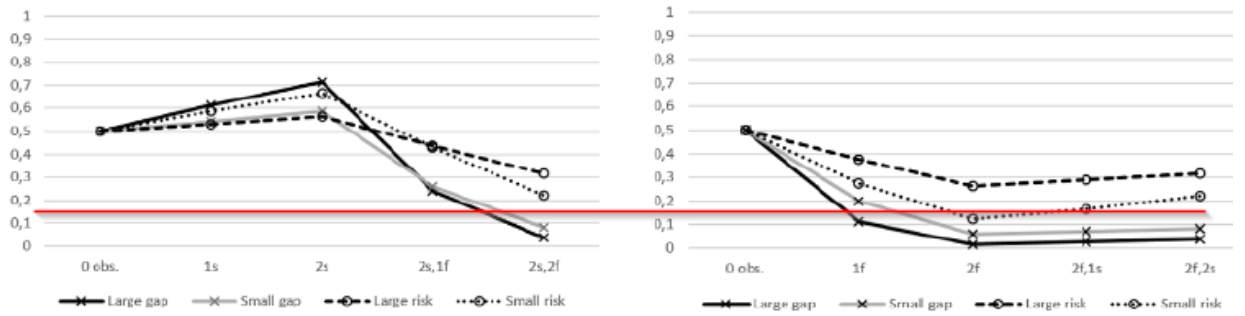
- The sequence of observations matters (not only the frequency of successes).

- Asymmetrical impact of rare occurences (by construction, the DSS is only attractive if failures are rare, and rare events modify beliefs more than common ones).

- Strong path-dependence.

- An indemnity *I* may induce experimentation for a few periods, then stop being sufficient.

Only for illustration:



If threshold = red line, experiment for small risks when successes 1st, stop if failures 1st.

The VitiREV APREM experiment in Buzet and Tutiac

- The VitiREV APREM experiment in Buzet and Tutiac:

4 campaigns (2019 to 2022)

2019-2021: very successful despite difficult conditions: Losses < 5%, pesticide reduction > 30%.

2022: 1 DSS failure (despite low pest pressure): 80% losses on 20ha.

- Cooperatives would not have tried the DSS without insurance.

Indications of learning about the DSS quality:

- Cooperatives insisted on no deductible in 1st year

... But *accepted a 5% deductible* in later years.

- The insurer computed a minimum premium for viability in 2019

... and *divided it by half* in 2022.

Complements and future research…

- **Loss aversion and regret aversion** slow experimentation. Insurance however helps by reducing the weight of yield losses. Particularly helpful for winegrowing, where there is a clear reference point.
- **Index insurance?** Helps with moral hazard but not with incentives to experiment, as possibility to sell one's crop even if indemnified + Which index for pests and disease?
- **Collective insurance** contract as a solution to the "produce loss" issue:

Growers do not value money and produce in the same way (reputation, personal values, buyer requirements…). Worse in developing economies.

⇒ Construct a collective contract where one grower experiments but all share both the potential insurance indemnity and the produce obtained at the end of the season? (in contexts where feasible under IGP rules).

Better than individual contract as obtain produce even if green method fails,

Better than informal mutual insurance as third-party insurer is better able to smooth returns.

?....

Thank you for your attention !

Merci pour votre attention !

Contact: Cecile.Aubert@u-bordeaux.fr

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September 25th 2025 - Bordeaux

Ce workshop a le soutien financier du Département des Sciences de l'Environnement et du Département CHANGES de l'Université de Bordeaux

Assessing the effects of spring precipitation on downy mildew and grapevine yields in France

Cláudia Mendes[1], David Makowski[1], François Brun[2]

[1] INRAE AgroParisTech University Paris-Saclay, UMR MIA
[2] ACTA – French Agricultural Technical Institutes
with the support of M. Raynal (IFV) & M. Fermaud (INRAE SAVE)

Session 4: Modelling the risks and yield losses associated with lower inputs

Final Workshop– 24-25 Sept 2025

Importance of grapevine cultivation

- Grapevine (*Vitis vinifera*) cultivation is economically and culturally vital in France and across Europe
- Yields directly affect the quantity and quality of wine production
- High interannual yield variability threatens vineyard profitability and long-term sustainability
- Spring is a vulnerable period for grapevines

Spring precipitation

Physiological role

- Supports budburst to flowering, aiding nutrient uptake and cluster formation.

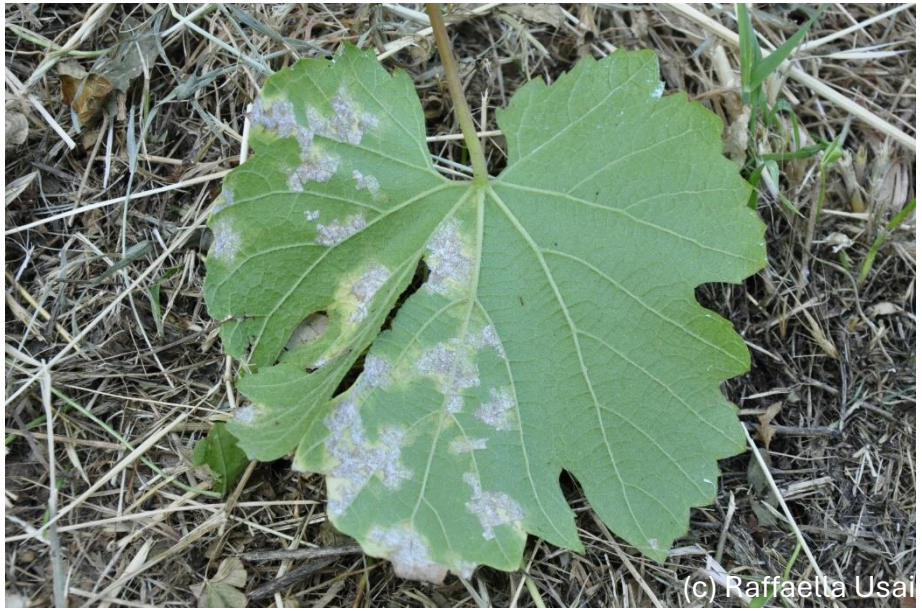
However, excess rainfall…

- Damages fruits and hinders photosynthesis
- Increases canopy wetness, fostering disease outbreaks
- Disrupts soil structure, enhancing runoff and erosion

Heuvel & Centinari 2021, Jones et al. 2015, Ramos et al. 2009, Salinari et al. 2006

Downy mildew concerns

- Downy mildew (*Plasmopara viticola*)
- One of the most destructive grapevine diseases worldwide causing:
- Leaf and fruit damage
- Defoliation
- Reduced sugar content and wine quality
- Crop losses up to 100% under epidemic conditions



- Thrives in warm, humid, and wet conditions

Weitbrecht et al.. 2021, Thind et al. 2004

Questions

1. What are the effects of high precipitation (HP) on grapevine yield losses?

2. What are the effects of HP on downy mildew pressure?

3. Is the effect of high spring precipitation on yields partly due to downy mildew pressure?

How to estimate the effects of HP?

Biased estimates – Risk of confounding

How to estimate the effects of HP?

Advanced statistical methods

Inverse Probability Weighting (IPW)

Model predicts the probability of the event as a function of the confounding factors

Standardization

Model predicts yield as a function of both the event and confounding factors

Double robust

Relies on both model types combined together

Linear Mixed-Effects Models (LME)
Generalized Boosted Models (GBM)

Methodology: Mendes et al. 2025

How to estimate the effects of HP?

Double robust approach

1. **Yield under HP**

$$A = \frac{1}{N} \sum \left[g(1, X_{ij}) + \frac{HP_{ij}}{\pi_{HP_{ij}}} (Y_{ij} - g(1, X_{ij})) \right]$$

2. **Yield under no HP**

$$B = \frac{1}{N} \sum \left[g(0, X_{ij}) + \frac{1 - HP_{ij}}{1 - \pi_{HP_{ij}}} (Y_{ij} - g(0, X_{ij})) \right]$$

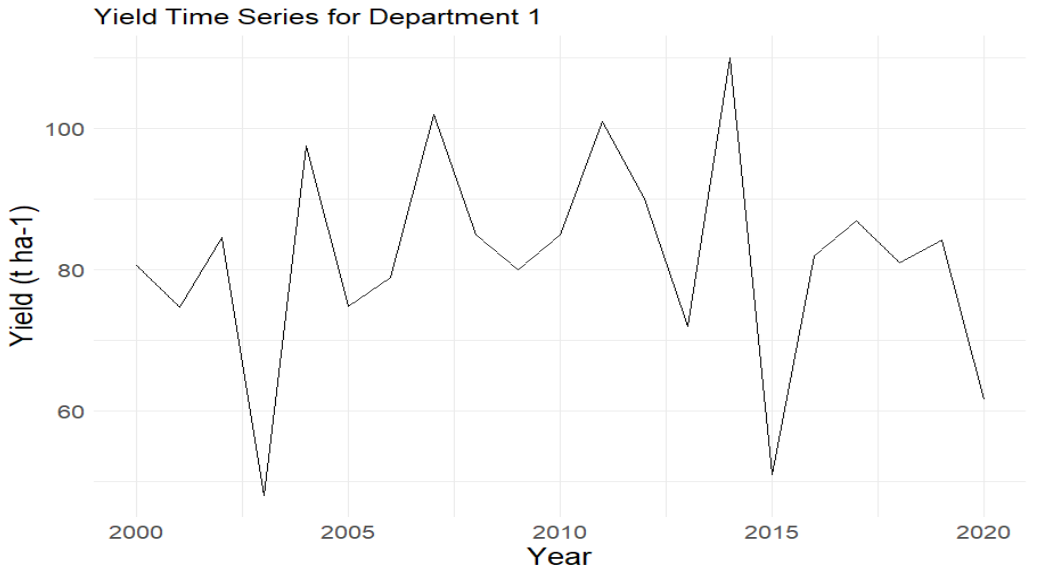
3. **Average Treatment Effect (ATE)**

$$\text{ATE} = A - B$$

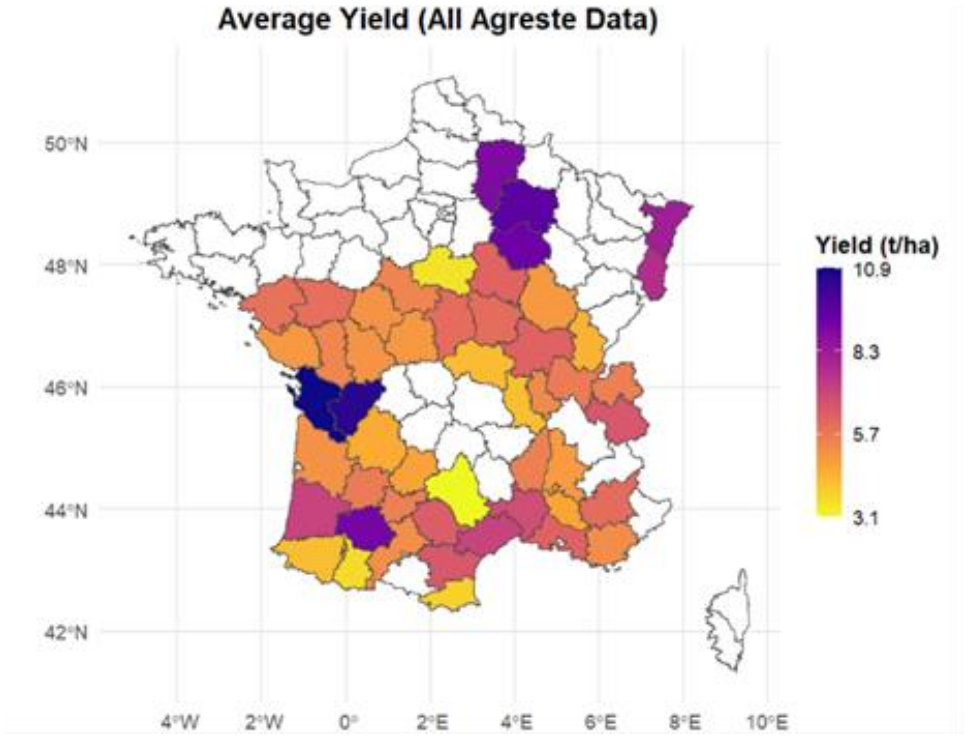
- HP_{ij}: binary indicator of high precipitation for department *i*, year *j*
- Y_{ij}: observed log yield
- X_{ij}: covariate vector
- $\pi_{HP_{ij}}$: predicted probability of HP
- $g(HP, X_{ij})$: predicted yield under HP / non-HP

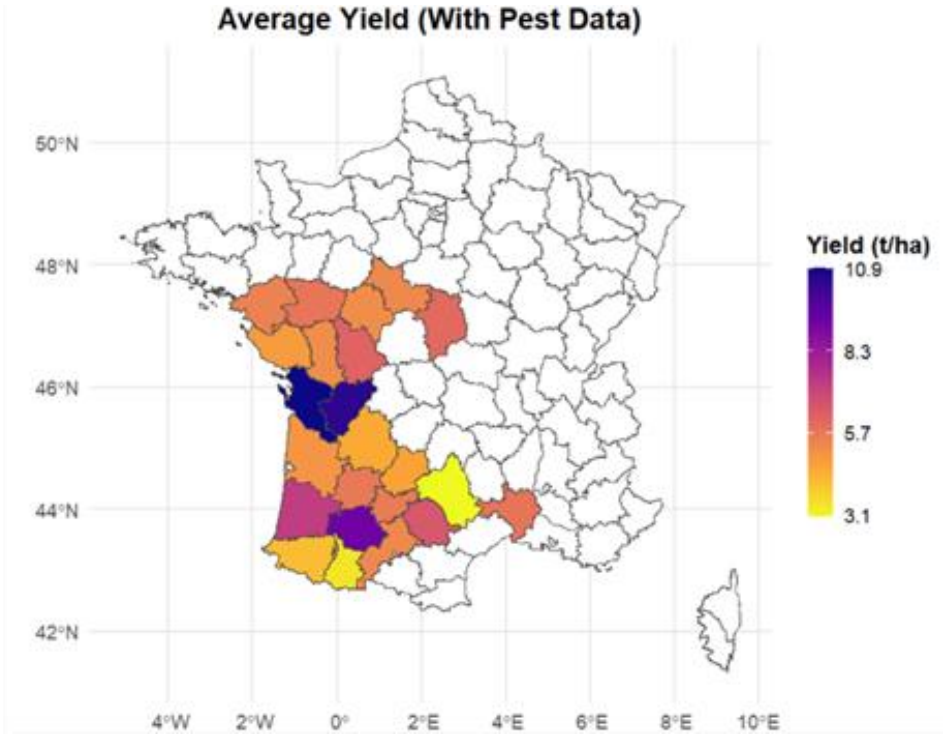
Methodology: Mendes et al. 2025

Data : grapevine yield data



Yield time series (2000-2023) per department





Source: Agreste

Diseases Data

Disease frequency (percentage of infected leaves among all leaves observed)

Disease severity (percentage of total leaf surface affected)

Source: Institut Français de la Vigne et du Vin (IFV)

Weather Data

Monthly covariates (2000-2023) per department

- **Precipitation**
- **Evapotranspiration**
- **Visible radiation**
- **Maximum temperature**
- **Number of days with Tmax > 30ºC**
- **Soil Wetness Index**

Source: SAFRAN

Final dataset

Identifying HP events

Based on the **top 20%**
monthly average precipitation
of each department

High precipitation (HP) binary variable calculated for each month and department between January-September

Example

- **80th percentile is calculated using all May values (2000–2023)** for each **Department** individually.
- For **each department-year**, the value of May precipitation is compared to the **department-specific 80th percentile**.
- If that year's May value is equal to or exceeds the 80th percentile,

  HP = 1;
  otherwise, HP = 0.

Source: SAFRAN

Questions

1. **What are the effects of high precipitation (HP) on grapevine yield losses?**

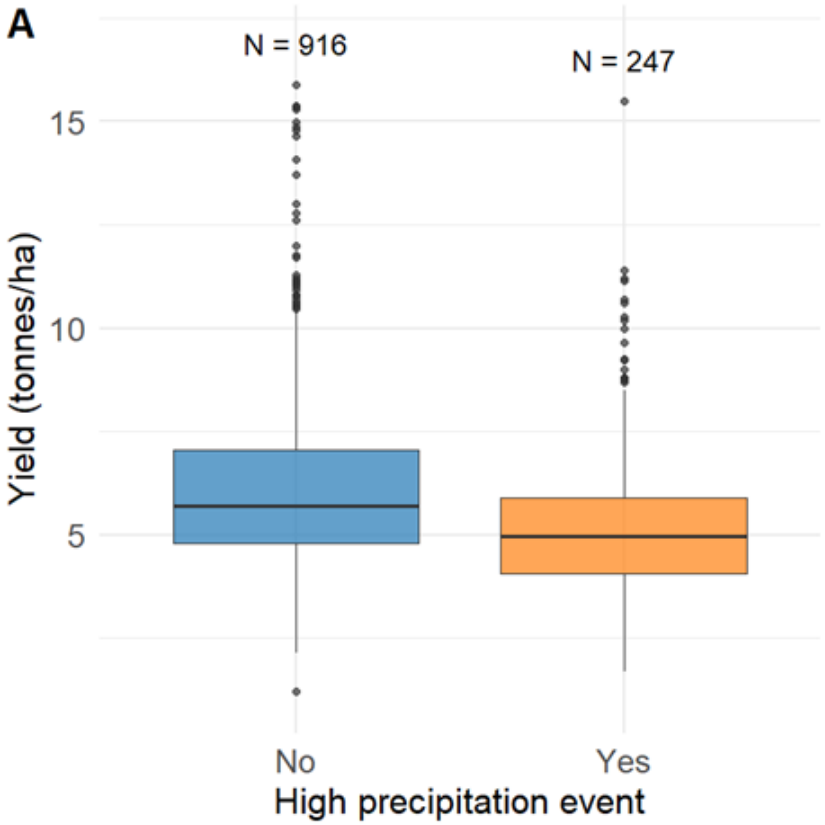
2. What are the effects of HP on downy mildew pressure?

3. Is the effect of high spring precipitation on yields partly due to downy mildew pressure?

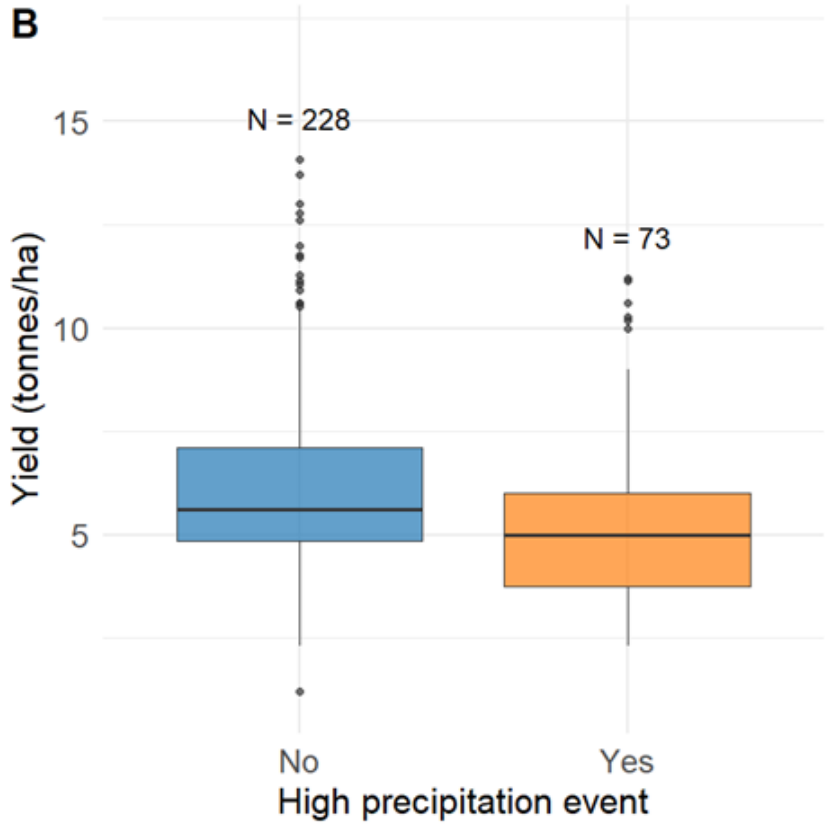
Question 1. What are the effects of high precipitation (HP) on grapevine yield losses?

Raw data : be careful, risk of bias !

Full Agreste dataset



Filtered dataset



“Lower yield in high precipitation events”

But be careful, risk of bias !

Question 1. What are the effects of high precipitation (HP) on grapevine yield losses?

Statistical models

Model 1:

Models predicting probability of HP occurrence as a function of covariates

Model 2:

Models predicting yield as a function of HP + covariates

⇨ **Double robust method (LME, GBM)**

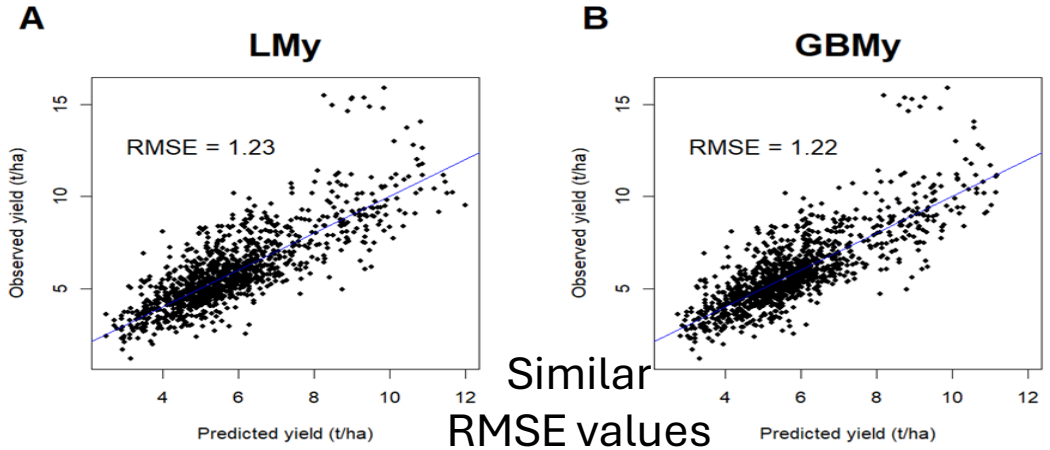
✖ **Bootstrapping analysis**

Cross-validation

Confounding variables considered in the models	
Average monthly evapotranspiration Average monthly maximum temperature (T_{max}) (Number of days with T_{max} > 30ºC) Average monthly soil wetness index (SWI) Average monthly visible radiation	January to September

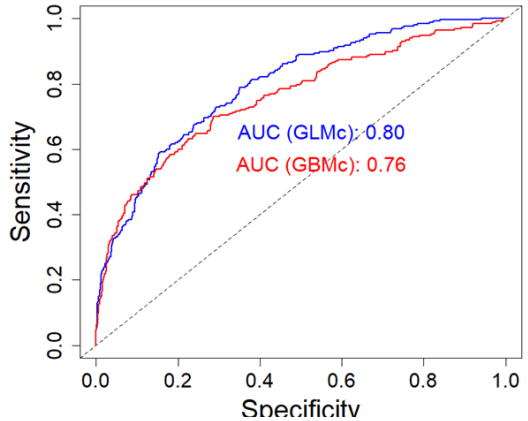
Model performance comparison

Yield prediction performance

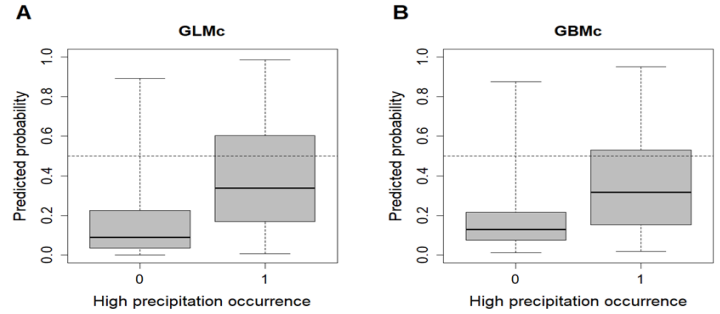


Similar RMSE values

Classification of high precipitation occurrence



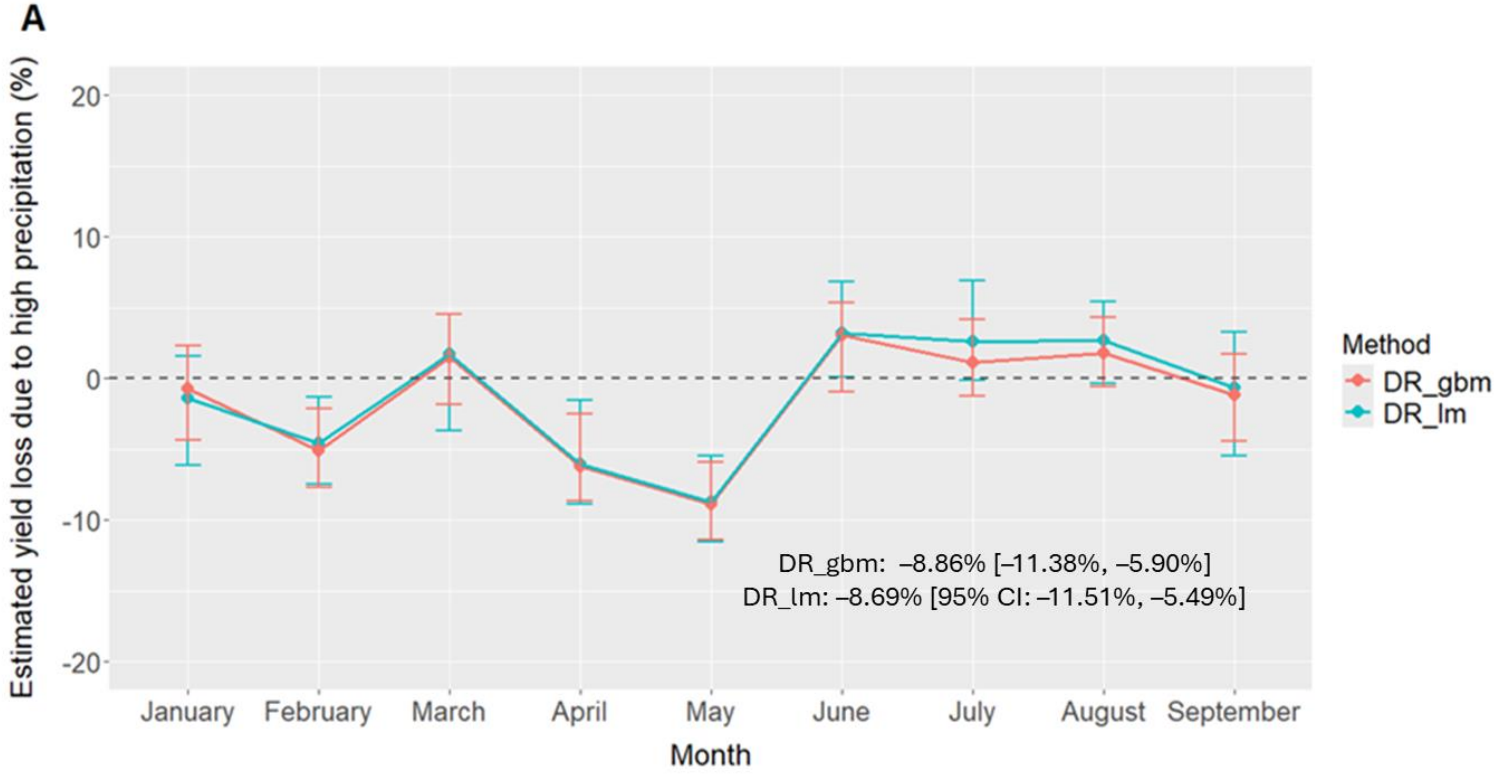
Predicted probabilities of high precipitation occurrence



Question 1. What are the effects of high precipitation (HP) on grapevine yield losses?

The causal impact of HP events showed the strongest negative yield Notament in May

Model 1 and 2



Santos et al. 2011, Jones et al. 2005; Ramos et al. 2008:

- Low precipitation and high temperatures in late spring (flowering in May and berry development in June) are favourable to grapevine yield
- May precipitation is significantly lower in high yield years than for low yield years

Questions

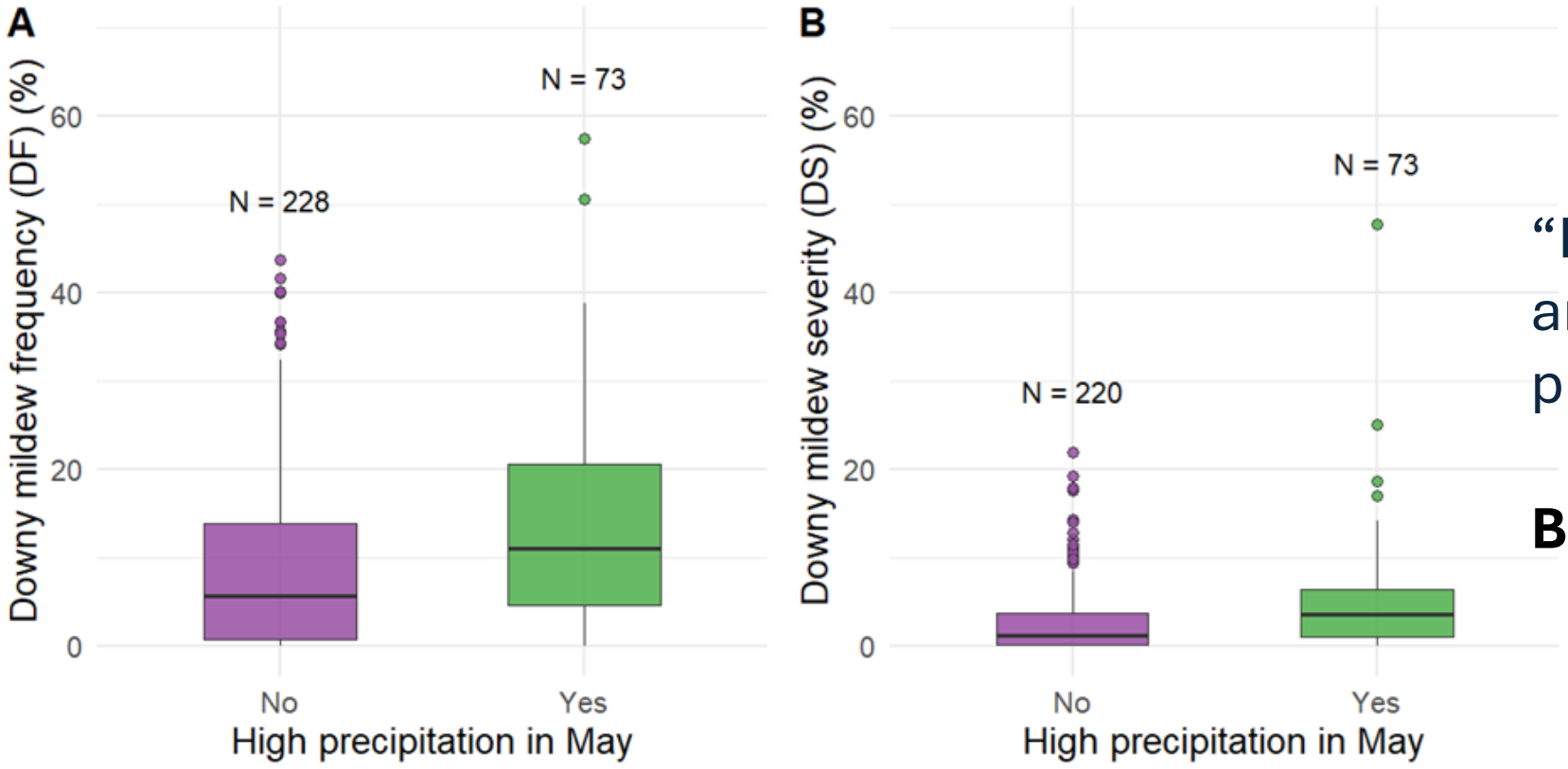
1. What are the effects of high precipitation (HP) on grapevine yield losses?

2. **What are the effects of HP on downy mildew pressure?**

3. Is the effect of high spring precipitation on yields partly due to downy mildew pressure?

Question 2. What are the effects of HP on downy mildew pressure?

Raw data



"Higher disease frequency and severity in high precipitation treatments"

But be careful, risk of bias !

Question 2. What are the effects of HP on downy mildew pressure?

Statistical models

Model 1:

Models predicting probability of HP occurrence as a function of covariates

Model 3:

Models predicting disease frequency and severity as a function of HP + covariates

⇨ **Double robust method (LME, GBM)**

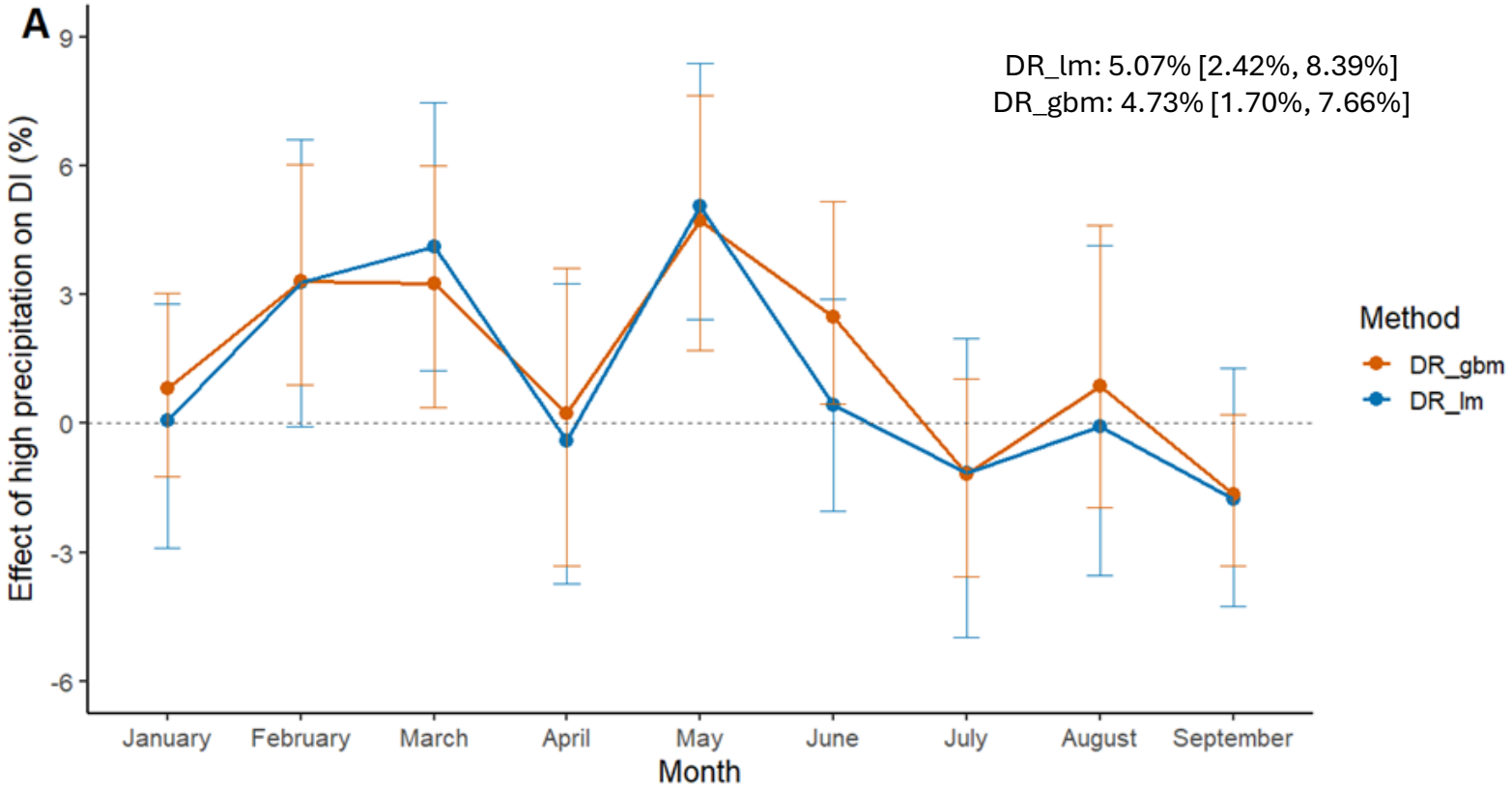
✖ **Bootstrapping analysis**

✖ **Cross-validation**

Confounding variables considered in the models	
Average monthly evapotranspiration Average monthly maximum temperature (T_{max}) Number of days with T_{max} > 30ºC Average monthly soil wetness index (SWI) Average monthly visible radiation	April To September

Question 2. What are the effects of HP on downy mildew pressure?

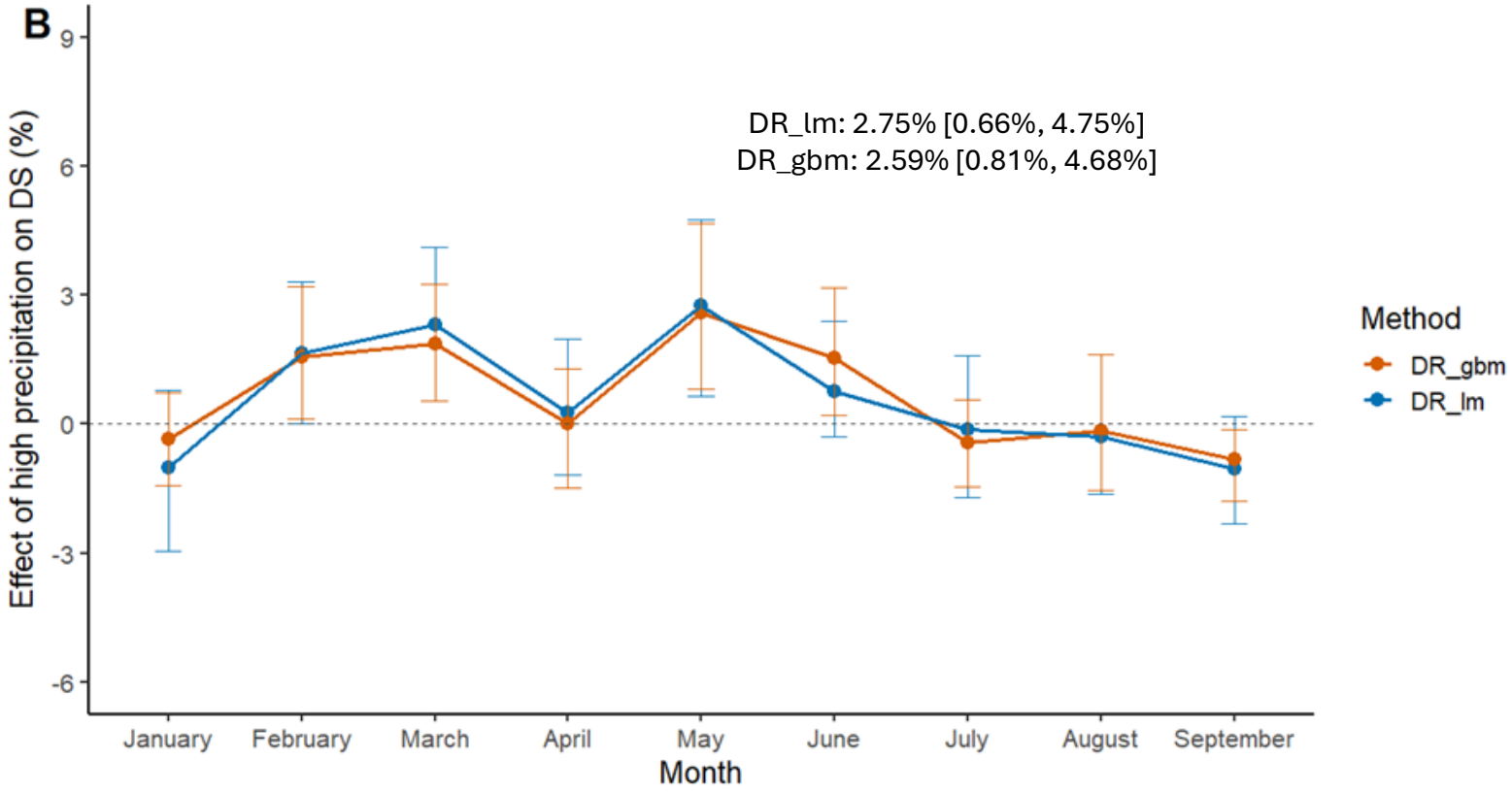
The causal impact of HP events on disease **incidence** showed the **strongest positive effect in May**



Model 1 and 3

Question 2. What are the effects of HP on downy mildew pressure?

The causal impact of HP events on disease **severity** showed the **strongest positive effect in May**



Model 1 and 3

Chen et al. 2019 & Chen et al. 2020

- Date of disease onset depends on spring precipitation
- Climate conditions in May were found to be decisive for the development of downy mildew in the Bordeaux vineyards
- Strong sensitivity of the probability of high disease severity on leaves to precipitation is consistent with the increasing trend of precipitation in May and June

Questions

1. What are the effects of high precipitation (HP) on grapevine yield losses?

2. What are the effects of HP on downy mildew pressure?

3. **Is the effect of high spring precipitation on yields partly due to downy mildew pressure?**

Question 3. Is the effect of high spring precipitation on yields partly due to downy mildew pressure?

Statistical models

Model 4:

Models predicting yield as a function of disease frequency or severity **+** covariates in May

Model 5:

Models predicting yield as a function of disease frequency or severity **+** HP **+** covariates in May

⇨ **Double robust method (LME, GBM)** ✖ **Bootstrapping analysis**

Cross-validation

Question 3. Is the effect of high spring precipitation on yields partly due to downy mildew pressure?

Effect of HP only

Model 1

- High precipitation in May **significantly reduces yield** ($\beta = -0.11$, $p < 0.001$)

Effect of disease only

Model 4

- Disease frequency: **significant negative effect on yield** ($\beta = -0.84$, $p = 0.05$)
- Disease severity: **even stronger effect** ($\beta = -1.89$, $p = 0.03$)

Combined effects of disease and HP

Model 5

- **HP has a negative significant effect on yield** ($\beta = -0.11$, $p < 0.01$)
- Disease effects are non-significant
- Indicates that the effects of disease pressure and HP on yield loss are not independent

Main conclusions

What are the effects of high precipitation on grapevine yield losses?

- Grapevine yield is reduced by an average of –8.69%

What are the effects of high precipitation on downy mildew pressure?

- Increases downy mildew frequency by 5.07%
- Increases disease severity by 2.75%

Is the effect of high spring precipitation on yields partly due to downy mildew?

- Disease frequency and severity have a negative effect on yield
- **BUT** effects become non-significant when precipitation is taken into consideration
- Effects of high disease incidence and high precipitation are partly intertwined

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Thank you for your attention !

Merci pour votre attention !

Contact mail : francois.brun@acta.asso.fr

Ce workshop a le soutien financier du Département des Sciences de l'Environnement et du Département CHANGES de l'Université de Bordeaux

3rd Workshop ARRUPVICO

Can insurance help farmers to take the risk of phytosanitary losses?

A time for sharing perceptions on existing initiatives and requirements

L'assurance peut-elle sécuriser la prise de risques des agriculteurs face aux pertes sanitaires des cultures ?

Un temps d'échange sur des initiatives en cours et la perception des besoins.

September 25th 2025 - Bordeaux

Ce workshop a le soutien financier du Département des Sciences de l'Environnement et du Département CHANGES de l'Université de Bordeaux

Modelling yield loss due to mildew: how to move from a loss model to a predictive model ?

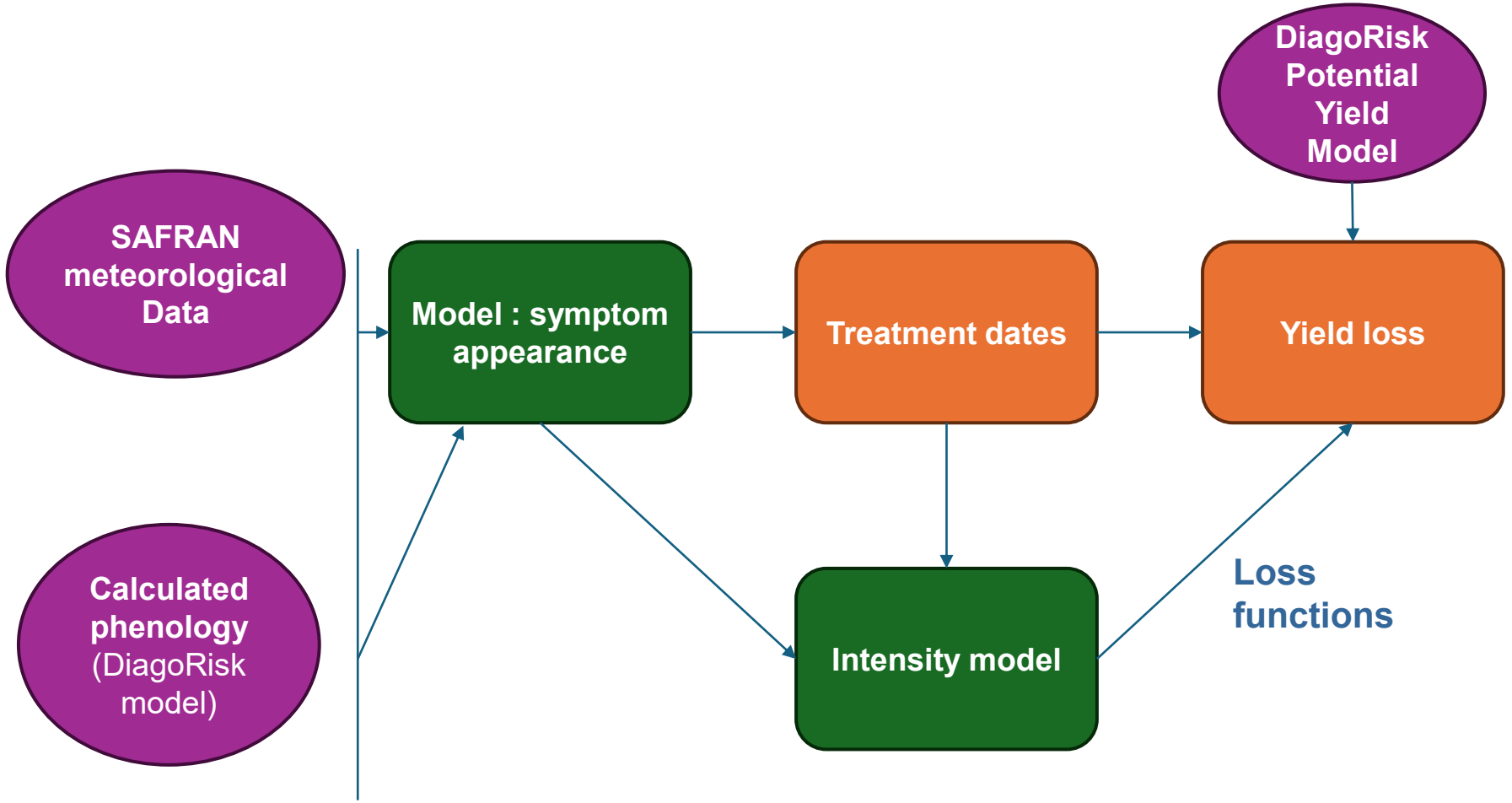
Clément BOURGADE

DiagoRisk

Session 4: Modelling the risks and yield losses associated with lower inputs

Final Workshop– 24-25 Sept 2025

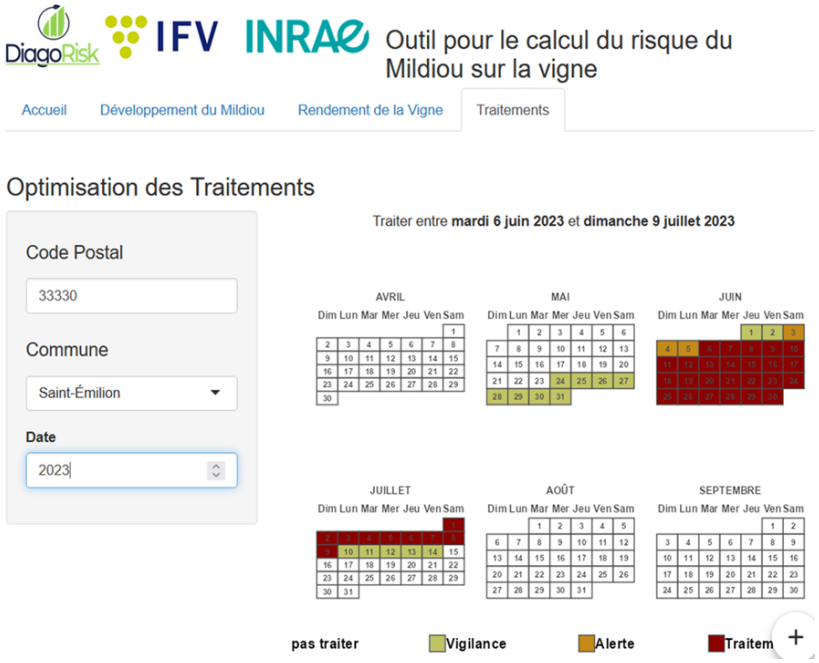
Mo rchitecture

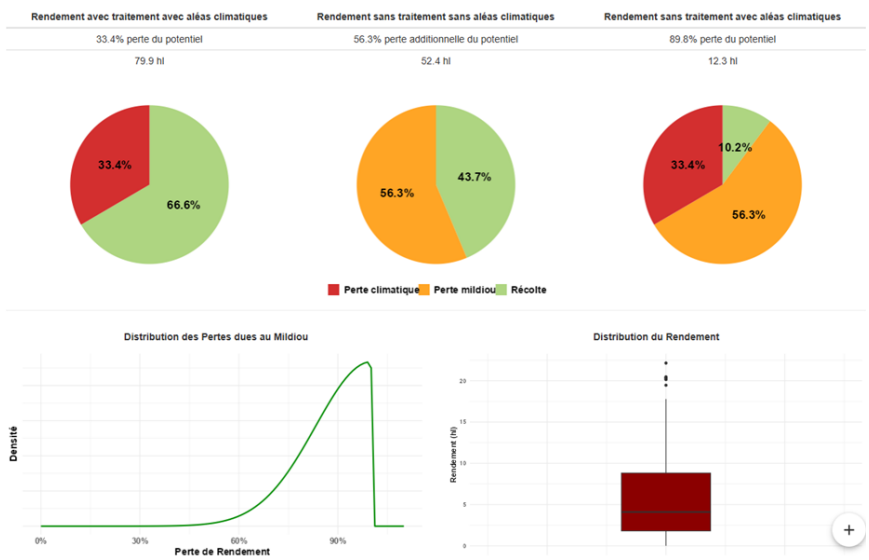


« Ap tion Mildiou »

Recom eatment Date & Estimated Yield Loss

Division of calendar into several periods depending on the risk of fungal attacks





Presentation of the complete model

J0 (Day 0)

Forecasts J15 (Day 15)

To measure the predictive power of the model at 15 days prior and the same day

Creation of a version of the model fed with climatic and phenological data 15 days in advance, with a view to prediction

Machine learning models functioning

	predictor variables			Mildew onset
Date	Temperature	Rain	Pheno	
Day 1	18,2	0,0 mm	72	✓
Day 2	21,4	12,1 mm	81	✓
Day 3	19,3	5,7 mm	79	✗
Day 4	22,7	8,4 mm	68	✓
Day 5	20,1	3,2 mm	75	✗
—	—	—	—	

dependent Variable (Mildew onset presence or absence)

Complet model J0 / Forecast at J-15

- The most important variables are the climatic variables 3 and 4 weeks before the onset date.
- We seek to validate the predictive capacity at J-15 (and J+7) by removing the variables relating to the last 2 weeks (and last week).

Complete model J0

monday	tuesday	wednesda	thursday	friday	saturday	sunday
			10th jully			

Restricted model J-15

monday	wednesd	wednesd	thursday	friday	saturday	sunday
			26june			
			10th jully			

Day of the forecast

Data used

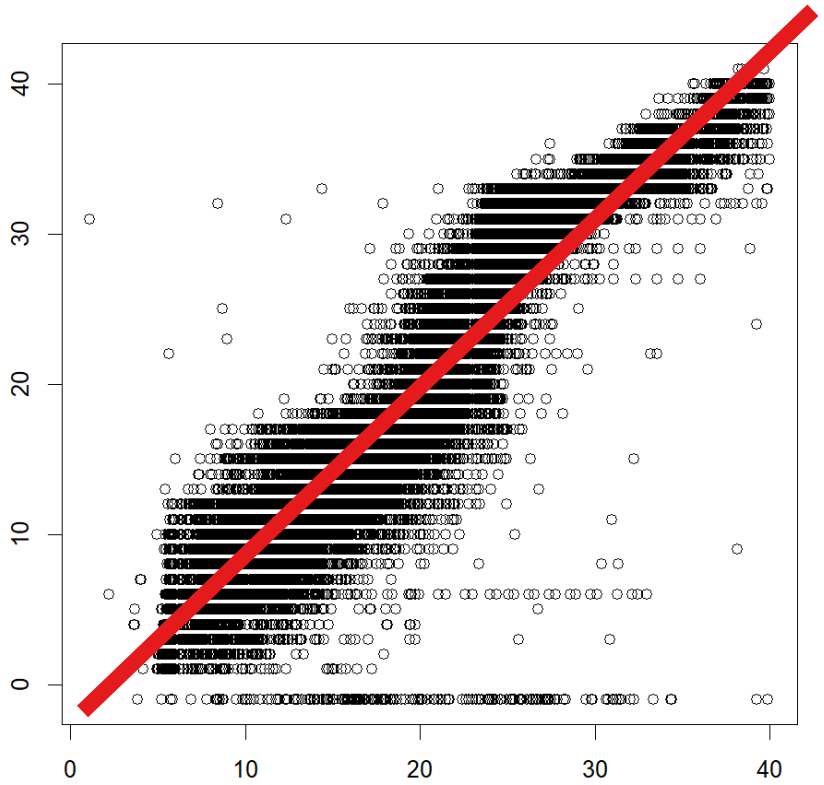
Phenology calculation

The 15-Day Forecast model does not provide the 15-Day shifted phenology, which is necessary to run it.

The solution adopted is to assign the phenology from the previous 15 days, calculated using and other model established by DiagoRisk.

Correspondence between calculated and observed phenological stages

observed



simulated

- The calculated phenology broadly corresponds to the observed phenology, regardless of the grape variety.

Co[illegible]one of the 15 days forecast model : Elimination of variables from the previous 2 weeks

76 variables

J0 model

```
 [1] "DATE_OBS"     "GridNo"       "MILLESIME"    "MGI"          "STADE_PHENO"  "Tas"          "prtot"        "huss"
 [9] "lwh"          "Tmin"         "Tmax"         "dprtot"       "dhuss"        "dlwh"         "dprtot_min"   "dhuss_min"
[17] "dlwh_min"     "dprtot_max"   "dhuss_max"    "dlwh_max"     "Tas_1"        "prtot_1"      "huss_1"       "lwh_1"
[25] "Tmin_1"       "Tmax_1"       "dprtot_1"     "dhuss_1"      "dlwh_1"       "dprtot_min_1" "dhuss_min_1"  "dlwh_min_1"
[33] "dprtot_max_1" "dhuss_max_1"  "dlwh_max_1"   "Tas_2"        "prtot_2"      "huss_2"       "lwh_2"        "Tmin_2"
[41] "Tmax_2"       "dprtot_2"     "dhuss_2"      "dlwh_2"       "dprtot_min_2" "dhuss_min_2"  "dlwh_min_2"   "dprtot_max_2"
[49] "dhuss_max_2"  "dlwh_max_2"   "Tas_3"        "prtot_3"      "huss_3"       "lwh_3"        "Tmin_3"       "Tmax_3"
[57] "dprtot_3"     "dhuss_3"      "dlwh_3"       "dprtot_min_3" "dhuss_min_3"  "dlwh_min_3"   "dprtot_max_3" "dhuss_max_3"
[65] "dlwh_max_3"   "Tas_4"        "prtot_4"      "huss_4"       "lwh_4"        "Tmin_4"       "Tmax_4"       "dprtot_4"
[73] "dhuss_4"      "dlwh_4"       "dprtot_min_4" "dhuss_min_4" "dlwh_min_4"   "dprtot_max_4" "dhuss_max_4"  "dlwh_max_4"
```

46 variables

J15 model

```
> names(X_train)
 [1] "DATE_OBS"     "GridNo"       "MILLESIME"    "MGI"          "STADE_PHENO"  "Tas_2"        "prtot_2"      "huss_2"
 [9] "lwh_2"        "Tmin_2"       "Tmax_2"       "dprtot_2"     "dhuss_2"      "dlwh_2"       "dprtot_min_2" "dhuss_min_2"
[17] "dlwh_min_2"   "dprtot_max_2" "dhuss_max_2"  "dlwh_max_2"   "Tas_3"        "prtot_3"      "huss_3"       "lwh_3"
[25] "Tmin_3"       "Tmax_3"       "dprtot_3"     "dhuss_3"      "dlwh_3"       "dprtot_min_3" "dhuss_min_3"  "dlwh_min_3"
[33] "dprtot_max_3" "dhuss_max_3"  "dlwh_max_3"   "Tas_4"        "prtot_4"      "huss_4"       "lwh_4"        "Tmin_4"
[41] "Tmax_4"       "dprtot_4"     "dhuss_4"      "dlwh_4"       "dprtot_min_4" "dhuss_min_4"  "dlwh_min_4"   "dprtot_max_4"
[49] "dhuss_max_4"  "dlwh_max_4"
```

- **The initial model predicts the presence of mildew for each day using weather data from the same day, as well as from 1, 2, 3, and 4 weeks prior.**
- **Model J15 uses variables from the previous 2, 3, and 4 weeks.**
- **We tested eliminating the least explanatory variables, but without conclusive results.**

Predictive capability

J15/ J0	Phenology	Area under the curve:	Observations
J0	Observed	0.8261	Problem with some phenological observation
J0	Chardonnay simulated	0.8412	
J-15	Ugni blanc* simulated	0.8306	
J-15	Chardonnay simulated	0.8595	
J-15	No phenology	0.8451	

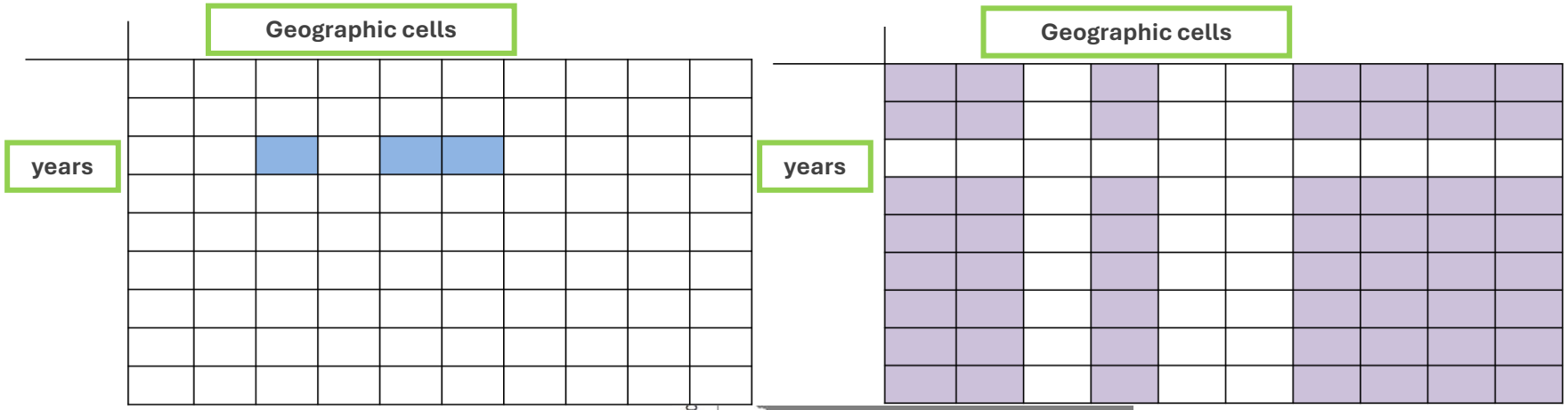
*Trebbiano

The model scoring the best result is the restricted J-15 model

Cro alidation established to test the models

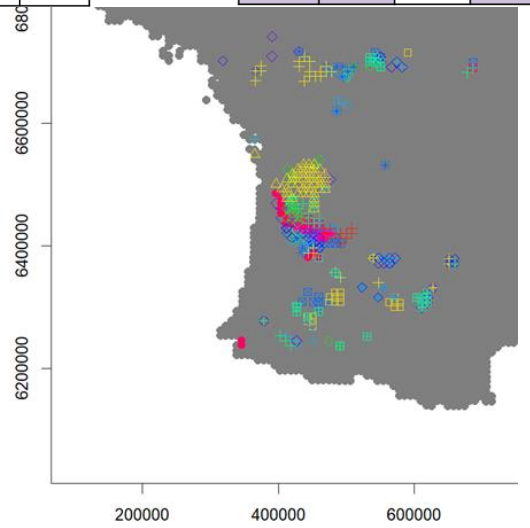
Testing

Training



The geographic cells are 64Km²

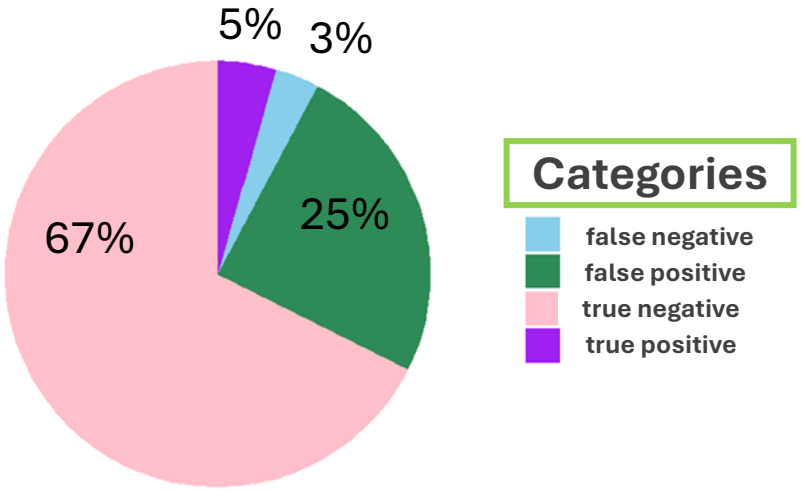
+20 years of data



Geographic groups : Agricultural homogeneous region

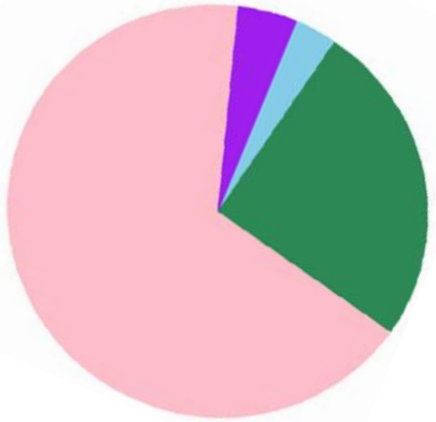
Comparison of cross-validation results by model for the mildew onset prediction

J0



Category	Value
Vrai neg	108.842105
Faux Neg	5.368421
Faux Pos	39.631579
Vrai Pos	7.157895

J-15



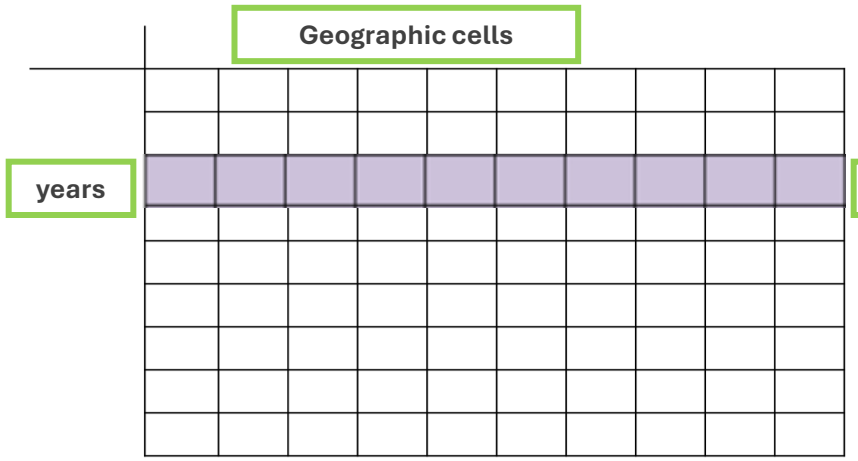
Category	Value
Vrai neg	107.315789
Faux Neg	5.263158
Faux Pos	40.315789
Vrai Pos	7.263158

Both results are very similar

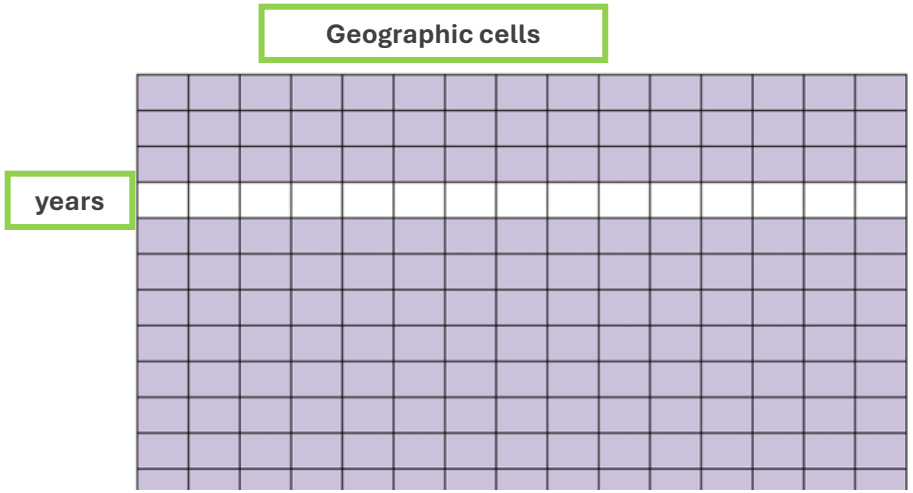
Vali n with previous geographical knowledge

Every year is isolated and used for the testing. Every parcel is used for training and testing

Testing



Training



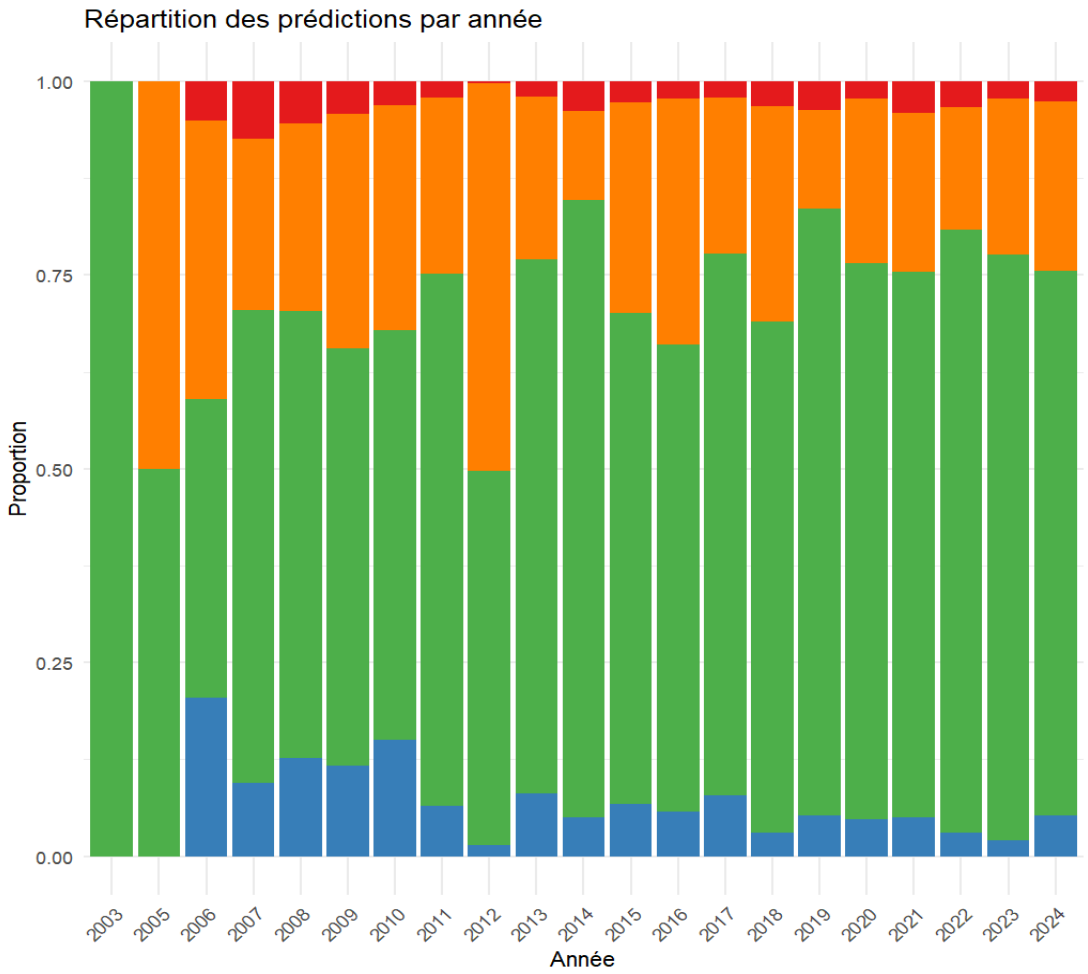
This methodology was used

Ability to predict the appearance of mildew

The output of the model is a probability of presence

Probability of presence > 50% is counted as presence of mildew

Distri of errors by year, Model J0



- Consistent results through the years
- J15 has similar results

Categories

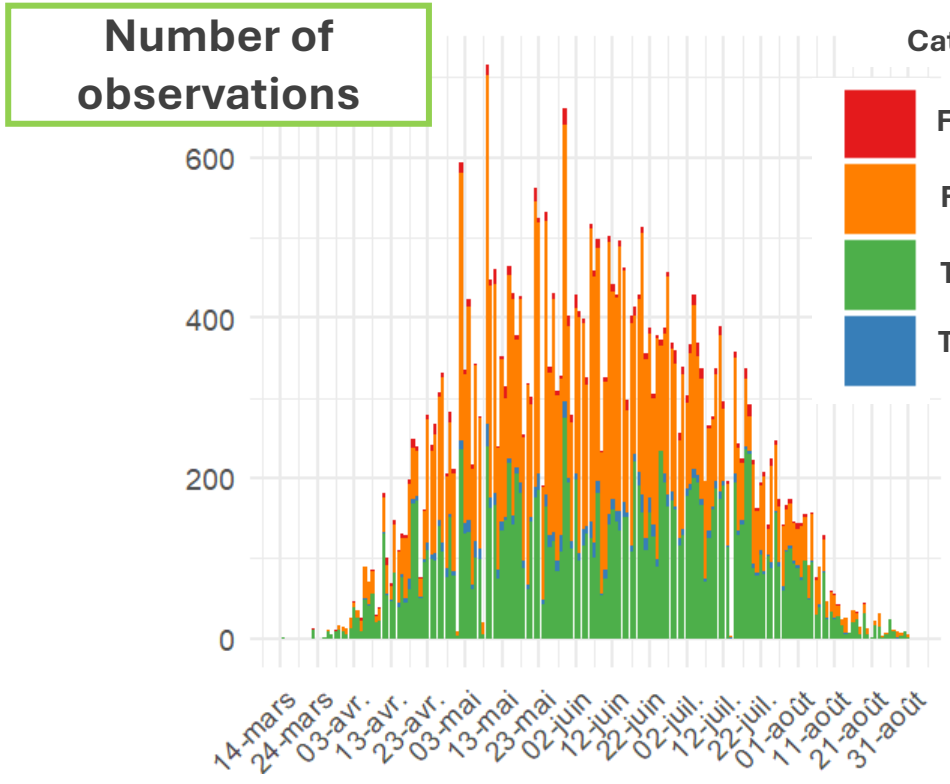
- False negative
- False positive
- True negative
- True positive

Analysis by date of appearance

Model’s results through the season

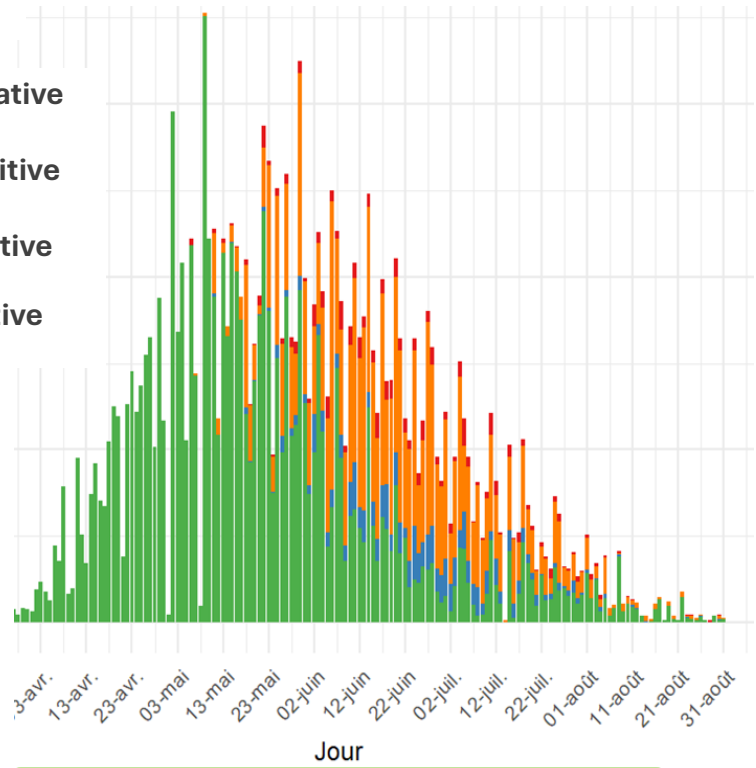
Both J0 and J-15 models are better than a random disease onset

Random version



None of the tested variables are explanatory

Model J-15

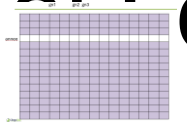


Variables with 15 days delay

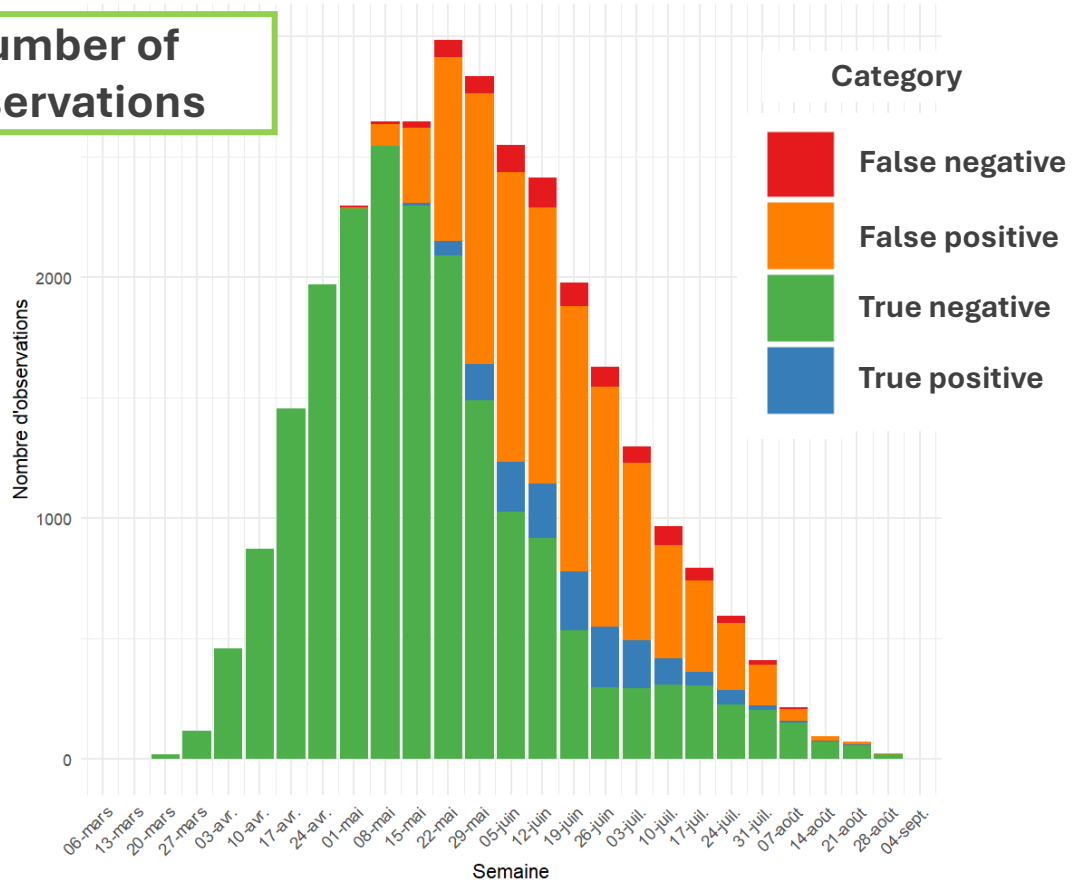
Distri rs by date

Prediction on the grape cluster

Mod Forecasts at J-15 days



Number of observations



days

The model's ability to detect true negatives at the start of the campaign was good.

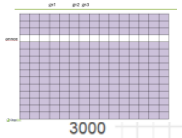
No visual deviation between J-15 and J0

For insurance purposes, **reduce false negatives**.

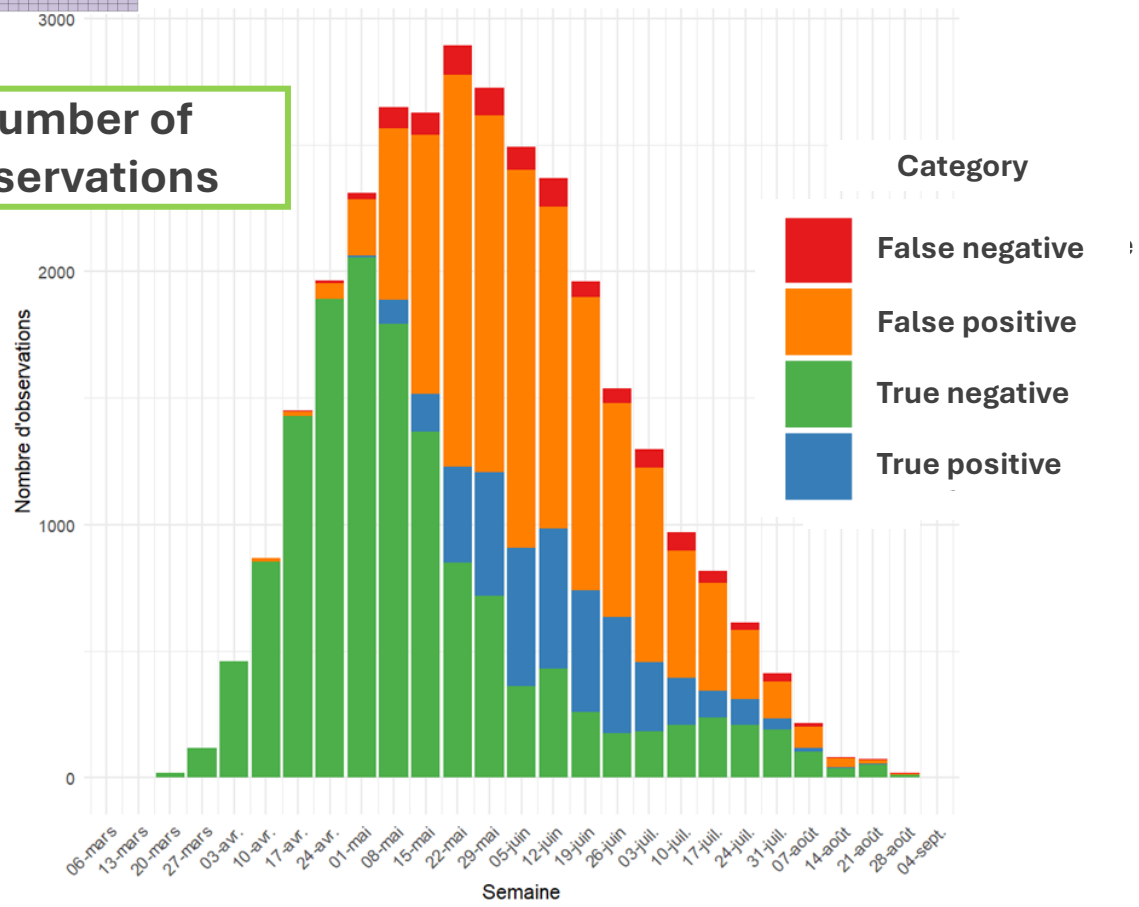
To reduce phytosanitary treatments, **reduce false positives.**

Distrib ors by date
Model Forecasts at J-15 days

Prediction on the leaf



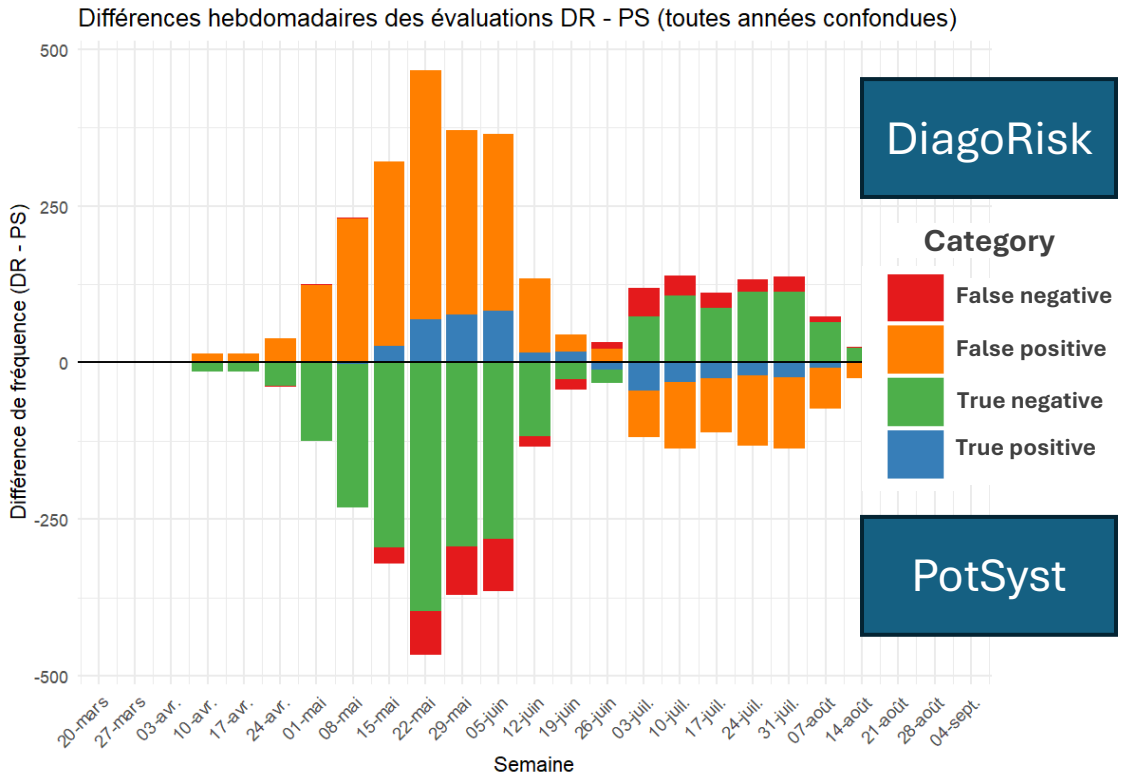
Number of observations



days

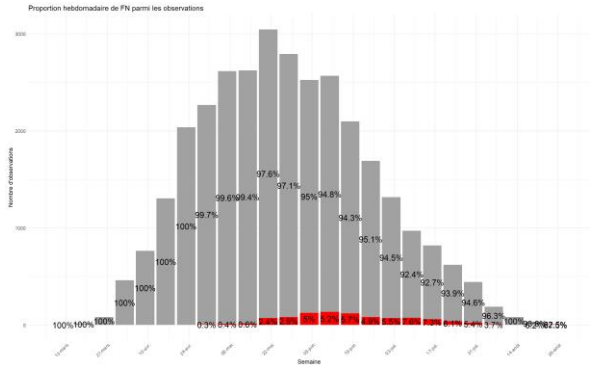
- Overall, we obtained better results in forecasting leaf mildew onset.

DR 15 versus the reference model

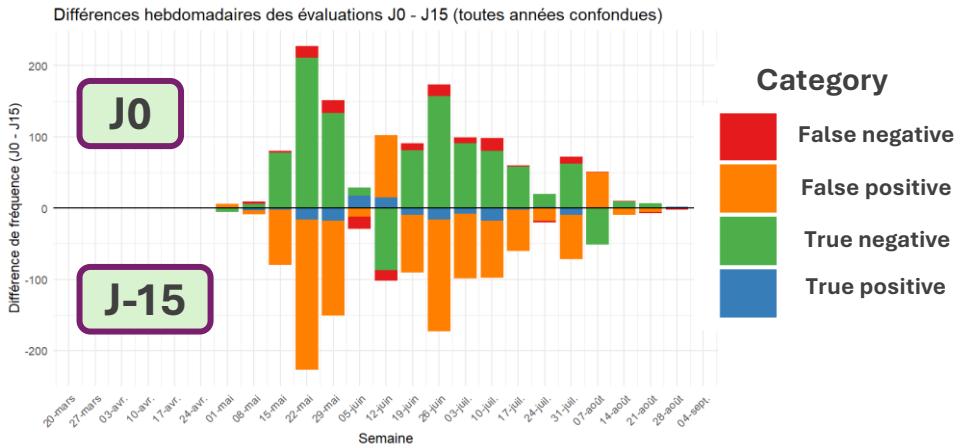


- Difference between our Leaf's results and the model used today as a reference
- Diagorisk is slightly more cautious up to the late June
- The overall results are quite similar, but DR has 15 days of anticipation

General observations



Weekly proportion of false negatives among J-15 model outputs



Weekly differences between our models

- J-15 model is slightly better than J0
- The average error rate is 5%, concentrated in the month of June
- J-15 is more cautious than J0

Conclusions and next steps

- Models have been established for leaves and for grape clusters, with quite good results
- We have been developing a probabilistic approach which seems promising
- We need to establish a leaf-cluster articulation of field observations to make an insightful model switch with need of :
  - Managing the heterogeneity of phenology between plots
  - Consider a plot-based approach and distinction for every variety of vine
  - Simplifying the model use by operating it via a smartphone app

- We are still dealing with error rates that are a little high to allow insurance to function properly, but we hope to be able to improve the results with more observations and better feedback from winegrowers.

Thank you for your attention !

Merci pour votre attention !

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Luc BOUCHER 06 85 48 01 87 luc.boucher@diagorisk.com

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Can insurance encourage the agroecological transition of zero insecticide rapeseed?

L’assurance peut-elle inciter la transition agroécologique vers un Colza zero insecticide ?

Pablo Yepes Llano

INRAE

Session 4: Modelling the risks and yield losses associated with lower input

Final Workshop– 24-25 Sept

Can insurance encourage growing zero insecticide rapeseed?

- # Introduction : the challenge of Zero Insecticide

  - ## Declining Insecticide Effectiveness

The declining effectiveness of conventional insecticides is a major concern for rapeseed producers, as pests are becoming more resilient and reducing overall crop yields.

  - ## Reduction in Authorized Insecticides

A significant reduction in the number of authorized insecticide molecules limits the options available to producers, hindering efforts to effectively manage pest populations and maintain yield stability.

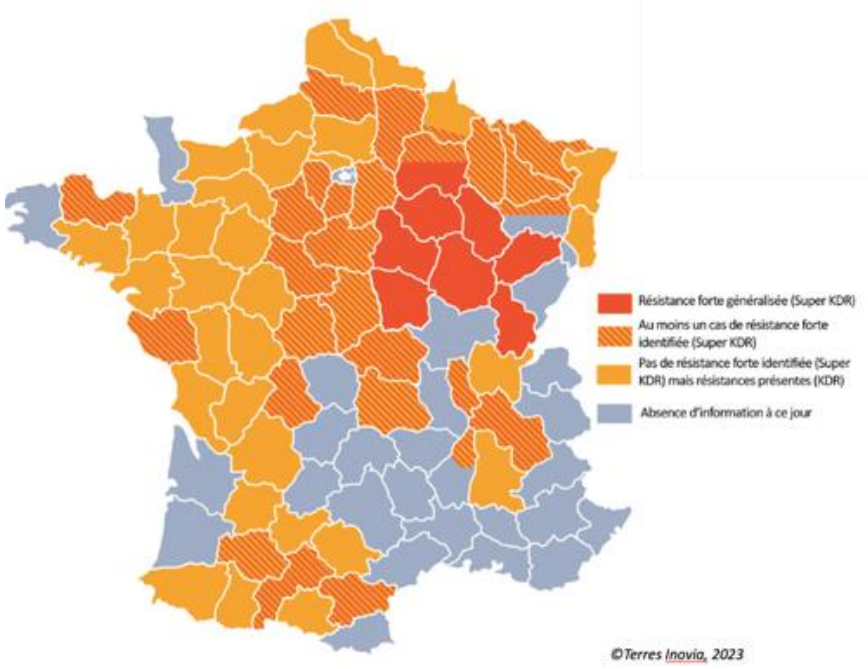
Introduction : the challenge of Zero Insecticide

Agriculture: “both the cause and the victim”

- Products withdrawn from the market
- Higher demand for biological products
- Reduced effectiveness
- More restrictive approvals
- Resistance

Regulated uncertainty:

- AMM involves evaluating hazards
- Insurance helps cushion risks from “knowns + unknowns.”



Introduction : How insurance can help?

- Risk Management Tool
- Financial buffer
- Risk pooling

Introduction : The potential role of Insurance in Sustainable Agriculture

- **Farmers use pesticides as act of self-insurance**
  - Encourage natural insurance
- **Climate adaptation**

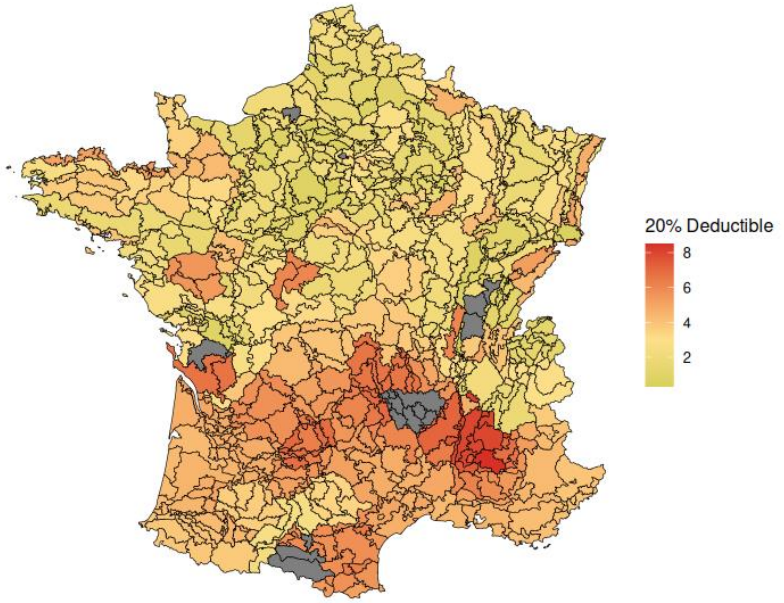
- **Encourages risk-sharing rather than risk avoidance**

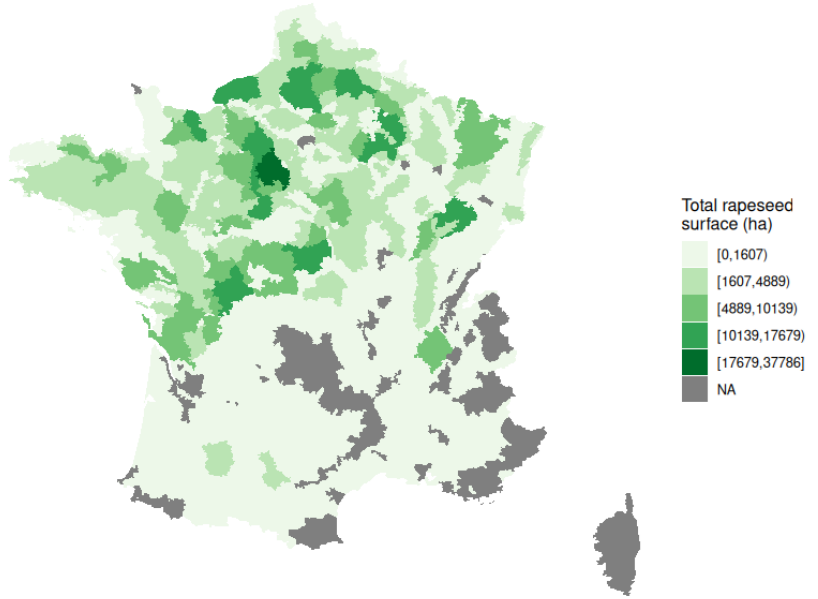
Should insurance compensate losses or guide farmers toward resilient systems?

The potential role of insurance Systems to develop Sustainable Agriculture: The Case of Zero Insecticide Rapeseed

Conventional Rapeseed Policy

- Focus: coverage against pest infestations and related yield losses.
- Financial implication: policies still provide protection
- Premiums increase over time

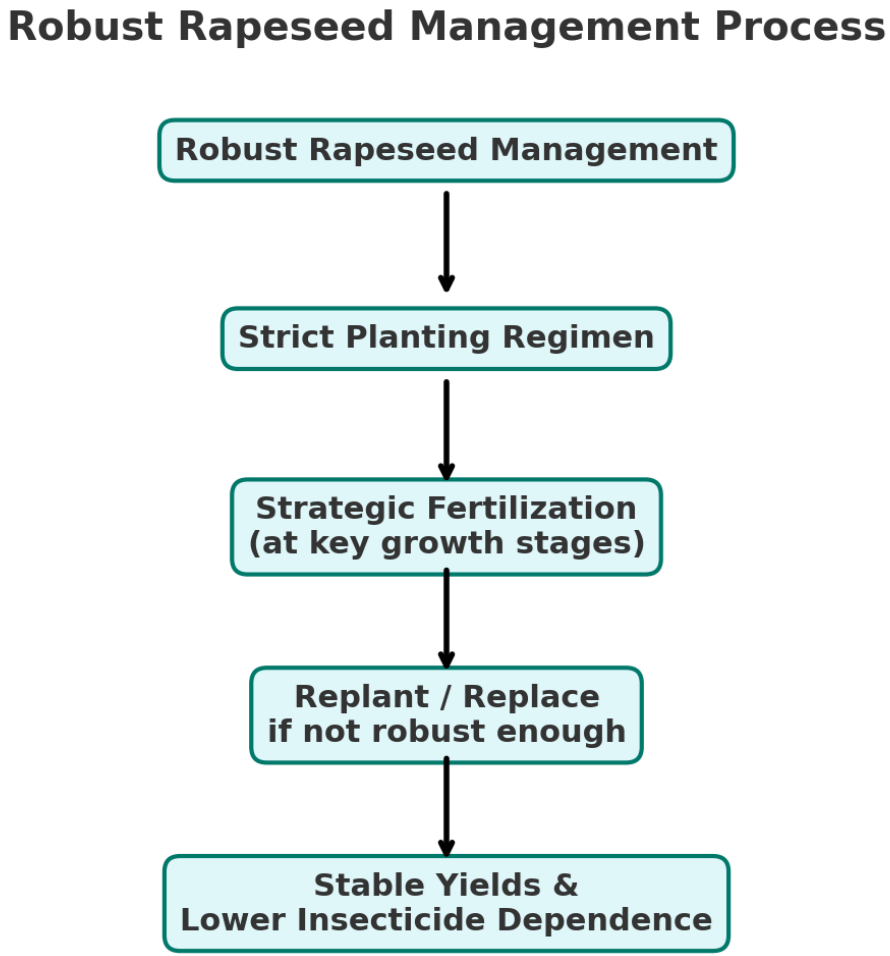




Robust Rapeseed

Terres Inovia rapeseed monitoring protocol

- Pest resistance: engineered to reduce dependence on insecticides.
- Yield stability: more resilient against pest challenges and regulatory changes.
- Sustainability support: helps farmers transition to agroecological practices.
- Environmental benefits: reduced chemical use lowers ecological impacts.
- Insurance advantages:
  - Promotes pest-resistant practices,
  - Offers lower premiums,
  - Encourages adoption of robust varieties,
  - Ensures better long-term financial sustainability.

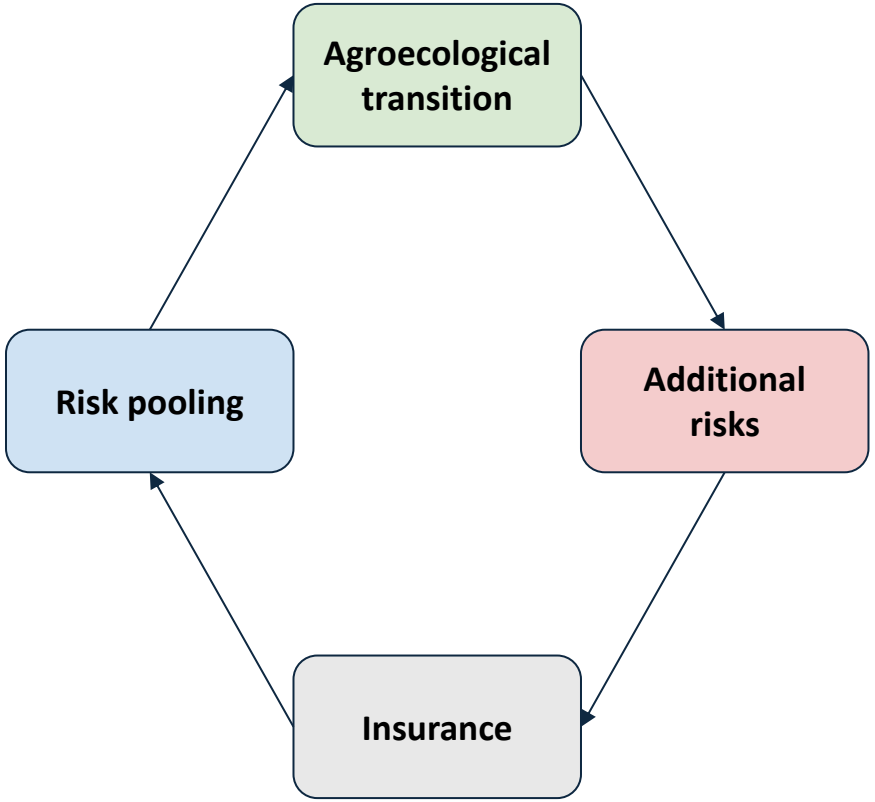


How insurance premiums are calculated ?

Risk pooling (mutualisation)

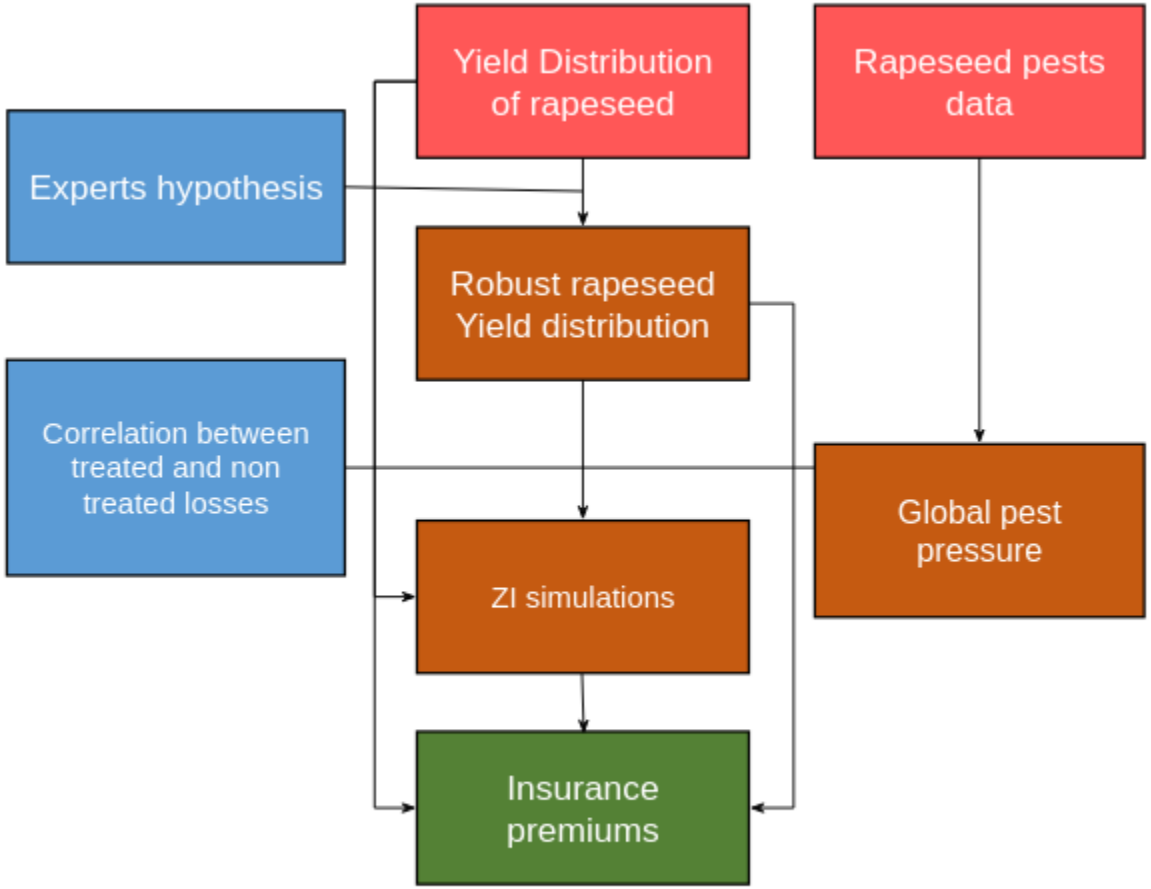
- Farmers don’t carry the burden of losses alone – they are shared across many
- One farmer’s bad year can be balanced by another’s good year, stabilizing a low correlation system
- Pooling smooths out regional and seasonal shocks, making premiums more affordable
- It transforms unpredictable individual risks into manageable collective ones

The more people get insured, insurance becomes more solvable and premiums falls.



Methodology: Data Analysis

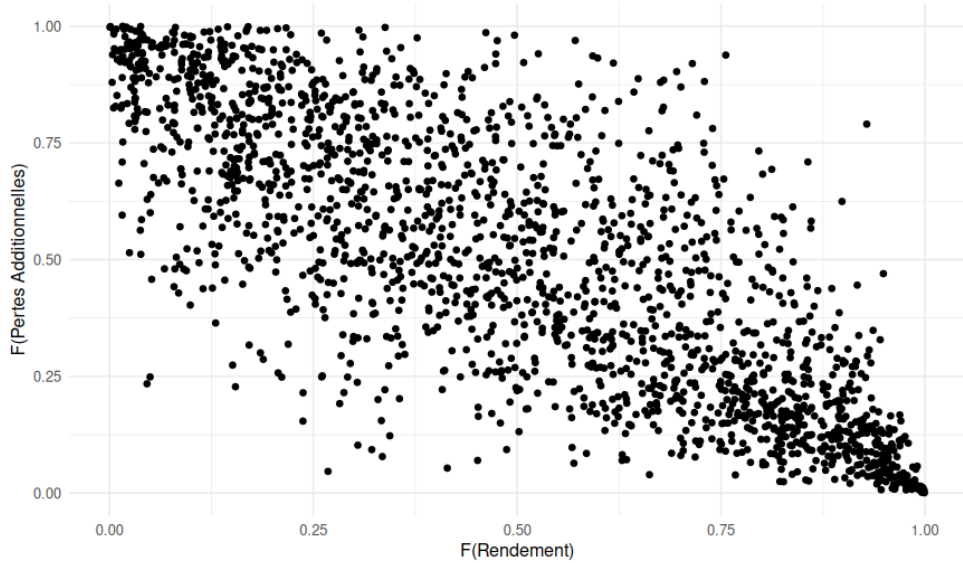
- Cross-referenced insect presence data with expert opinions to assess pest impacts on crop yields in both conventional and robust rapeseed.
- Calibrated a crop yield loss model using the plant health bulletin data, incorporating yield distribution by agricultural region and pest impacts as fixed effects.
- Simulated additional yield losses due to pests without treatment, utilizing a vine copula approach to model complex dependencies between variables.
- Determined theoretical



Hypothesis

- Same impact for every region
- Gumbel copula for modeling correlation between yields and insect damage with 3 correlation hypothesis (0, 0.3, 0.6)
- We want a pressure value for all pests. For this, we have pest data. Our first hypothesis is that all pests have the same impact on yield. Our second hypothesis is that the covariance of pests is stable over time and space (i.e., in different regions). We use a copula vine to represent the variability of overall pressure on yield based on pest data.

Value	Presence observations (percentage)	Additional losses
0	0%	0%
1	6%	5%
2	16%	10%
3	37%	20%
4	100%	40%



• Insurance results

Type of rapeseed	Average premium rate 5% deductible	Average premium rate 20% deductible	Variation in average yield / conv	France fixed premium 5% deductible	France fixed premium 20% deductible	France fixed subsidy
Conventional	7,562%	2,854%	0%	119 M€	45 M€	31 M€
Robust	6,201%	1,936%	6,2%	103 M€	32 M€	23 M€
Zero insecticide	8,307%	3,452%	-10%	117 M€	49 M€	34 M€
Robust ZI (b)	7,463%	2,807%	-4,42%	112 M€	42 M€	29 M€
Robust ZI	6,913%	2,388%	-2%	106 M€	37 M€	26 M€

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Insurance results

- Although there is no direct economic incentive to switch to ZI, the question arises regarding the difference of €50 per hectare
- **€5,000 per year for 100 hectares to avoid exposure**

Type de Colza	Différence du reste à charge assuré à Franchise 5%
Conventionnel	0 €/ha
Robuste (CR)	-57,42 €/ha
Zéro insecticide (ZI)	+85,11 €/ha
Robuste zéro insecticide (CRZIb)	+25,65 €/ha
Robuste zéro insecticide (CRZI)	-1,28 €/ha

- ## Insurance results

  What does the farmer have to pay for a zero insecticide robust rapeseed?

Average gross product	**Total additional Cost**
1034 €/ha (-20,1 €/ha)	
Risk cost	
80 €/ha (-0,7 €/ha)	**+20,4 €/ha**

Risk cost	**Out-of-pocket auto-insurance**		**Farmer risk cost**
	52,34 €/ha (+1,1 €/ha)		
80 €/ha (-0,7 €/ha)	**Insurance premium** **8,29 €/ha** (-6,1 €/ha)	**Insurance (20%)**	
	Subsidies **19,34 €/ha** (-4,3 €/ha)	**27,62 €/ha** (-1,8 €/ha)	**60,6 €/ha** (-5 €/ha)

- **Insurance results**

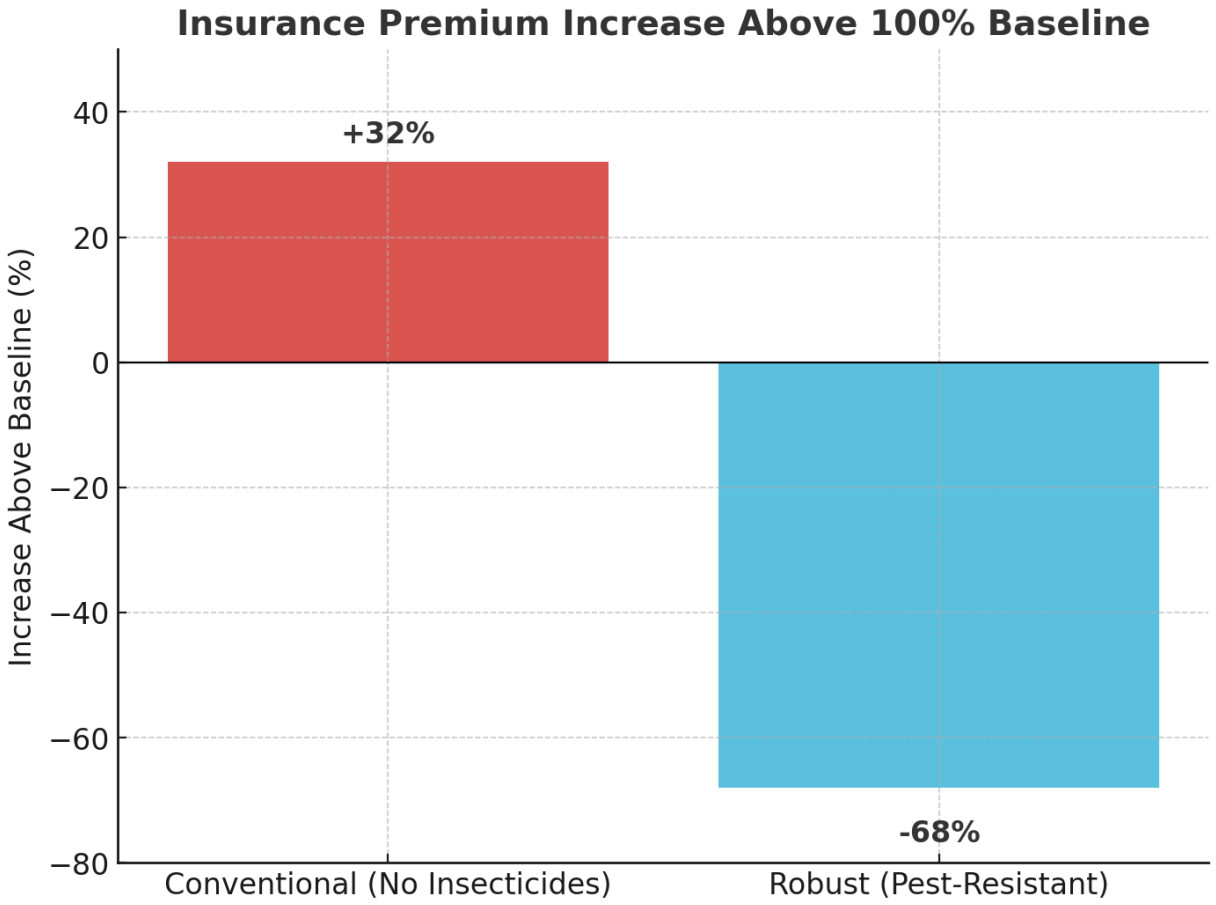
  What does the farmer have to pay for a zero insecticide robust rapeseed?

Average cost	Pesticide savings	Total farmer's Cost
+20,1 €/ha		
Farmer risk cost		
-5 €/ha	-17,4 €/ha	-1,3 €/ha

General results

Significant Rise in Insurance Premiums for Conventional Rapeseed

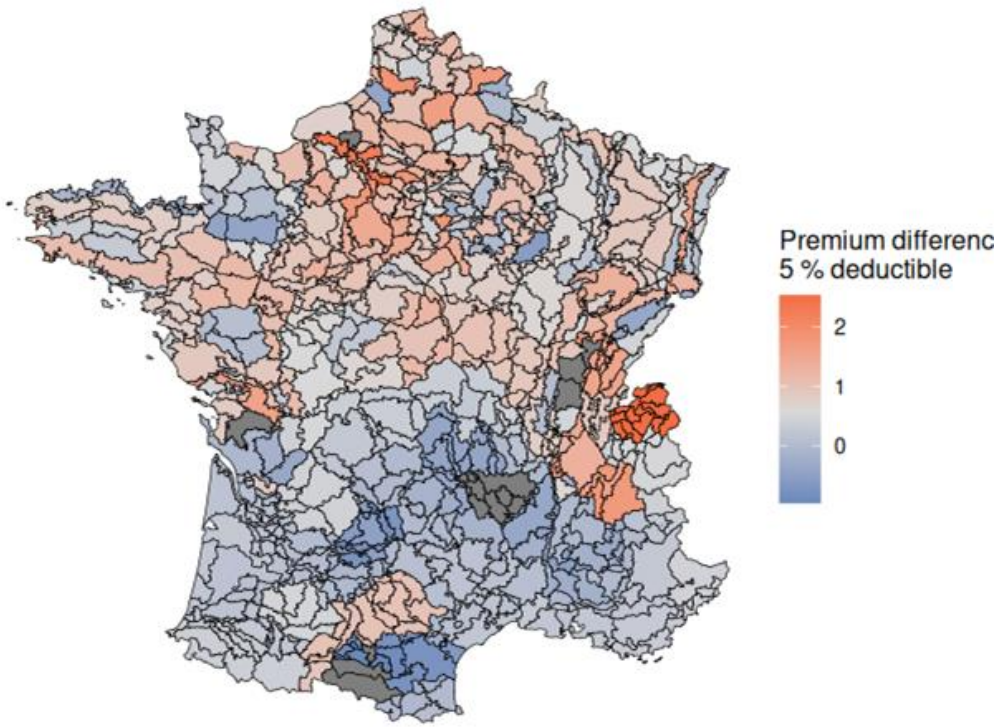
- Conventional rapeseed (without insecticides):
  - Premiums may rise up to +132%
  - Creates major financial challenges for farmers
- Robust rapeseed (pest-resistant):
  - Maximum premium increase of only +32%
  - Much more financially sustainable
- Key takeaway:
  - Large disparity in premium evolution
  - Tailored insurance policies could support sustainable transition
  - A tailored insurance program can help support all risk linked to robust rapeseed, but only 68% of conventional ZI



• Higher Yield Losses in Conventional Rapeseed

Conventional rapeseed without insecticides is subject to significant yield losses due to pest infestations, leading to reduced productivity. In contrast, robust rapeseed varieties, designed for pest resistance, exhibit lower yield losses even in the absence of insecticides, promoting sustainable agricultural practices.

- The insurance premium for a 5
  roughly represents the range c
  risk for the crop.
- We estimate that this range
- varies greatly
  between different regions
  of France.



- # Limits of the study

The analysis highlights the role of tailored insurance policies in supporting sustainable agricultural practices among rapeseed producers. By demonstrating that insurance premiums for robust rapeseed are significantly lower compared to conventional varieties without insecticides, the study reinforces the feasibility of transitioning to pest-resistant crops. The moderate cost differences indicate that financial incentives align with ecological goals, offering farmers a viable path towards agroecological farming and sustainable production methods.

However robust rapeseed with insecticides is still more attractive than zero insecticide. But by a factor of around 5.000 euros per year in average.

Limits of the study

Yield assumptions

- Average gain of **+6.2% for robust rapeseed** vs. conventional → based on limited and interdependent studies.
- Average yield loss without treatment estimated at **–10%** (Le Gall, 2018) → cautious value, may be underestimated.
- **100% effectiveness of insecticides**

Methodology

- Linear transformation of quantiles used to shift from conventional to robust yields.
- Calibrated with experimental results → possible biases difficult to quantify.

Assumptions on pest pressure

- Robust rapeseed tolerates pests better via **avoidance/adaptation mechanisms**.
- Under low pest pressure, treated conventional rapeseed can perform equally or better.
- Moderate and severe losses treated identically for both types (neutral assumption).

Spatial and temporal variability

- Assumed **homogeneous distribution** of pest presence and severity at national scale.
- Reality: variability across **climate years and regions**.
- Database too limited to integrate this heterogeneity.

Yield–pest loss relationship

- Used a **Gumbel copula** to model yield and pest-related losses.
- Insufficient data → unable to validate or quantify the link.
- Three intensity scenarios tested (Kendall's tau) → results based on the most unfavorable case.

Scope of the analysis

- Not explored: **systemic risks** (large-scale spatial correlation).
    - If synchronized events occur, this increases annual variability of total indemnities and need for reinsurance.

Insecticide efficiency

If insecticides have a 25 % efficiency in reducing pest damages, the costs would be similar to treated robust rapeseed.

The additional risk would be equivalent to the reduction in insecticide costs.

Type de Colza	Différence du reste à charge assuré à Franchise 5%
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Robuste (CR)	-57,42 €/ha
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Robuste zéro insecticide (CRZIb)	-2,53 €/ha
Robuste zéro insecticide (CRZI)	-47,28 €/ha

• Perspectives and futur research

Insecticide efficiency

- Using treatment data, what is the relation between yields and pesticides?

Yield–pest loss relationship

- What are the most important pest to pay attention?
- What is the effect of changing climate in this relationship?
- Which ideas and politics could help a zero pesticide transition?

Thank you for your attention !

Merci pour votre attention !

Contact mail : pablo.yepes-llano@inrae.fr

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Modelling risk from the yield perspective to an insurance perspective

Martial Phélippé-Guinvarc’h, Le Mans Université, DiagoRisk

Session N°4 : Modelling the risks and yield losses associated with lower inputs

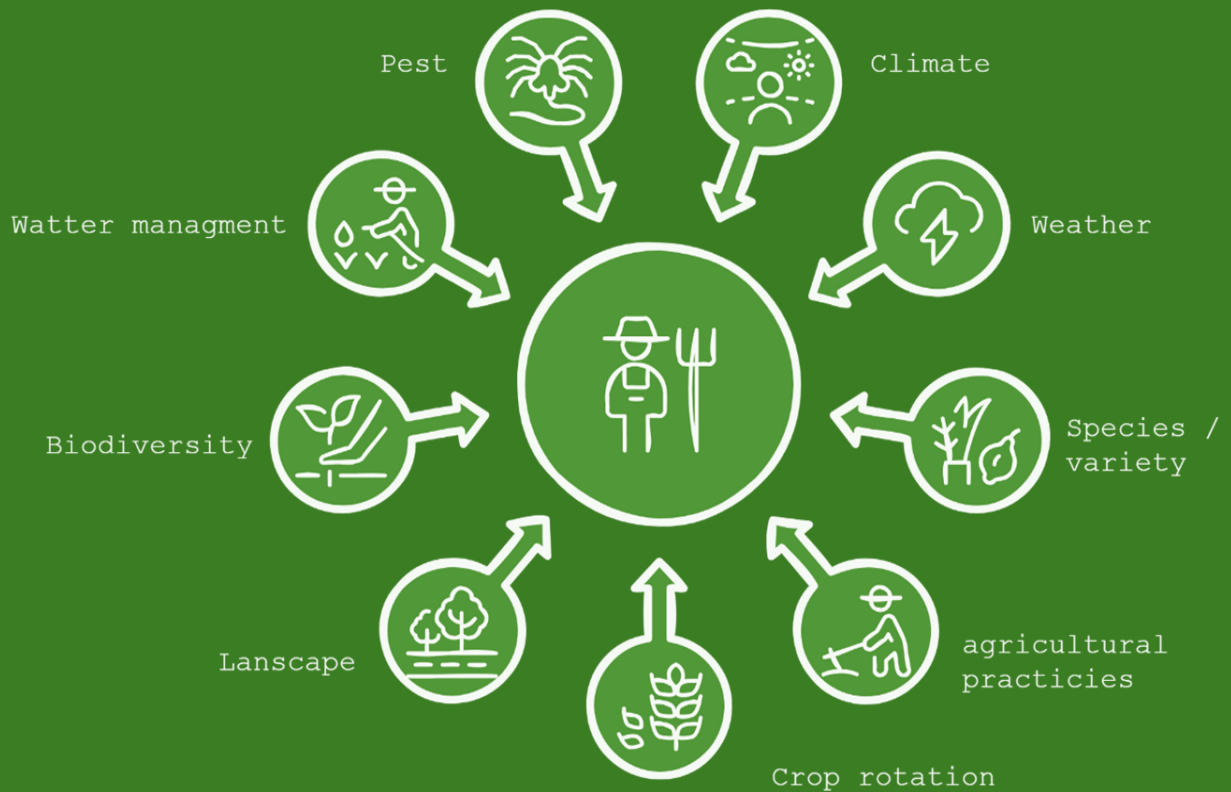
Final Workshop– 24-25 Sept 2025

Contents

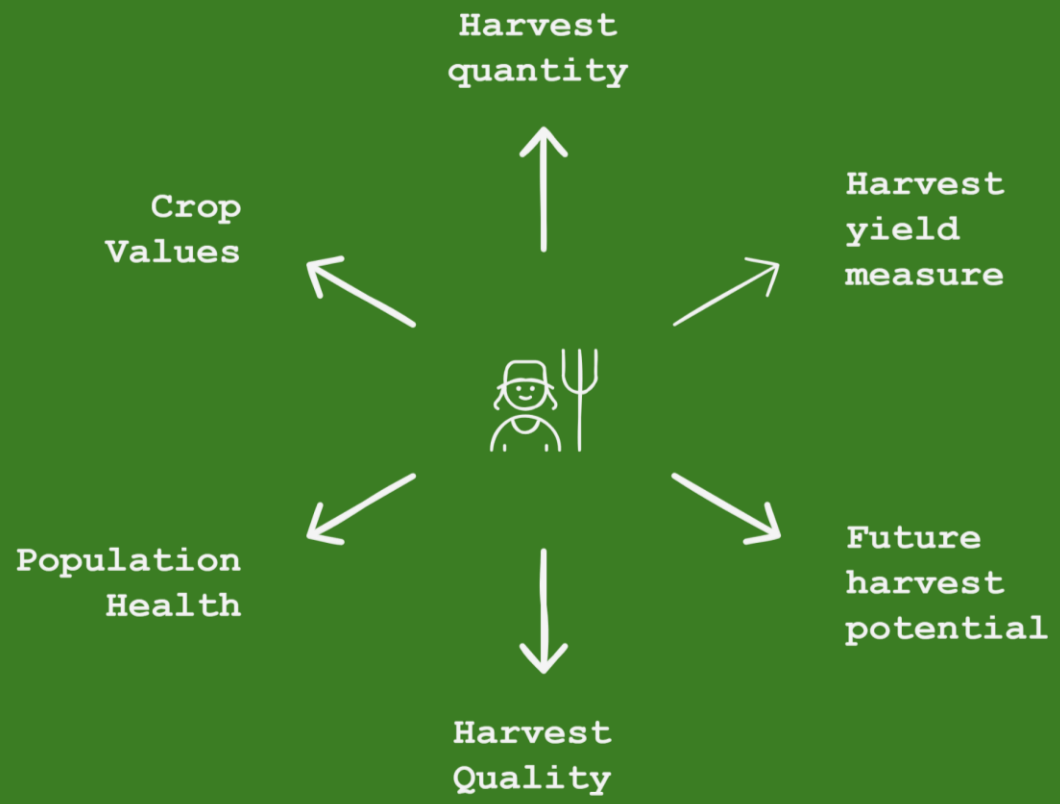
- Why agricultural insurance is needed to smooth the transition
- Reformulating the problem of data for assessing insurance risks
- Illustrations:
  - Mapping of insurable capital in vineyards
  - Creation of a database of typical farms
  - …

Harvest risk, a summary

Factors affecting crop value

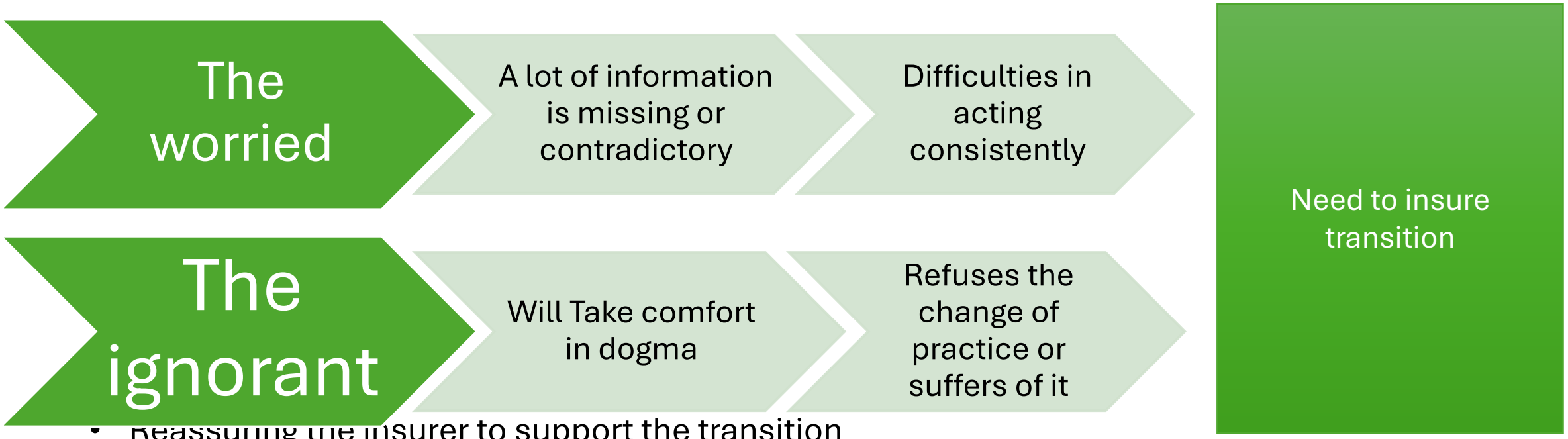


The harvest yield



Insuring ignorance

- The challenges facing the agricultural world are disruptive and, as a result, a source of some ignorance (for example, diseases now controlled by chemicals).



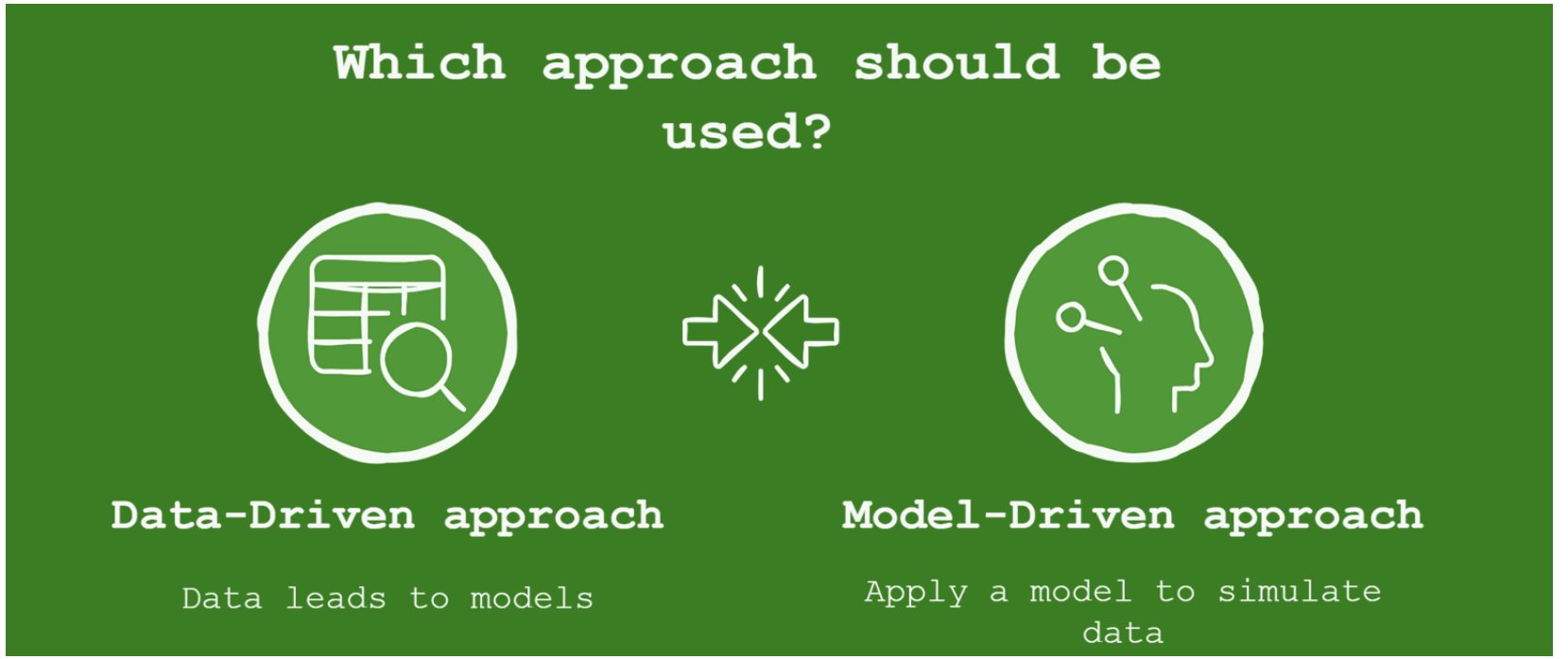
- Reassuring the insurer to support the transition
- Need for a best estimate of costs to ensure transition

One difficulty is obtaining adequate data for insurance purposes.

- Data structures
  - Spatial
  - Region / Landscape / Parcel / Intra-parcel
- Temporal
  - Minute: hail
  - Intra-annual: GDD/GDH
  - Historical/long term: Yields
- Spatio temporal
  - Pests
- Volume / accessibility / quality / inaccessibility
- Survey and test data

- Heterogeneous fields
  - Plants
    - Cultivation practices
    - Epidemiology
    - Pests
- Climate/weather
- Prices / margins
- Social / mass retirement
- Landscape
- Farm France

Databases do not take into account the complexity of the subject



- Actuarial modelling of the yield insurance for the Farm France
- Reinsurance of crop insurance
- Ban on neonicotinoids in sugar beet
- Oilseed rape Zero Insecticide
- Modelling the phenological stages of grapes

Why mapping insurable values in vineyards?

- **Wide variations** in value between vineyards
  - The appellation system (AOC/AOP): **yield limits**
  - The price of a wine depends on the reputation of its appellation and terroir

- Isolating the value of the harvest from that of the wine
  - Official statistics are based on the value of the **wine sold**.
  - Vinification is also used as an economic buffer.
  - Stock and vintage management.

- Lack of detailed public data
  - Detailed data exists but is subject to statistical confidentiality
  - Public data is too aggregated (by department, for example) and does not allow for detailed analysis at vineyard level.

- Without a map of production value, even a detailed analysis of winegrowing risks cannot be aggregated.

Why mapping insurable values in vineyards ?

Main sources :

1. **Customs wine register (CVI)**
   - Reliable but incomplete data per appellation or commune
   - Champagne excluded (4% of vineyards, 27% of exports)

2. **National Institute of Origin and Quality (INAO)**
   - List of authorized communes per appellation
   - Geographical maps (.shp)

3. **French Ministry of Agriculture**
   - Aggregated data per department and type of wine
   - Price scale for harvest insurance
   - Price per hectoliter and appellation

Mapping insurable values in vineyards
Methodological approach

- There is little theoretical literature on data combinations

- Problem reduction :
  - CVI -> appellations not secreted in the statistics
  - INAO authorizations -> 127 645
- Optimization program, with the following weightings:
  - AOP: 1, IGP: 1/3, VSIGP: 1/4

$$\text{maximize} \quad \sum_{a \in \mathcal{A}, c \in \mathcal{C}} \alpha_a s_{ac}$$

$$\begin{aligned}
\text{subject to} \quad \sum_{c \in \mathcal{C}} s_{ac} &\leq s_a, && \forall a \in \mathcal{A} \ \ (Appellations) \\
\sum_{a \in \mathcal{A}} s_{ac} &\leq s_c, && \forall c \in \mathcal{C} \ \ (Counties) \\
s_{ac} &\geq 0, && \forall (a,c) \in \mathcal{A} \times \mathcal{C} \\
s_{ac} &= 0 && \{\forall (a,c) \in \mathcal{A} \times \mathcal{C}\} \bigcap \{INAO_{ac} = FALSE\}
\end{aligned}$$

Mapping insurable values in vineyards
Results and validation

- **Stable convergence:** Kendall correlation > 99.8% between solutions

- **Departmental validation:** 88.8% Kendall correlation with official statistics by wine type

- **Total France:** €7.57 billion expected harvest value
    - AOP (Appelation Origine Protected) 69%,
    - Spirits “Eaux-de-vie” 13%,
    - IGP (Indication Geographique Protégée) 16%,
    - Wines without IGP 2%.

- **Average yield:** 60.6 hl/ha (high)

- Allows applications on meteorological data SAFRAN (Meteo France) or by agricultural region

Creating a typical farm data set
Why doing this?

- **Main objective:**

- Construct a representative set of typical farms reflecting spatial and technical-economic diversity
- Enable more detailed analyses and better communication with the farming profession

- **Combined data sources:**

- RICA (Réseau Information Comptable Agricole/Farm Accountancy Data Network) - anonymized economic data
- RPG (Registre Parcellaire Graphique) - precise location of plots of land
- MSA (Mutualité Sociale Agricole) - communal data
- Census of Agriculture - exhaustive ten-year view

Creating a typical farm data set
How?

Main challenge:

- Data is anonymized (RGPD) -> no direct merging possible
- Different granularities and geographical scales
- Variables cannot be directly matched

Mathematical optimization approach :

- Optimization model that statistically distributes RICA/FADN farms across agricultural regions
- Minimization of differences between observed and reconstructed local statistics
- Variables to be equalized: area per crop, livestock, standard gross product, etc.

Creating a typical farm
How?

Mathematical formula :

- Minimize the squared difference between regional data and the weighted sum of RICA/FADN farms.
- Constraints on extrapolation coefficients in FADN
- Resolution by administrative region (432 agricultural regions in France)

$$\min_{\alpha_{e,ra}} \sum_{ra \in \mathcal{RA}} \left(\sum_{Q \in \mathcal{Q}} \left(Q_\ell^{ra} - \sum_{e \in \mathcal{E}} \alpha_{e,ra} Q^e \right)^2 \right)$$

$$\begin{aligned} \text{sous réserve} \quad & \sum_{ra \in \mathcal{RA}} \alpha_{e,ra} \leq a_e, && \forall e \in \mathcal{E} \\ & \alpha_{e,ra} \leq \min(a_e, a_{ra}) && \forall (e, ra) \in \mathcal{E} \times \mathcal{RA} \\ & \alpha_{e,ra} \geq 0, && \forall (e, ra) \in \mathcal{E} \times \mathcal{RA} \end{aligned}$$

Other examples: satellite imagery, IoT and AI

- **Satellites, drones and IoT ultimately produce few data bases**

- Video playback since 2014-2016
  - Yolo 11 / Faster R-CNN / SSD / …
  - Roboflow / CVAT (MIT) / Make Sense …
  - Easy to train models
  - Cross-referencing with other sensors
  - Pl@ntNet 2014

- A growing literature :
  - Phenotyping,
  - Disease detection
  - Weed management
  - Yield estimation

- Systematize, produce, cross-reference and disseminate data over several years, harvests and plots

Universe

Search 500,000+ Open Source Computer Vision Projects...

← Back

pecan-yield

Instance Segmentation

GENERAL

Overview

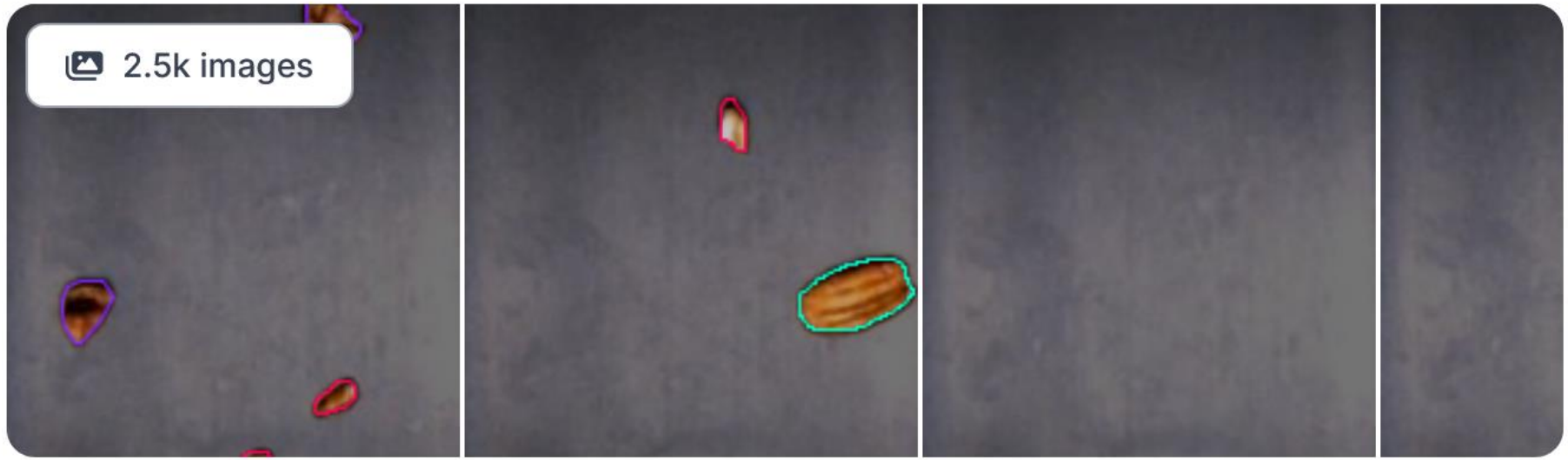
DATA

Images 2457

Dataset 3

Analytics

DEPLOY



pecan-yield Computer Vision Model

USDA Pecan Updated 3 days ago

Use this Dataset

Use this Model

0 stars

TAGS

Instance Segmentation Model yolov11 yolov11s-seg roboflow-3-s-seg

METRICS

mAP@50

89.7%

Coping with agroecological transition and climate change

AI or models for data production

Data modeling to reassure insurance companies

Insurance to ease the transition

Thank you for your attention !

Merci pour votre attention !

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3rd Workshop ARRUPVICO

Can insurance help farmers to take the risk of phytosanitary losses?

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September 25th 2025 - Bordeaux

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US crop Insurance scheme

Liberty Agriculture & Parametrics

Antoine KAHN – Agriculture & Parametrics Underwriter

US crop Insurance scheme

What is Federal Crop Insurance Program (FCIP)?

- Federal Crop Insurance Program (FCIP) was **established in 1938** following the Great Depression (prior to 1938, private sector unable to fund crop losses), **wheat** was the 1st authorized insured crop
- Designed to protect American farmers against crop losses due to **natural disasters** and **market fluctuations**
- Evolved significantly with the **Federal Crop Insurance Act of 1980**, expanded coverage and introduced **premium subsidies** to encourage participation
- This **Public Private Partnership** is vital for food security and sustainable farming
  - **Private insurance** companies sell and service policies
  - The **United States Department of Agriculture (USDA)** regulates and supports the program
- Latest Agriculture Improvement Act of 2018 - also known as the 2018 **Farm Bill** - has been extended by the Biden administration until 30/9/2025 (fiscal year) and 31/12/2025 (crop year)

US crop Insurance scheme

Role of the United States Department of Agriculture (USDA)

- United States Department of Agriculture (USDA) is an executive **department of the U.S. federal government**
- The Federal Crop Insurance Program (FCIP) is overseen by two entities under the USDA
  - the **Risk Management Agency (RMA)**
  - the **Federal Crop Insurance Corporation (FCIC)**
- USDA is responsible for developing and executing federal policies on food, agriculture, natural resources, rural development, nutrition, and related issues

US crop Insurance scheme

How does crop insurance work?

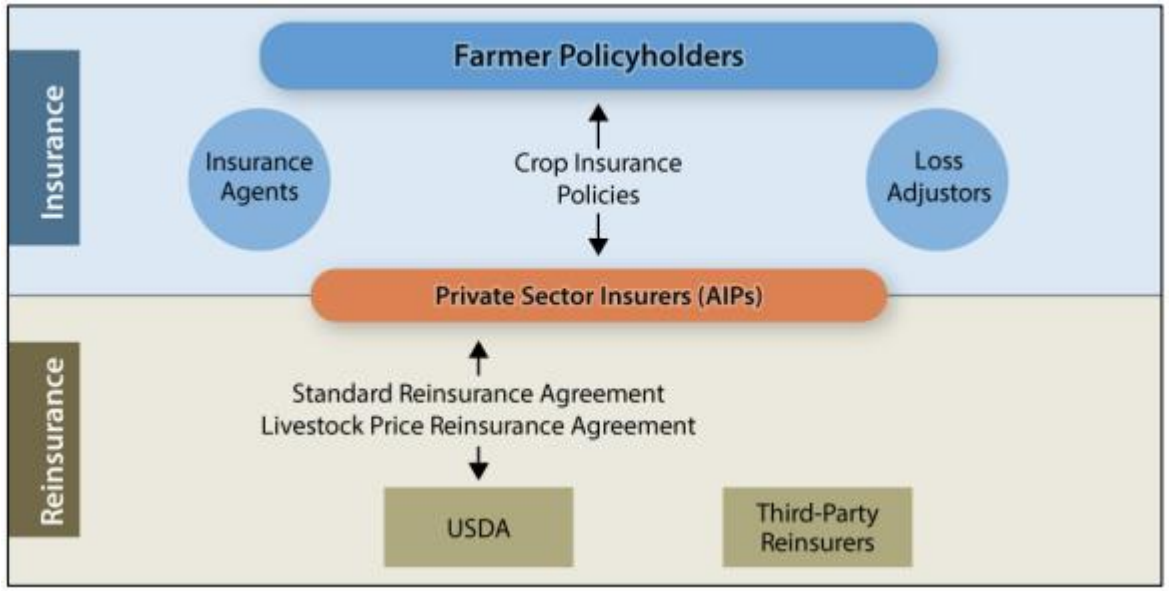
- **Standardized Agreements** between Federal Crop Insurance Corporation (FCIC) and insurance companies:
  - Standard Reinsurance Agreement - **SRA for crops**
  - Livestock Price Reinsurance Agreement - **LPRA for livestock**

  SRA and LPRA establish terms and FCIC provide reinsurance and subsidies on eligible crop insurance contracts sold by the insurance company

- Farmers buy insurance from **Approved Insurance Providers (AIPs)**
  - 12 AIPs for Standard Program (SRA)
  - 11 AIPs for Livestock Program (LPRA)
  - Some are Nationwide, others are operating in 1 State

US crop Insurance scheme
How does crop insurance work?

- **Approved Insurance Providers (**AIPs) cede a % of their underwriting risks to FCIC depending on the State
  - Tier 1, Tier 2 and Tier 3 states with various cession %
  - AIP added value: strategy on fund designation is key to overperform industry
  - FCIC provides reinsurance : shares in the losses and gains
  - AIPs must follow FCIC's policy terms and cannot modify them, very strict set of requirements



US crop Insurance scheme
Multi Peril Coverage

- Multi Peril coverage against drought, flood, hail, frost, disease, insect damage, and price drop
- Covers **more than 100 commodities** including
  - Field crops (corn, soybeans, wheat, cotton, etc.)
  - Specialty crops (perennial: fruits/nuts trees)
  - Livestock and animal products (milk, cattle, bees, etc.)
  - Grazing lands (pasture, forage, sustainable land management)
- Coverage is available in **all U.S. counties**, varies by location and commodity
- Farmers can choose from various policy types:
  - **Yield-based**: Protects against low production yields
  - **Revenue-based**: Protects against low revenue (yield x price).
  - **Area/index-based**: Based on county-level losses rather than individual farm results
  - **Whole-Farm**: covers all farm revenue
  - **Rainfall Index**: for pasture and forage

US crop Insurance scheme
Customized Coverage

- Who are the **buyers**?
  - Most large farms and those growing major crops
  - Smaller farms and organic producers less likely to participate
  - Lenders may require insurance for farm loans

- Farmers can choose among **many types of policies and policy options** to customize the coverage to their farm specific needs
  - **Basic coverage level** 50–85% of expected value
  - Higher coverage = higher premiums
  - Catastrophic (CAT) coverage available for severe losses
  - Lots of insurance coverage options available
  - Not all policy types (e.g., revenue vs. yield loss) are available in every state

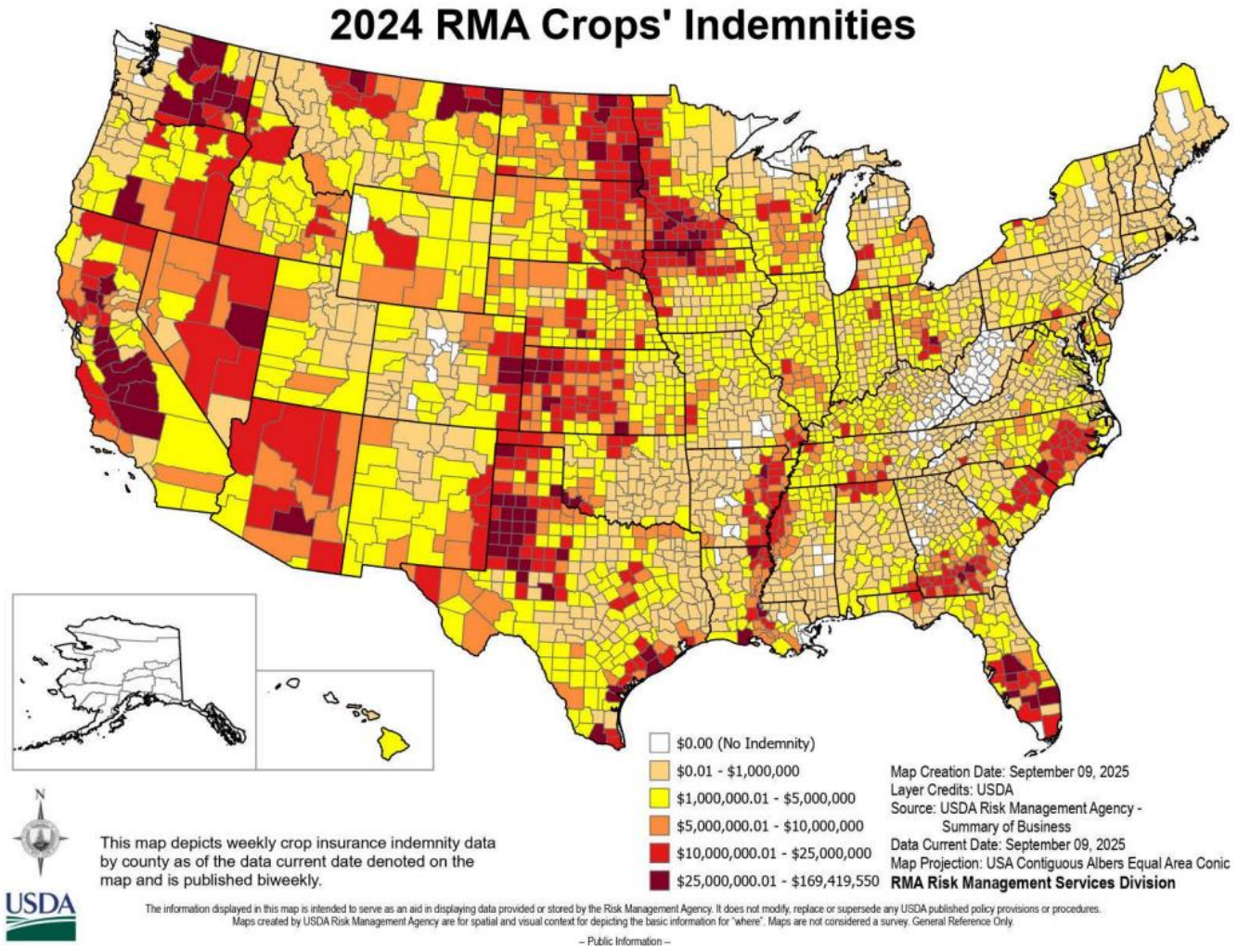
US crop Insurance scheme
Highly subsidized

- **Premium subsidies** from the federal Government
  - Farmers receive subsidies to make coverage affordable
  - Subsidy rates vary by coverage level and policy type
  - Up to 67% for basic coverage (100% for CAT)
  - Administrative fees also apply

- **Claims** management
  - Farmers file a claim, if approved, the insurance company pays an indemnity
  - USDA and insurers share responsibility for safeguarding the FCIP against fraud
  - USDA’s Farm Service Agency use technologies like GIS, improving claim processing and fraud detection

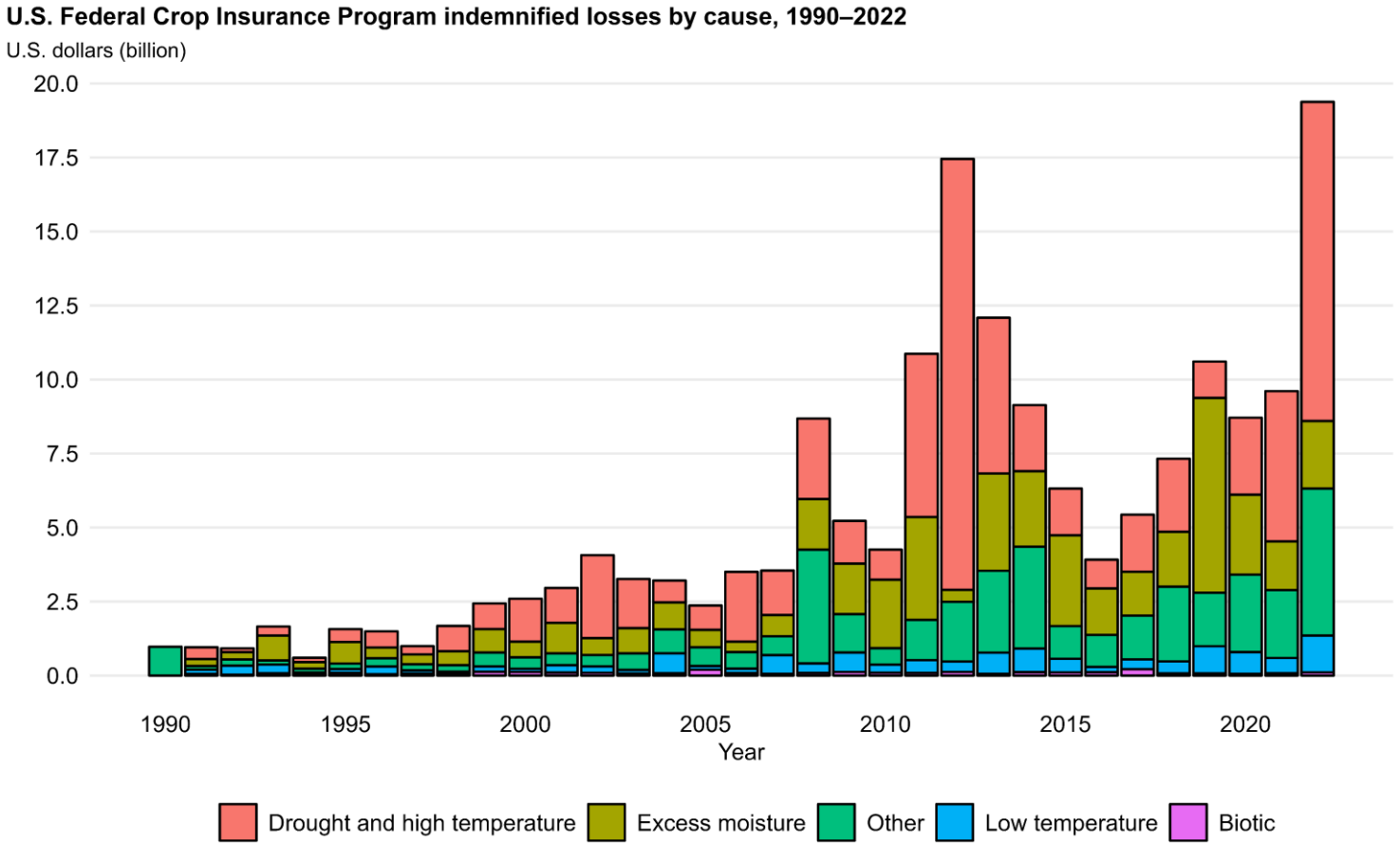
US crop Insurance scheme
2024 Participation

- More than 2 million policies
- Planted acres
  - More than 90% for corn, soybeans, and cotton
  - More than 85% for wheat
- Total Sum Insured **$192Bn**
- Total premium **$17.3Bn** with **$10.4Bn** subsidies
- Indemnity **$15.6Bn**
- Gross loss ratio **90%** (99% in 2023)



US crop Insurance scheme
Coverage of Phytosanitary losses

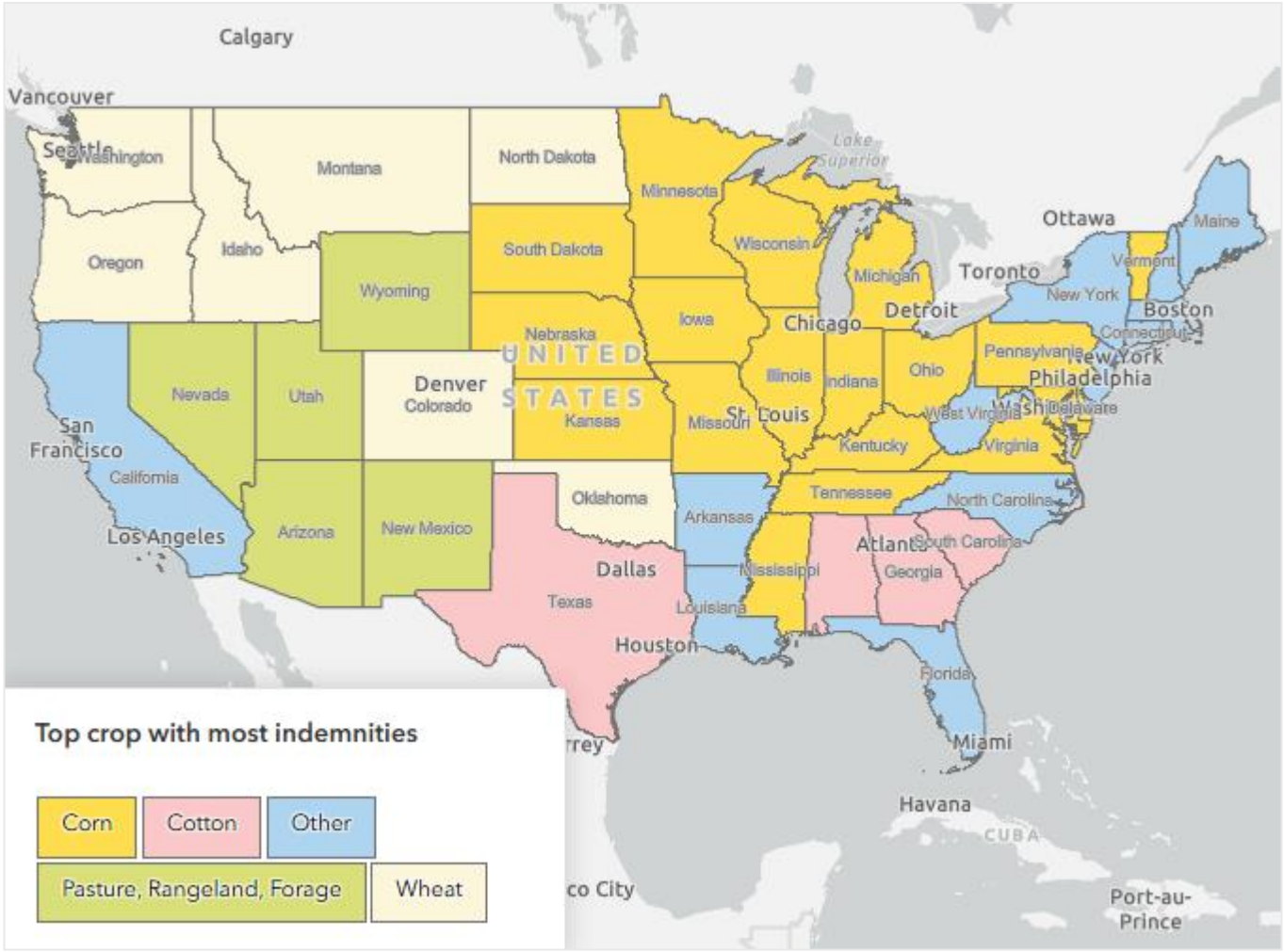
- Since 2000, few indemnified losses are related to Biotic damages
- This is explained by the generalized usage of phytosanitary products
- The Environmental Protection Agency (EPA) regulates their usage
- More than 25% of used solutions in the US are forbidden within EU



Note: "Drought and high temperature" includes indemnities due to drought, failure of irrigation supply, failure of irrigation equipment, inability to prepare land for irrigation, heat, hot wind, and fire. "Excess moisture" includes indemnities due to excess moisture, precipitation, rain, and flood. "Low temperature" includes indemnities due to cold wet weather, cold winter, freeze, and frost. "Biotic" includes indemnities due to plant disease, wildlife, insects, mycotoxin, and Asian soybean rust. "Other" includes indemnities due to all other causes not explicitly listed. FCIP data are from the Risk Management Agency Summary of business as of May 7, 2024.
Source: USDA, Economic Research Service, using data from USDA, Risk Management Agency.

US crop Insurance scheme
In summary

- Revenue component remain the main specificity of the FCIP compared to other territories
- Crop-Hail Insurance and Private Product sold with MPCI but not subsidized
- US land widely diversified



Crop insurance payouts for top crops by state (2001 – 2022)

Thank you for your attention !

Merci pour votre attention !

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Viewpoint of an international broker
Mickael GORECKI

Willis Towers Watson France

Final Workshop– 24-25 Sept 2025

A Strategic Opportunity

A broker sees the agroecological transition as **a strategic opportunity to reshape the agricultural insurance market**:

- Emerging coverage needs
- Growing demand for tailored solutions
- A chance to position as a trusted partner in a sustainable transformation

“The agroecological transition is not just a challenge—it’s a lever to reinvent agricultural insurance.”

Titre de la diapositive/slide title

Role as a Facilitator

The broker plays a key role as:

- An intermediary between wine growers and insurers
- A risk management advisor for new agricultural practices
- A promoter of innovative solutions (indexed insurance, parametric models, climate multi-peril coverage)

They also support farmers in:

- Understanding coverage options
- Optimizing insurance portfolios
- Accessing subsidies and public schemes

Titre de la diapositive/slide title

Technical and Collaborative Vision

The broker must:

- **Rely on reliable data** (agronomic, weather, satellite)
- **Collaborate with technical stakeholders** (AgTech startups, cooperatives, research institutes)
- **Co-develop insurance products** with insurers

“Tomorrow’s insurance must be built with wine growers—not just for them.”

Titre de la diapositive/slide title

Key Challenges

- **Market education**: explaining new risks and solutions
- **Adapting economic models**: accounting for yield variability
- **Building trust**: ensuring transparency in coverage mechanisms

Conclusion

As a broker, supporting the agroecological transition means anticipating tomorrow’s risks, offering tailored solutions, and actively contributing to the resilience of agriculture. It’s also a unique opportunity to give insurance a renewed purpose—serving a more sustainable and responsible model.

Thank you for your attention !

Merci pour votre attention !

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Feedback on a case of vineyard yield protection for phytosanitary losses : can insurance cover the risk of producers when reducing the usage of synthetic pesticides ?

Vincent Féraud
Head of Agriculture and Nature Insurance
AXA Climate

Session 5 – the insurer's point of view:

Is the agro-ecological transition insurable? How can risk be pooled and covered?

Final Workshop– 24-25 Sept 2025

AXA Climate model and origination of this pilot project

AXA Climate

Science Scientific expertise at the core of our business

Data Quantify physical and financial risks

Insurance
To protect humans, nature, and economic activities from climate risks

Training
To boost scientific and professional knowledge of nature and climate

Consulting
To support organisations in their adaptation and transformation

Finance
To structure mechanisms and strategies to finance the transition

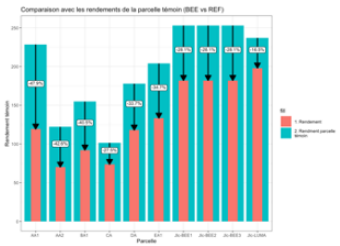
RÉMY COINTREAU

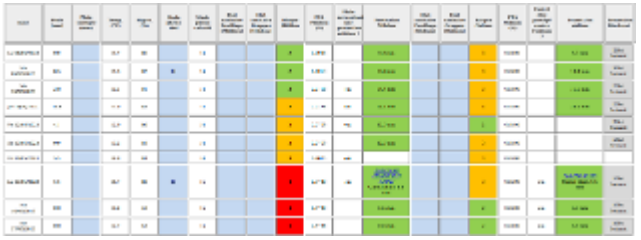
Client: Rémy Cointreau
Market: Cognac (France)
Credentials: Transition insurance, pesticide reduction, decision support system

Objective of the mission: Develop an insurance product to convince wine growers to reduce the usage of chemical pesticides

Outcomes: Structuration and pricing of a hybrid insurance product based on a yield index and in-field disease measurement. In addition, the usage of a decision support tool (precision farming) to reduce risk was also integrated as a core part of the insurance product

Deliverables: Transition insurance product now running for two years and covering yield drop resulting from pesticide use reduction





Context for this insurance program

COGNAC

Cognac production

- Cognac is an AOP, collecting wine from 4k+ winegrowers in the region, and main job provider in the Cognac region
- 97.5% of cognac production is exported (154m of bottles)
- Primarily, Rémy Cointreau is mainly producer (distilleries) and distributor of cognac spirits. Rémy Martin being one of the ”big four” cognac houses.

ÉCOPHYTO
RÉDUIRE ET AMÉLIORER L'UTILISATION DES PHYTOS

Pesticides and biocontrol treatments

- Pesticide are synthetic products, which are highly targeted and biocidal. This efficiency often works as a kind of insurance against diseases (mildew, powdery mildew (oïdium), black rot). It’s cheap for the growers, but expensive for the environment and it’s inhabitants
- Biocontrol products can be defined as stimulators of natural plant defences, repellents, environmental modifiers, etc. This includes micro-organisms like bacteria, yeasts, fungi, viruses, but also chemical mediators, or natural substances.

RÉMY COINTREAU

Pesticide reduction program

- Rémy Cointreau was looking to support part of its winegrowers to reduce pesticides usage on grapes by turning to biocontrol products
- Insurance has been identified as key instrument to convince them that they will not be worst off compared to winegrowers that spray their grapes

Description of the insurance program

What is covered?

- Yield losses linked with the outspread of wine disease (mildew, powdery mildew (oïdium), black rot)

What are the conditions for the coverage to be valid?

- Pest management strategy is based almost exclusively on biocontrol treatments
- The grapes are appropriately protected using the biocontrol treatment (the **use of a Decision Support Tool** is mandatory)

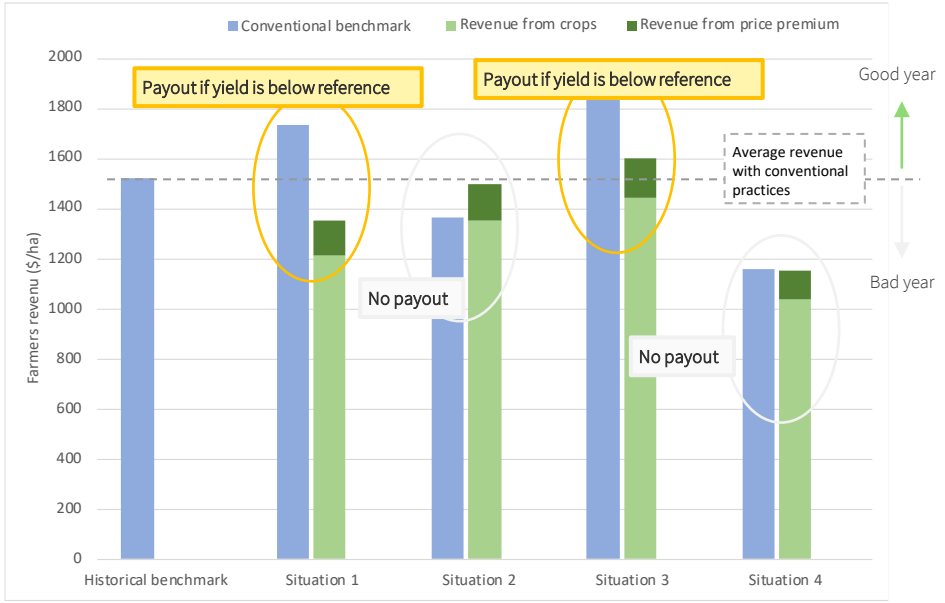
How are the losses assessed?

- Physical loss adjustment is performed in the grapes at specific development stages to assess yield losses
- Correct usage of the biocontrol treatment is evaluated using a set of rules (traceability) that relies on comparing actual application with the recommendation of the Decision Support Tool

Bureau National Interprofessionnel du Cognac

DeciTrait

Decision Support Tool (DeciTrait - IFV) - monitoring



Lessons learnt from this first pilot

2023 and 2024 : bad conditions to start a new insurance program

- 2023 was wet and warm : high production of grapes but also very favourable to mildew
- 2024 was wet and cold : high disease pressure from mildew + yield drops, even in case of conventional pesticide usage (gap in biocontrol/conventional wasn't so large)
- In context of high disease pressure, high yields lead to high differential biocontrol/conventional while low yields lead to smaller gap (correlation)

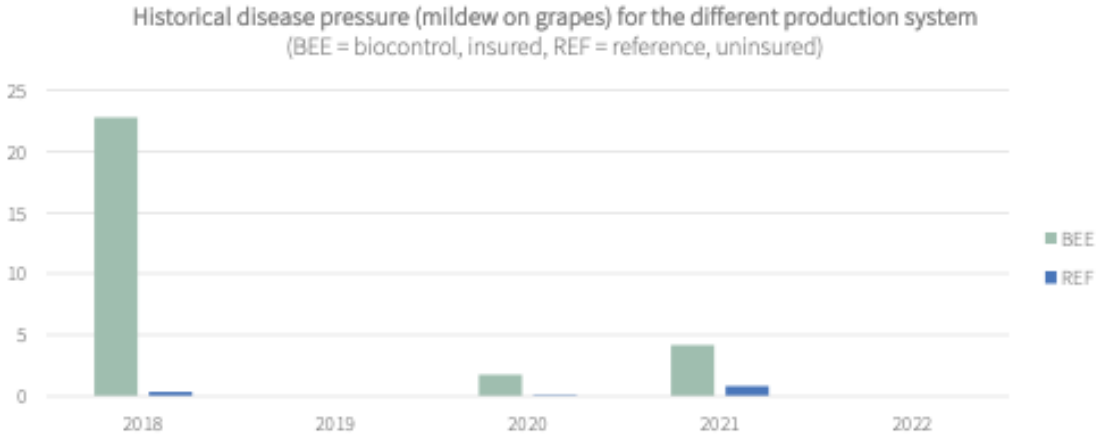
Transition program are complex to set-up

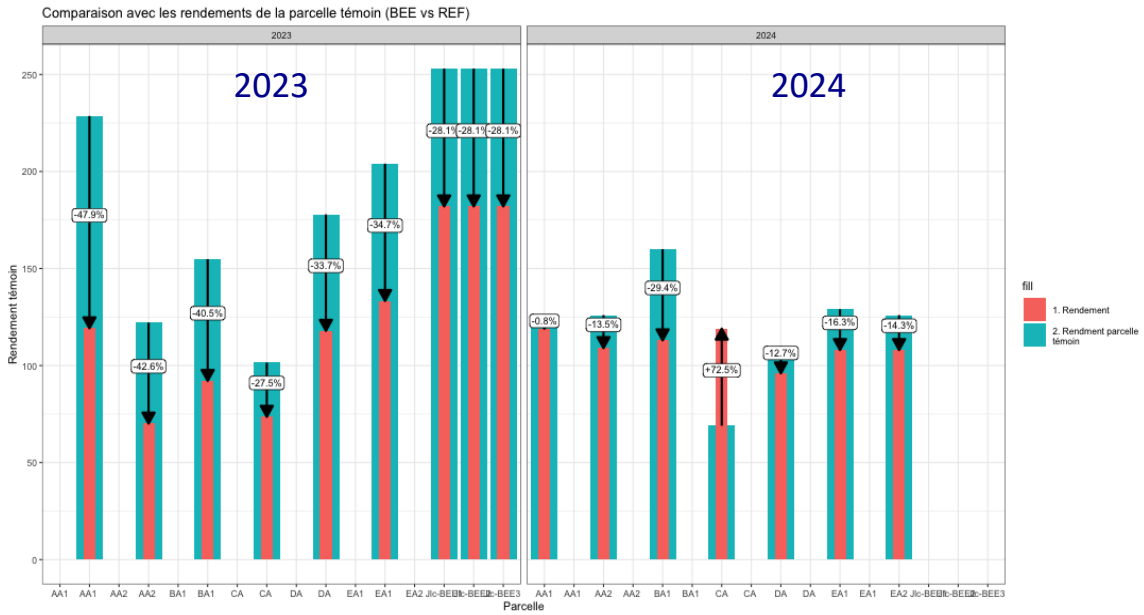
- Continuous improvements made on structure (covering only years with low yields) but dependant on available data
- Better understanding of the risk is a key area of investment to deploy transition programs (e.g. climate correlations in new practice, age of plots, etc)

→ experience gained over last few years and building up our transition risk expertise

Solidity of the business case is crucial to establish transition insurance on long-term

- Pesticide reduction is a case for insurance (high volatility) but no clear financing mechanism (or regulatory) to extend it beyond RSE budget (esp. specialty crop)
- Cognac crisis: tariffs from USA and China, sales have drop dramatically. Overproduction cuts down interest in any insurance (from high yields quotas to minimal quotas)
- Even with insurance that pays losses, chemical pesticide on speciality crop is a very costly move





After a couple of years of experience, our perspective on Ag transition insurance

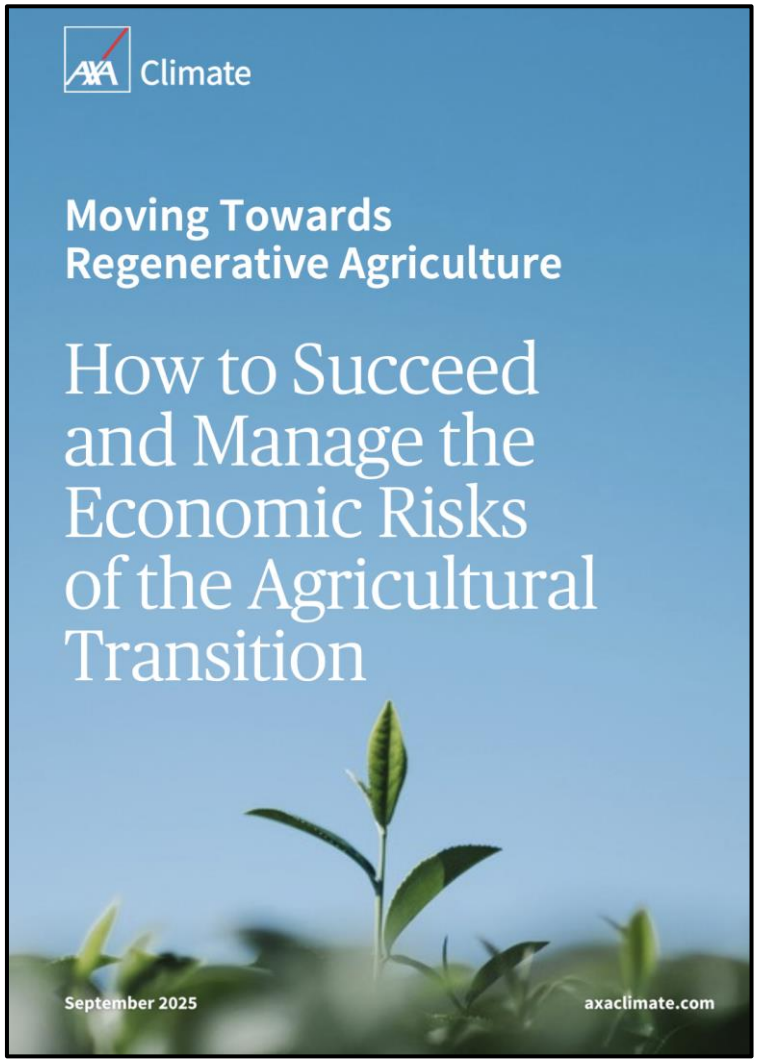
The agricultural transition is a complex process, impossible to sum up in a single statistic. There is no single transition. There exists a multitude of pathways, each with its own specific risks and costs, to be assessed in its local context, according to the practices and crops involved.

Our approach at AXA Climate to supporting this transition:

- Meet in situ with key players
- Understand local and territorial specificities
- Decipher and make accessible the costs and risks associated with transition practices (temporality, nature of the risk, underlying perils, scalability, etc)
- Co-develop appropriate financial solutions
- Act as an insurer for the transition

	Few underlying risks, well understood	Many underlying risks, poorly understood
LOCALIZED RISKS		
High impact of practice change	Agro-meteorological model with farm-specific parameters (sowing date, soil, fertilization level)	Farm-wide yield index
Low impact of practice change	Satellite plot index, field measurements or a hybrid of the two	Yield difference vs. counterfactual experience at field scale (via precision farming tools)
SYSTEMIC RISKS		
Strong impact of practice change	Weather index or hybrid index at regional level	Yield index relative to regional statistics
Low impact of practice change	Measure of the peril on representative samples	Yield index between practice group and reference group

Example for a different business case:
Potential to use Disease Pressure Models as a basis of parametric insurance coverage for relevant crops



Moving Towards Regenerative Agriculture

Thank you for your attention !

Merci pour votre attention !

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A time for sharing perceptions on existing initiatives and requirements

Can insurance secure farmers' risk-taking in the face of crop health losses?

A time for discussion on current initiatives and the perception of needs.

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Prospects and identification of research areas

Luc BOUCHER

Final Workshop– 24-25 Sept 2025

Session 6: Perspectives and identification of research axes

- 1:30 pm – 4:00 pm
- 14:00 – 14:10 Introduction
- 14:10 – 15:00 Inventory of problems / group
- 15h00 -16h00 : Pooling discussion exchanges

Brainstorming

- **Creation of groups**
- **Ideas**
  - **Priorisation** (post-it)
  - **Selection of 3 - 4 ideas** (2 quarts max)
- **Description**
- **Presentation to group in plenary session at the end**

Identification of issues

1 – Risk knowledge and modelling	3 - Markets and regulations
2 – Technical combinations	4 – Mobilizing professionals

GOUVERNEMENT
Liberté
Égalité
Fraternité

ÉCOPHYTO
RÉDUIRE ET AMÉLIORER L'UTILISATION DES PHYTOS

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