



EAAP 2026, 07.09.2026, Hamburg, Germany

Resilience of European livestock systems: multiple scales, context specificity and methodological insights

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INRAE

la Repubblica

EL PAÍS | 50
EL PERIÓDICO GLOBAL

La sequía asfixia a las ganaderías de toros de lidia

Los costes se han duplicado por alza de los precios de los alimentos y la energía y la falta de agua, según la presidenta de la Asociación de Ganaderías de Lidia



Una ganadería de toros bravos en la zona de Bailén (Jaén).
JOSÉ MANUEL PEDROSA EFE

Cinta senese di nuovo a rischio: “La peste suina africana può distruggere gli allevamenti”

di Leonardo Romanelli

L'allarme del Consorzio che tutela una delle razze autoctone più antiche e rappresentative del patrimonio agroalimentare italiano. Entrando in contatto con cinghiali o altri animali i capi possono essere contagiati



Le Monde

« Tout le monde a la boule au ventre » : situation de crise pour l'agriculture française, entre deux canicules

Cultures brûlées, élevages décimés, baisse de production à deux chiffres pour certaines filières : les exploitants dressent le bilan des très fortes chaleurs de la fin juin et redoutent déjà les suivantes.

Par Manon Rescan

Publié le 03 juillet 2026 à 05h00, modifié le 03 juillet 2026 à 12h18 · Lecture 5 min.

· [Read in English](#)



Dans l'une des prairies de Yannick Frain, éleveur d'agneaux pré-salés, à Roz-sur-Couesnon (Ille-et-Vilaine), le 29 juin 2026. LOUISE QUIGNON POUR « LE MONDE »

RESILIENCE

The capacity of a system to deliver its functions in the face of challenges

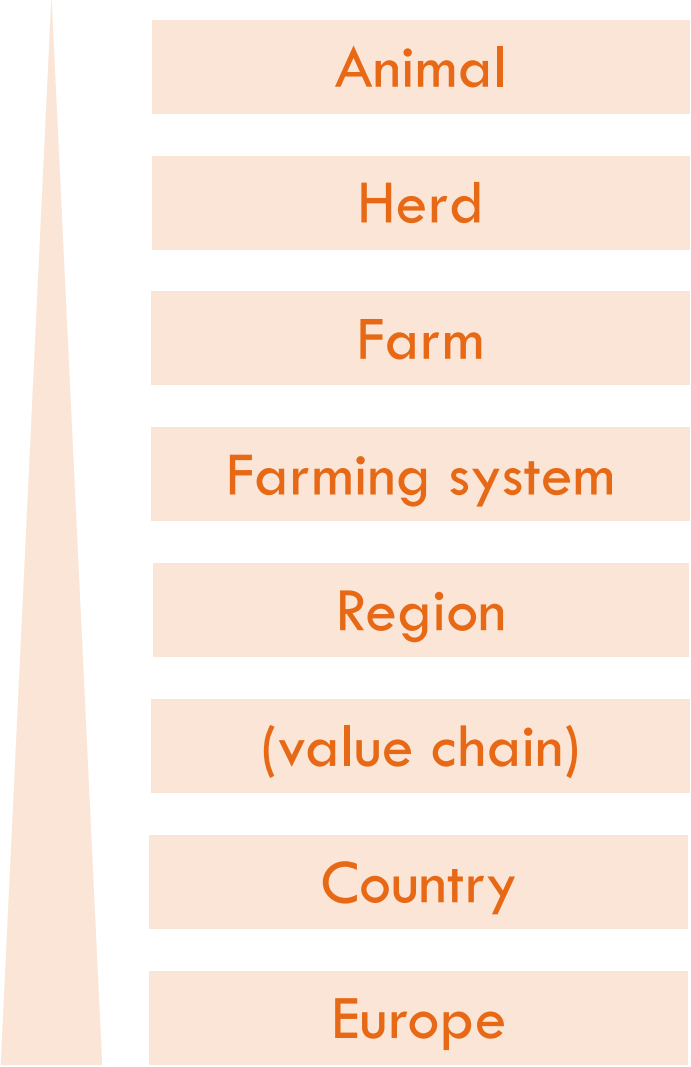
Resilience
of what
to what
for what
purpose ?

Carpenter et al. (2001) + *Meuwissen et al (2019)*

Resilience
of what —————→
to what
for what
purpose ?

There are
different **levels** at
which we can put
the **boundary**





Animal

Herd

Farm

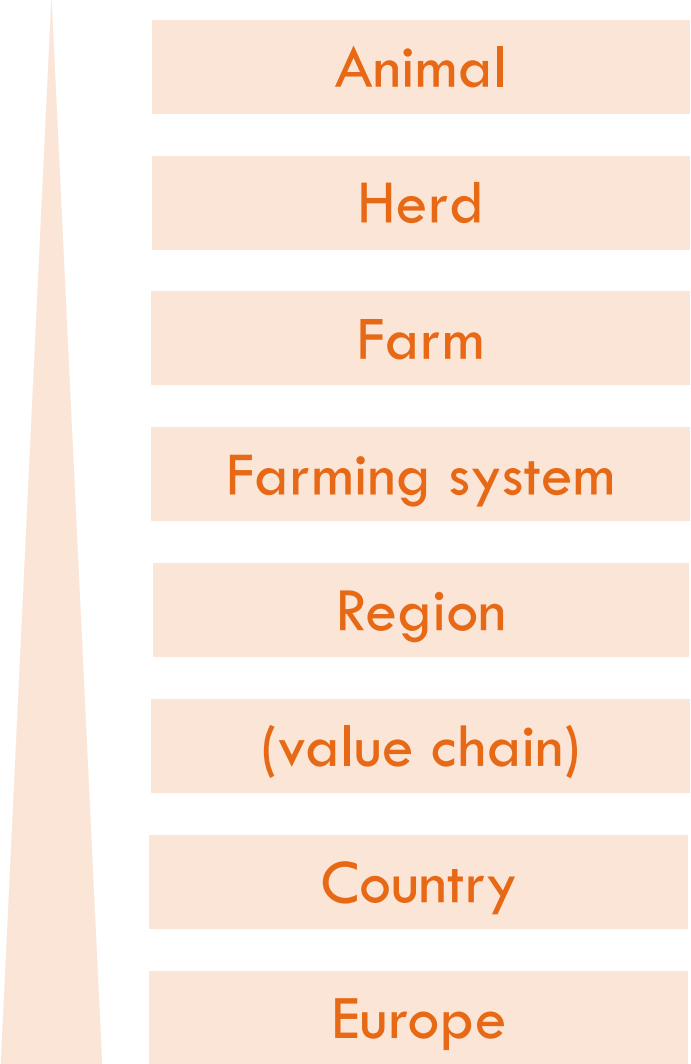
Farming system

Region

(value chain)

Country

Europe



Animal

Herd

Farm

Farming system

Region

(value chain)

Country

Europe

For each scale/level:

Different actors

Different visible elements

Different possible actions

Livestock systems are characterized by:

MULTIPLE SCALES

Resilience
of what
to what —————→
for what
purpose ?

There are multiple
possible
challenges

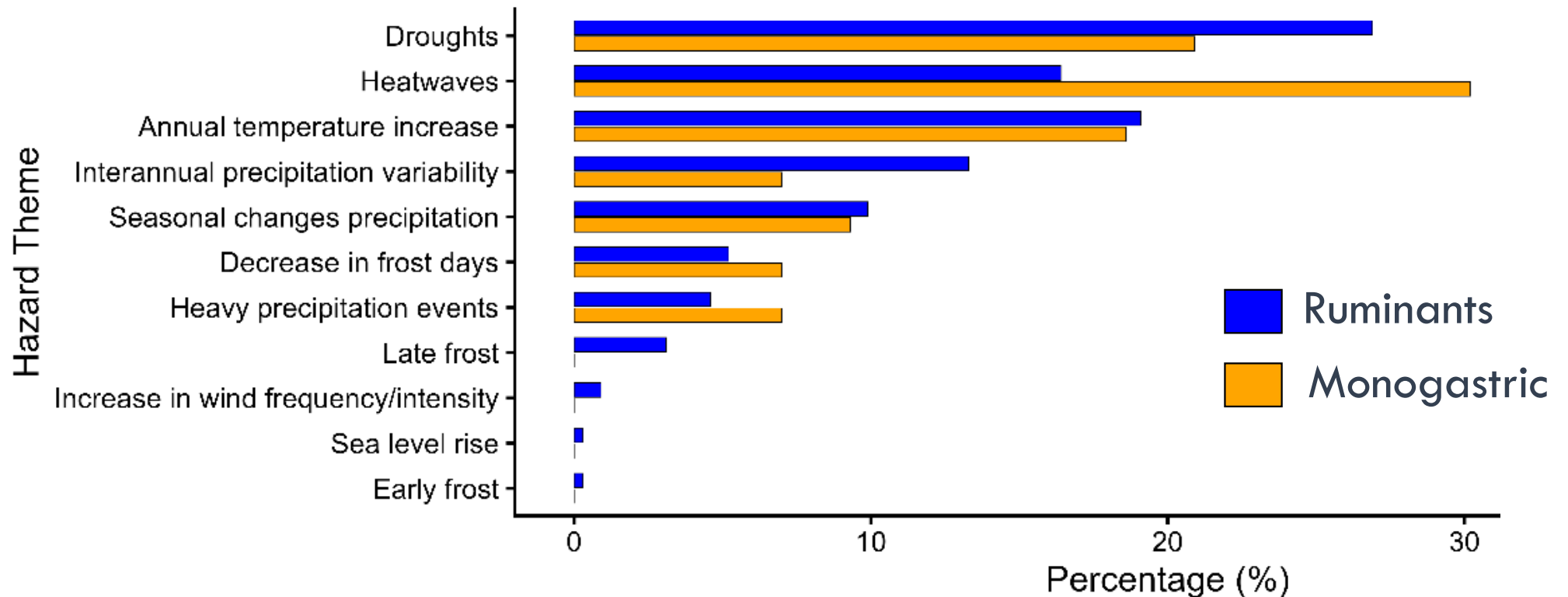
Which are the main **climate-related hazards** and **impacts** to livestock systems in the different parts of France?



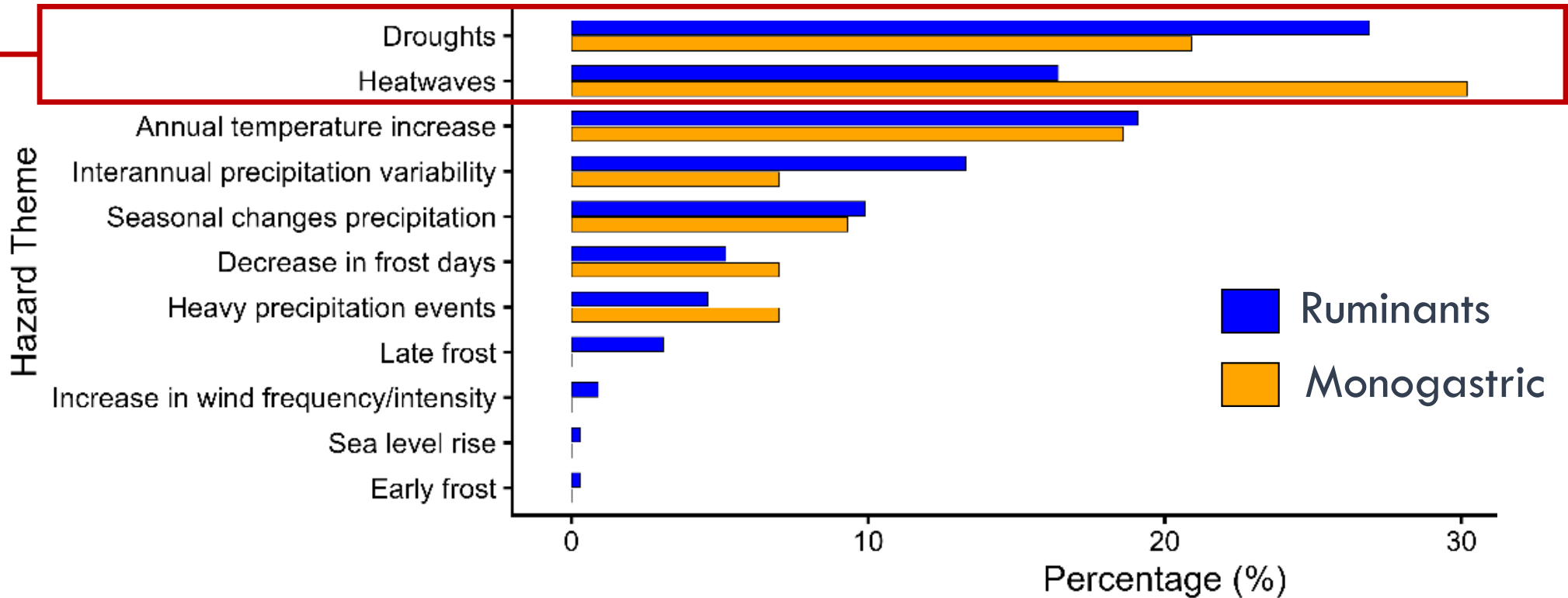
Laurine Coré--Brazier

- 85 gray literature documents reviewed
- 27 stakeholder interviews

Main climate-related hazards and impacts to livestock systems in the different parts of France

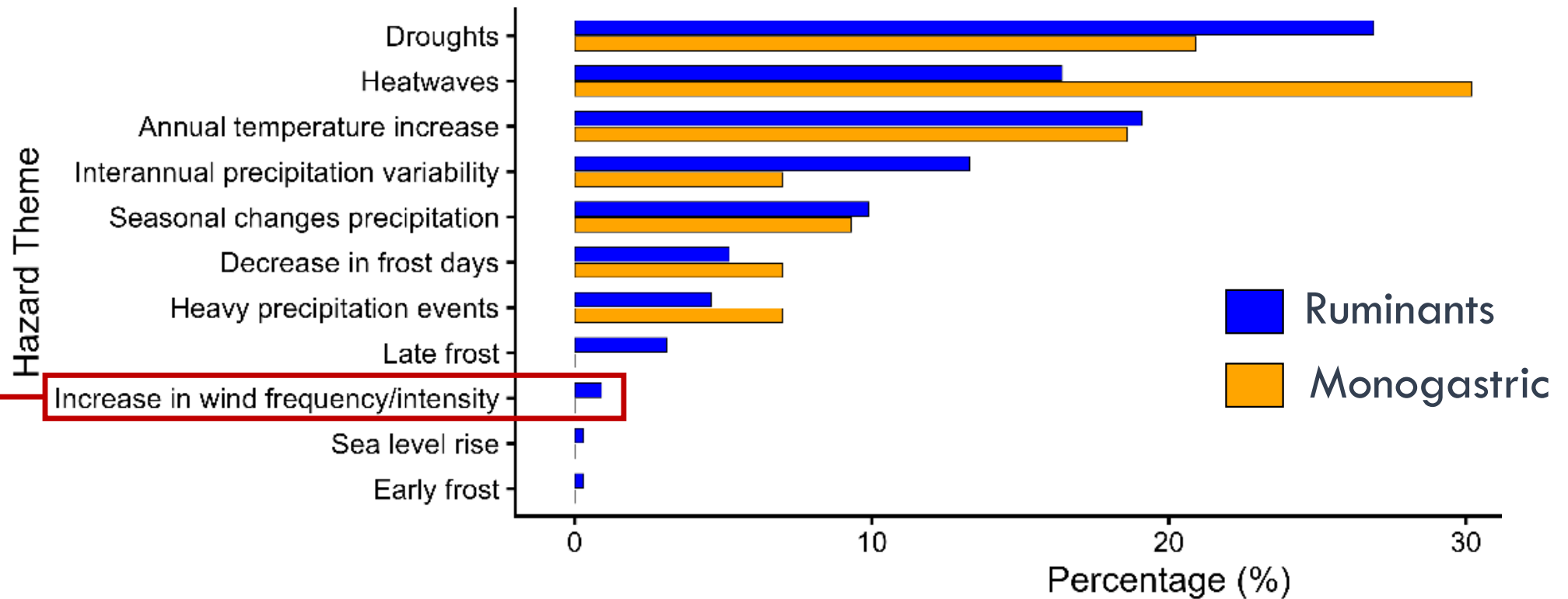


Main climate-related hazards and impacts to livestock systems in the different parts of France



Most frequent, different for ruminants and monogastric

Which are the main **climate-related hazards** and **impacts** in the different parts of France?



Very specific and rare but not less important

Heatwaves and droughts

```
graph TD; A[Heatwaves and droughts] --> B[Brittany]; A --> C[Auvergne-Rhone-Alpes]; B --> D[Uncertain shocks]; C --> E[Gradual but intensifying pressures]; F[Perceptions on challenges depend on geographical and historical contexts];
```

Brittany

Uncertain shocks

Auvergne-Rhone-Alpes

Gradual but intensifying pressures

Perceptions on challenges depend on geographical and historical contexts

Livestock systems are characterized by:

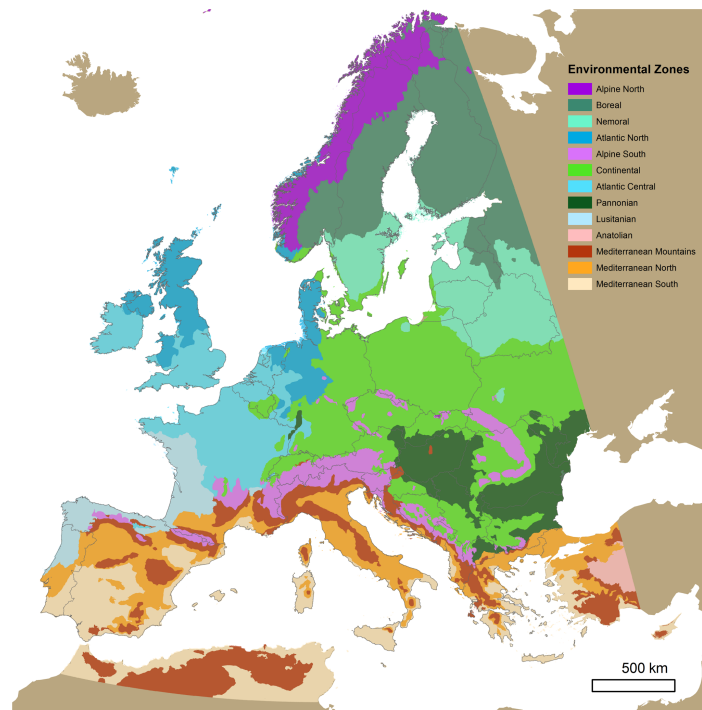
MULTIPLE SCALES

CONTEXT-DEPENDENCY

Europe is highly heterogeneous

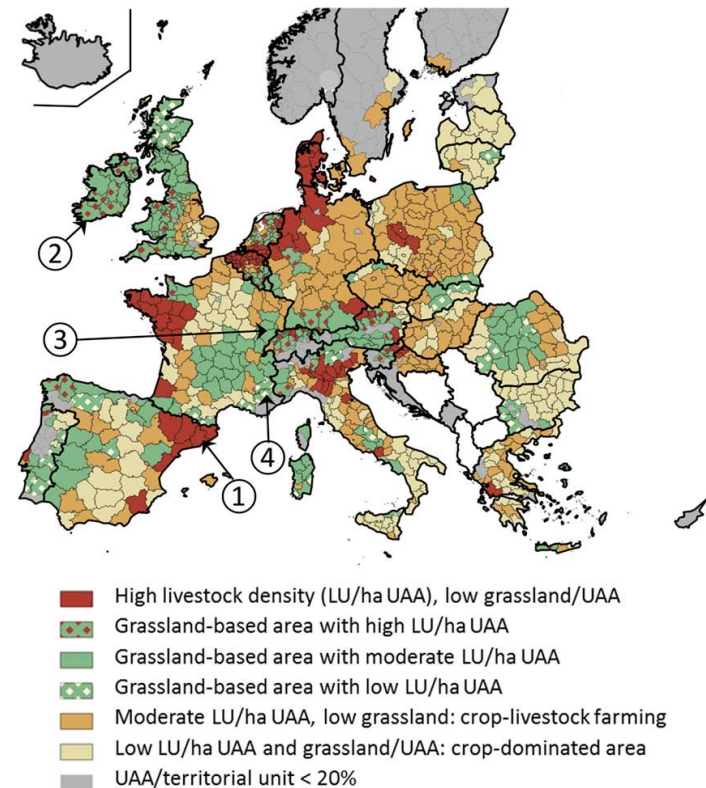
Environmental heterogeneity

Metzger 2018



Livestock heterogeneity

Dumont et al., 2017



A diversity of challenges (only a few examples)

ENVIRONMENTAL

Heatwaves and
droughts

A diversity of challenges (only a few examples)

ENVIRONMENTAL

Heatwaves and
droughts

ECONOMIC

Low economic
viability of farms

A diversity of challenges (only a few examples)

ENVIRONMENTAL

Heatwaves and
droughts

ECONOMIC

Low economic
viability of farms

SOCIAL

Societal pressure on the
livestock sector

A diversity of challenges (only a few examples)

ENVIRONMENTAL

Heatwaves and
droughts

ECONOMIC

Low economic
viability of farms

SOCIAL

Societal pressure on the
livestock sector

INSTITUTIONAL

Continuously changing
norms and regulations

Livestock systems are characterized by:

MULTIPLE SCALES

CONTEXT-DEPENDENCY

MULTIPLE DIMENSIONS

Resilience
of what
to what
for what
purpose ?

Resilience
of what
to what
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What do livestock
systems deliver?

LIVESTOCK SYSTEMS ARE **NOT**
ONLY ABOUT FOOD
PRODUCTION

Bocage Bourbonnais



Which other goods are provided by livestock systems other than food?



Which other goods are provided by livestock systems other than food?



Landscape identity

Biodiversity

Animal welfare

Social welfare

[...]

Methods for assessing resilience

Methods for assessing resilience

Quantitative

Qualitative



Methods for assessing resilience

Quantitative

Qualitative

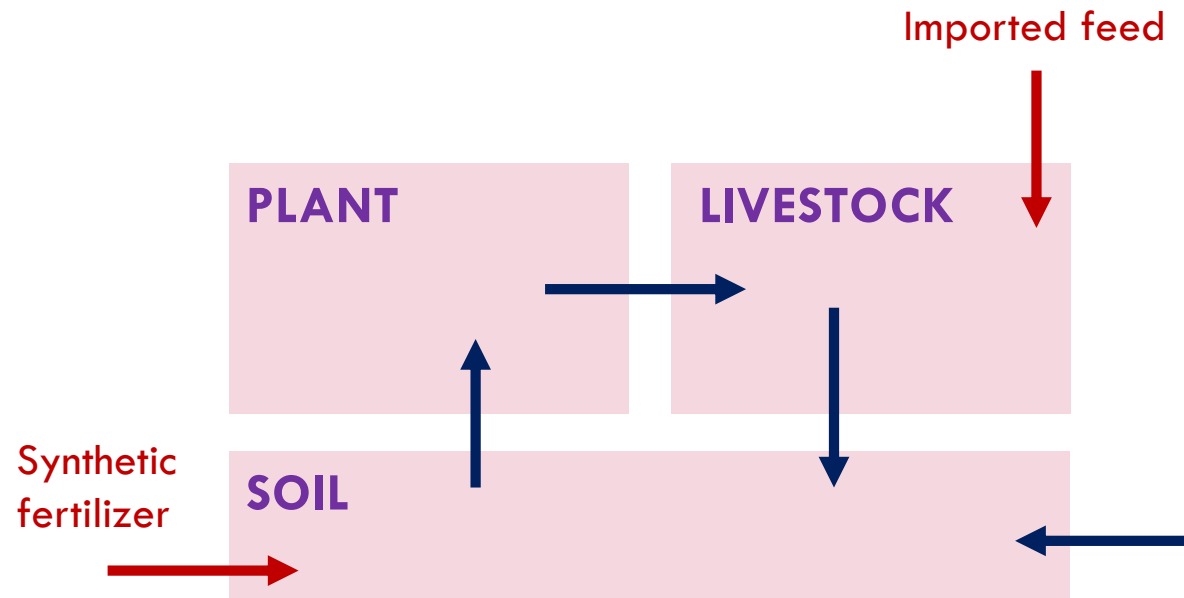


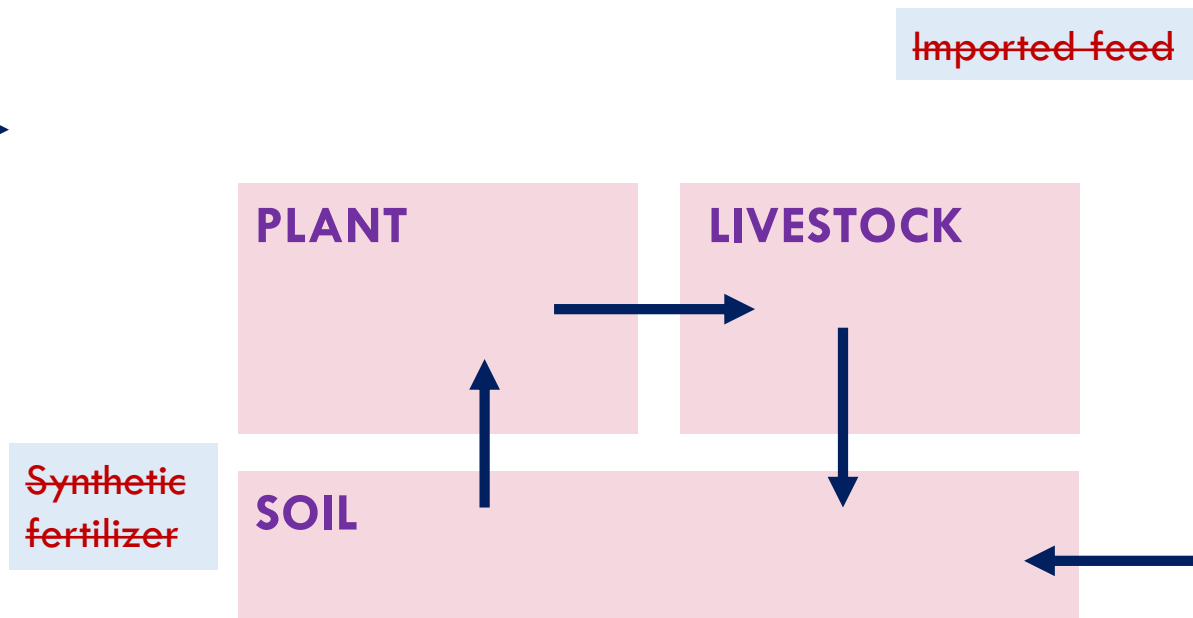
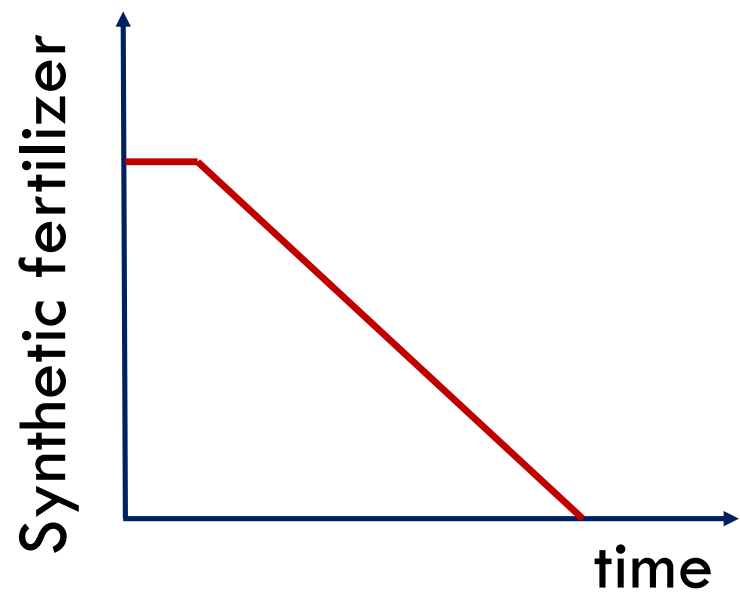
Simulation models

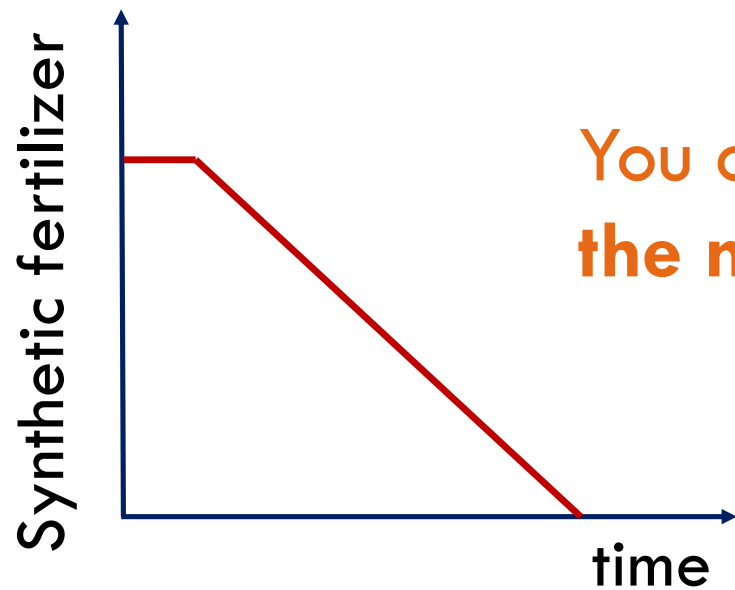
How resilient is an agricultural region to decrease in synthetic fertilizer and imported feed availability?



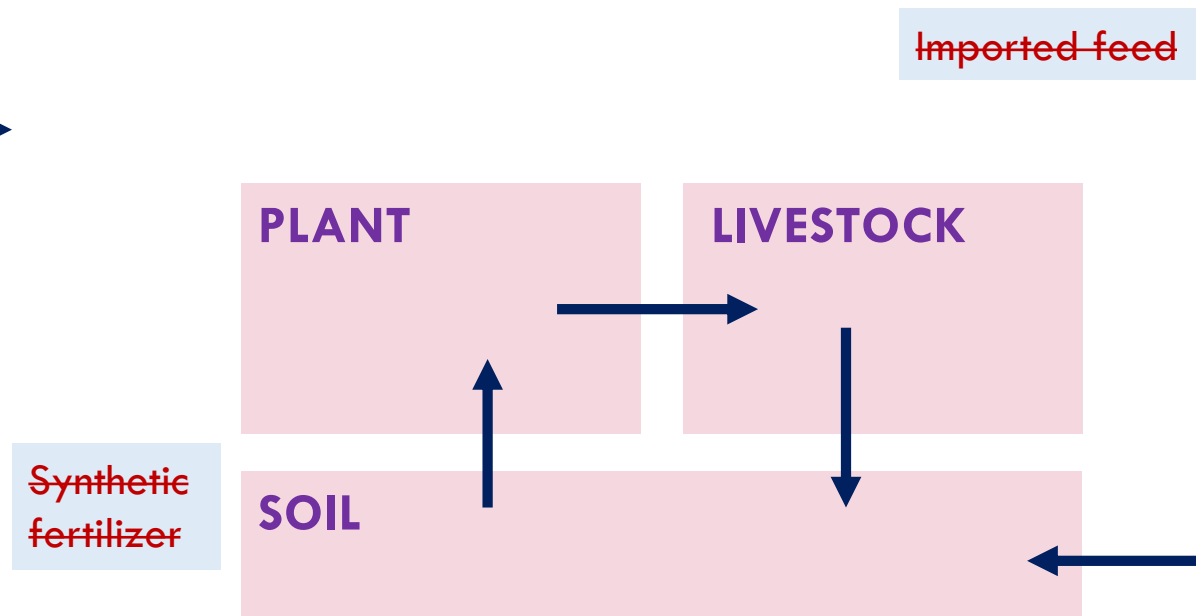
Modelling a region in terms of nitrogen compartment and fluxes







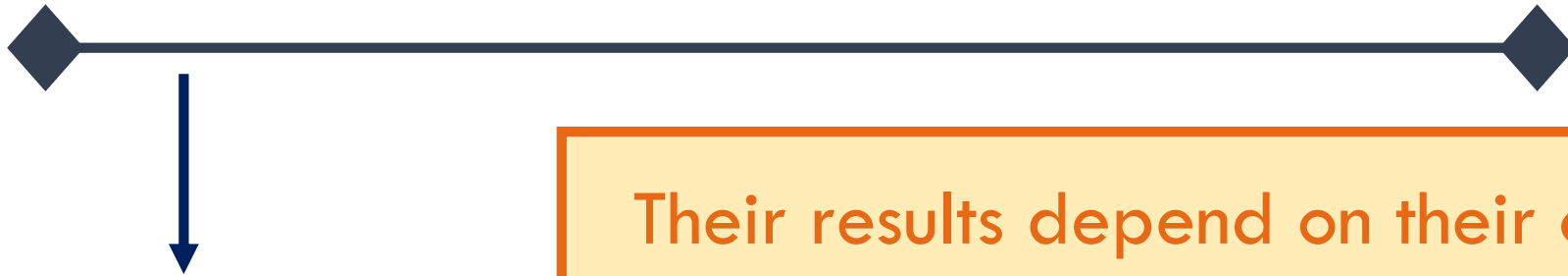
You can model only things **included in the modelling framework**



Methods for assessing resilience

Quantitative

Qualitative



Simulation models

System dynamics

Agent-based models

Their results depend on their own
assumptions

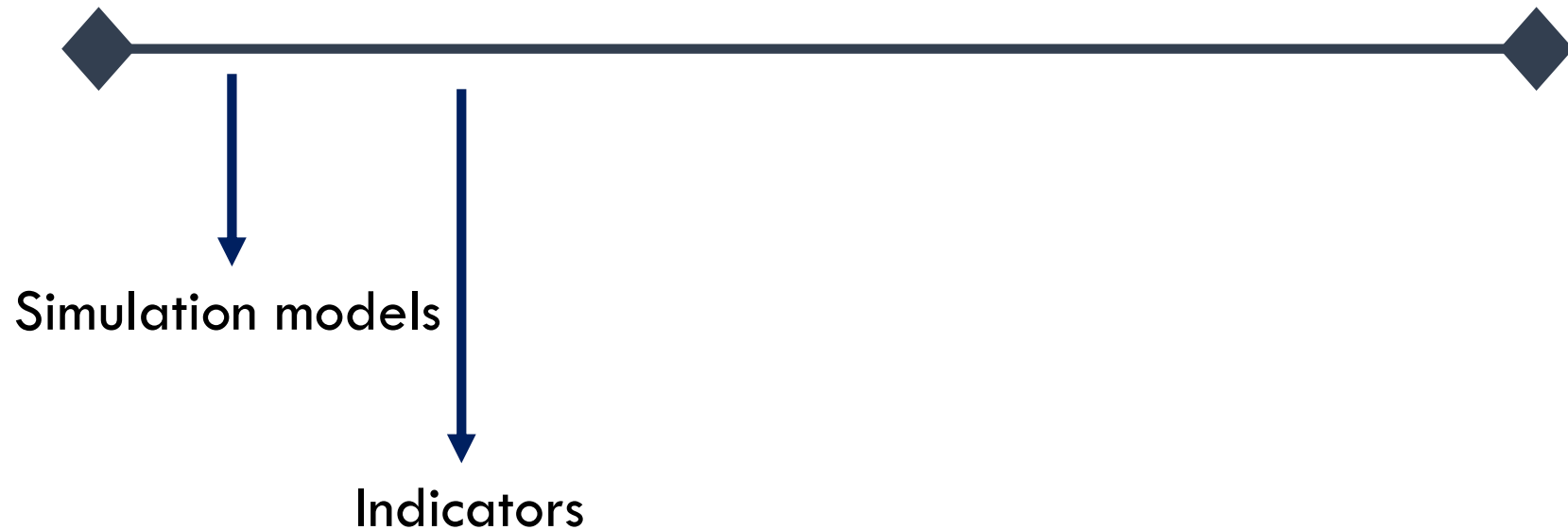
No out-of-the-box scenarios

Many aspects **cannot be modelled**

Methods for assessing resilience

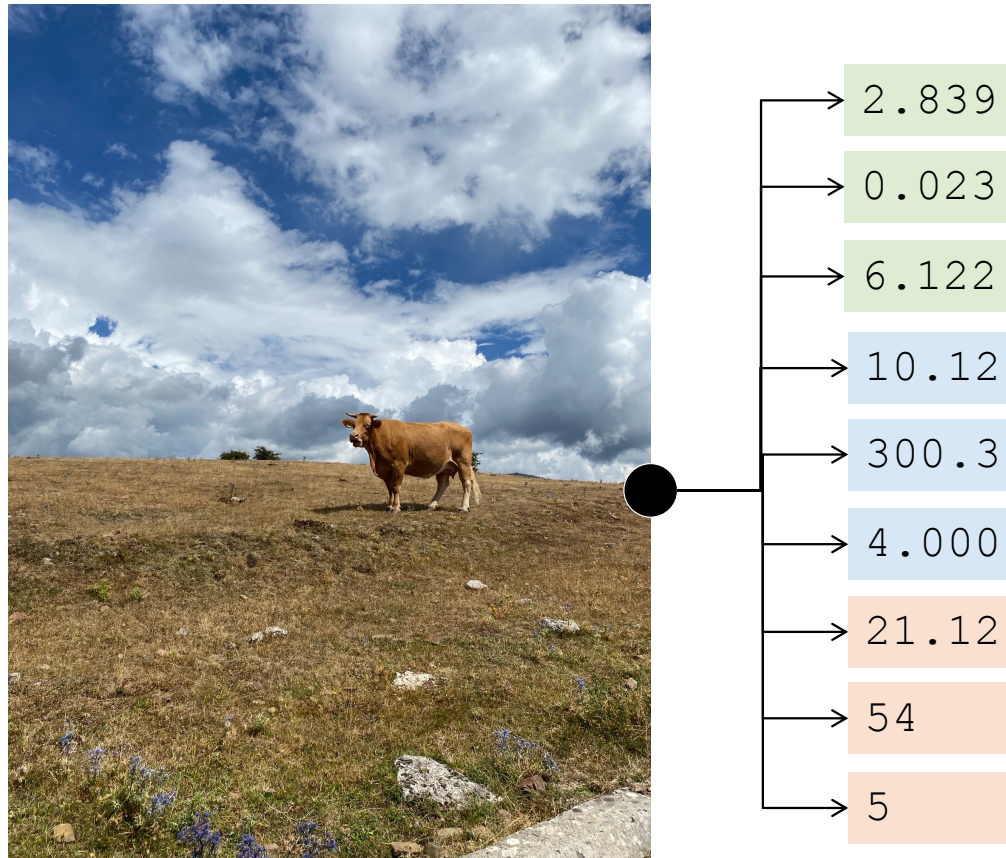
Quantitative

Qualitative

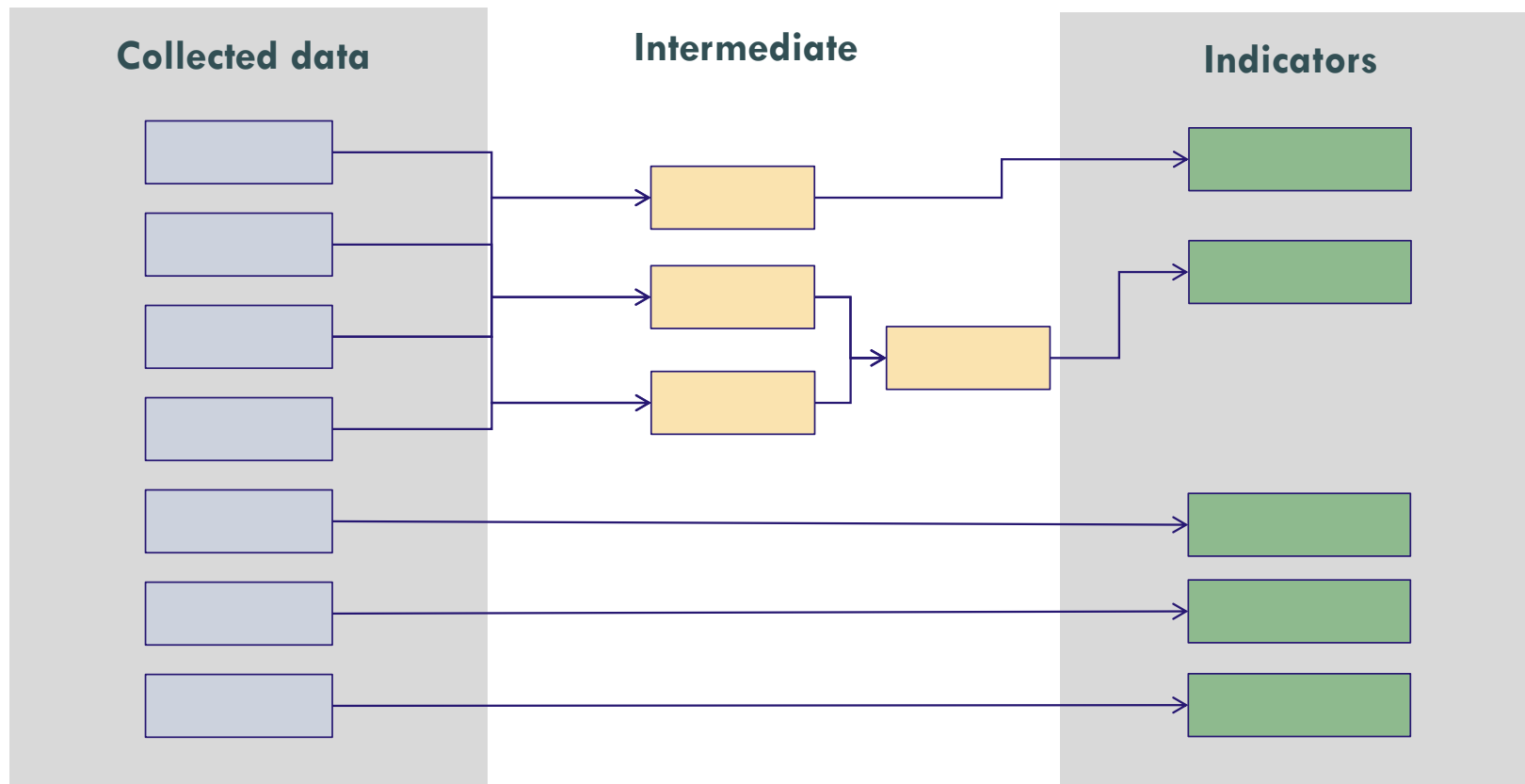


Approach by indicators

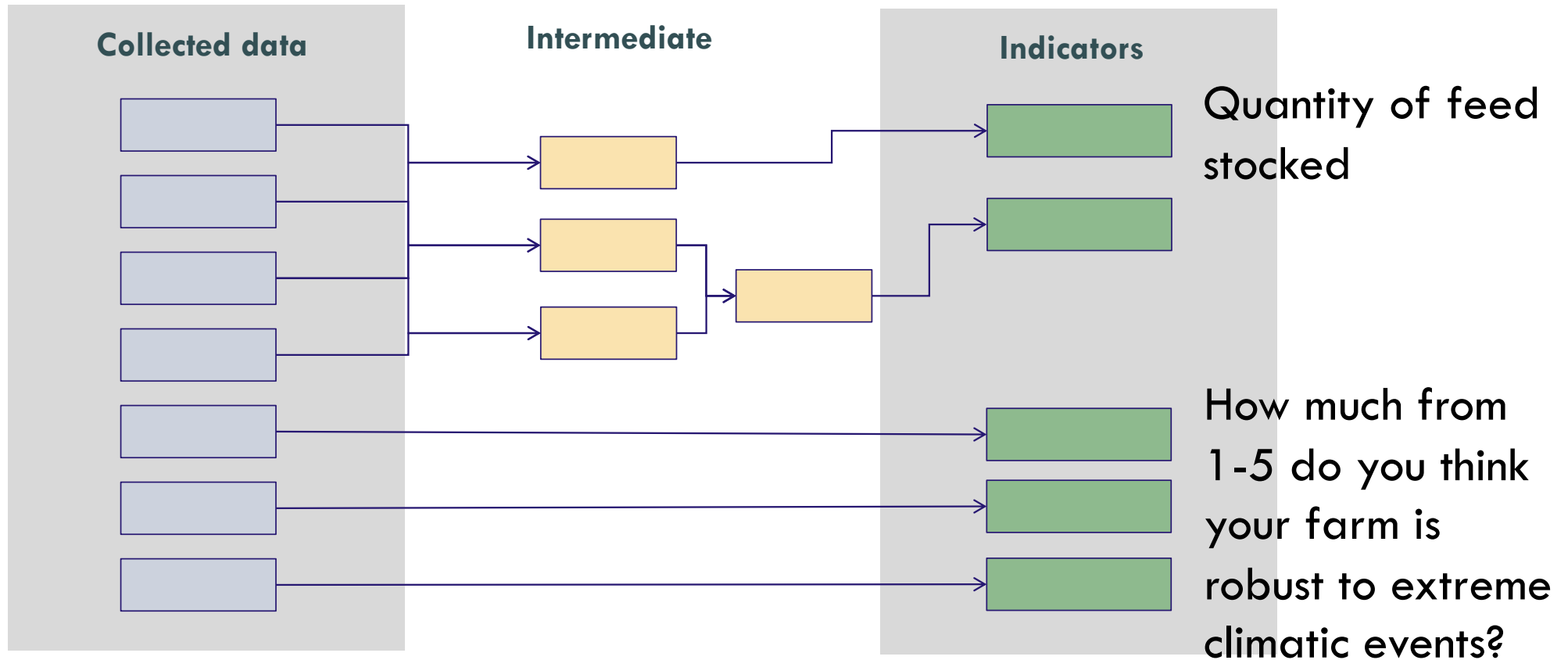
Translating dimensions of the system into measurable quantities



Approach by indicators



Approach by indicators



Methods for assessing resilience

Quantitative

Qualitative



Indicators

Data are **difficult to access**

Not all dimensions **can be quantified**

Methods for assessing resilience

Quantitative

Qualitative



Focus groups
Interviews
Document review...

Methods for assessing resilience

Quantitative

Qualitative



Difficult to communicate with
synthetic metrics

Difficult to compare across case
studies



Focus groups
Interviews
Document review...

Methods for assessing resilience

Quantitative

Qualitative



Each method has **limits** and **advantages**

Methods for assessing resilience

Quantitative

Qualitative



Each method has **limits** and **advantages**

Resilience assessment methods are tools for
supporting resilience enhancement of livestock
systems

Participatory processes

Facilitate the collective intelligence for resilience improvement



Participatory processes

Facilitate the collective intelligence for resilience improvement



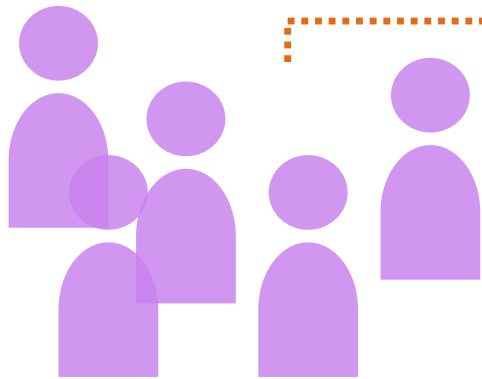
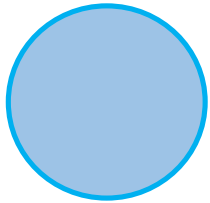
Shared representation of the current system (including the **point of view of other actors**)

Imagining **desired future scenarios** collectively

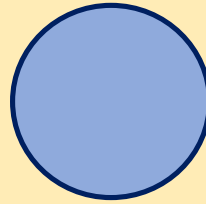
Backcasting

Reidsma et al. (2023)

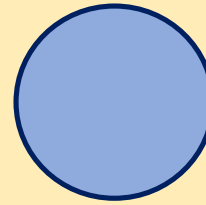
Current system



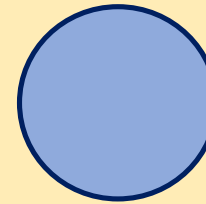
2030



Future system 1



Future system 2



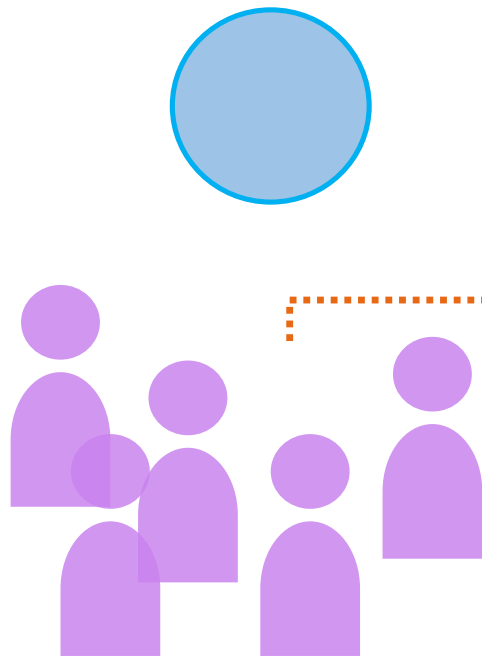
Future system 3



Backcasting

Reidsma et al. (2023)

Current system



2030

Table 3

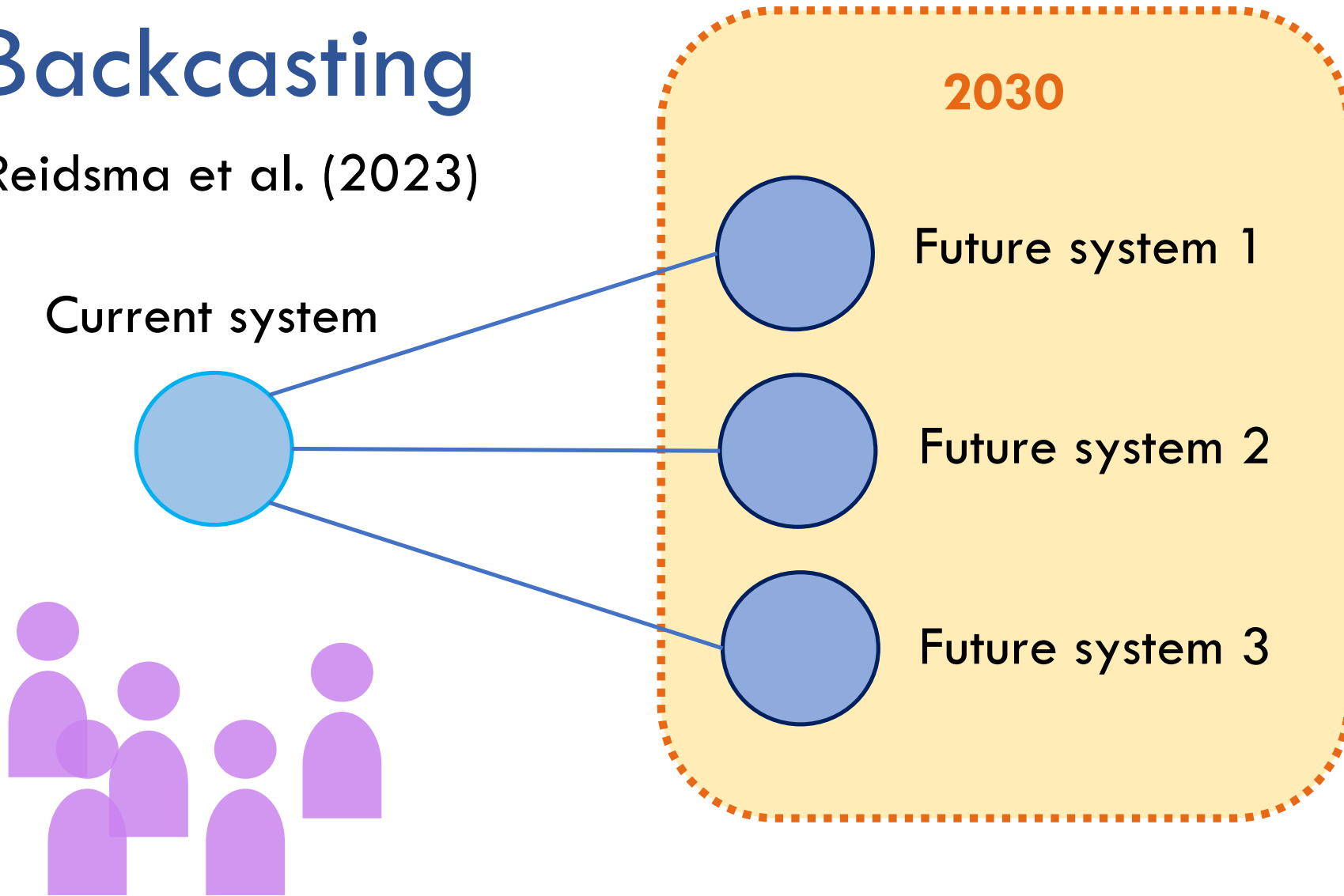
Developments of system indicators per function and resilience attributes for the status quo, system decline and minimum and maximum developments in alternative systems. Arrows down (↓) and brown imply strong negative, down-right (↘) and orange moderate negative, straight (→) stable, right-up (↗) and light green moderate positive, and up (↑) and dark green strong positive developments, with others in-between.

Function/resilience attribute	Name	Number of times discussed	Expected average developments in future systems			
			Status quo	System decline	Minimum of alternative systems	Maximum of alternative systems
Function	Food production	8	→	↘	→	↗
	Bio-based resources	2	→	↘	↘↓	→↗
	Economic viability	11	→↘	↘	→↗	↗
	Quality of life	1	↘	↓	↘	↑
	Natural resources	7	→	↘	→	↗
	Biodiversity & habitat	4	→	→↘	→	↑
	Attractiveness of the area	4	→↘	↘↓	→↗	↗
	Animal health & welfare	2	→↗	→	→	↗
Resilience attribute	Reasonable profitable	4	→↘	↘	→↗	→↗
	Production coupled with local and natural capital	5	→	↘↓	→↗	↗↑
	Functional diversity	3	→	→	→	→↗
	Response diversity	3	→	↘↓	→	↗
	Exposed to disturbance	3	→↗	↗	→	→↗
	Spatial and temporal heterogeneity (farm types)	2	→↗	→↗	→↘	↗↑
	Support rural life	4	→	↘	→↗	↗
	Socially self-organized	5	→	↘	→	↑
	Appropriately connected with actors outside the farming system	2	→↘	→↘	→↗	↗↑
	Coupled with local and natural capital (legislation)	1	→	→	↗	↑
	Infrastructure for innovation	7	→	→↘	↗	↗↑
	Diverse policies	2	→	↘	→↘	↗↑

¹ Results for FR-Beef are not included in this table.

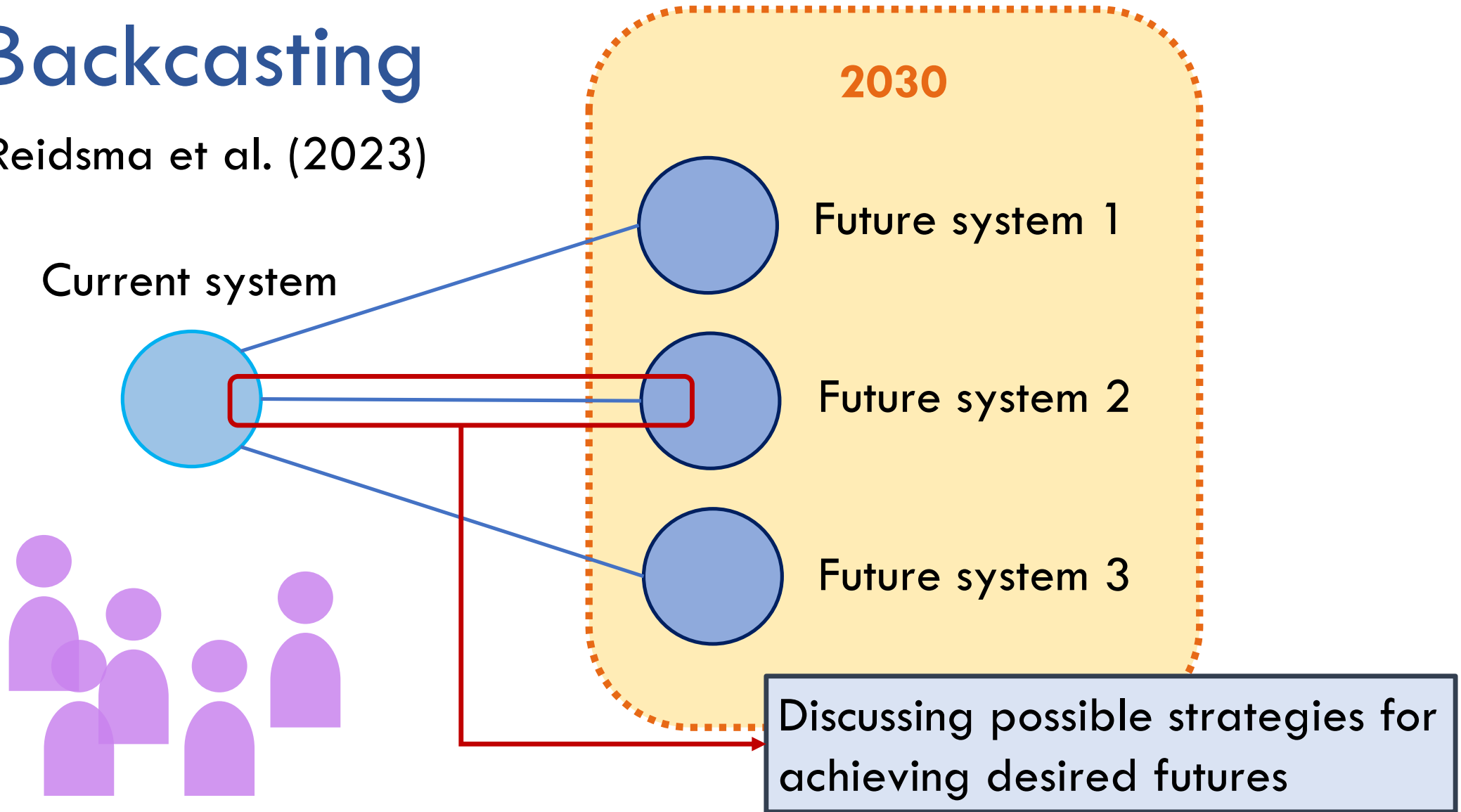
Backcasting

Reidsma et al. (2023)



Backcasting

Reidsma et al. (2023)



Example of actions proposed for the Bocage Bourbonnais



Which strategies to cope with challenges?

ROBUSTNESS

ADAPTABILITY

TRANSFORMABILITY



Droughts

- Diversification
- Buy external feed
- Cultivate and store feed
- Insurance schemes

Social distrust

Which strategies to cope with challenges?

ROBUSTNESS

ADAPTABILITY

TRANSFORMABILITY



Droughts

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- Change of the practices to make the system more drought resistant.
- Agroforestry

Social distrust

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Social distrust

- Adapting practices

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Social distrust

- Adapting practices

Engage a dialogue with the civil society for making citizens more aware of the reality of livestock

Which strategies to cope with challenges?

ROBUSTNESS

ADAPTABILITY

TRANSFORMABILITY



Droughts

- Diversification
- Buy external feed
- Cultivate and store feed
- Insurance schemes

Mostly symptomatic fixes, in the short term, exposing farmers to other costs

Social distrust

- Adapting practices

Which strategies to cope with challenges?

ROBUSTNESS

ADAPTABILITY

TRANSFORMABILITY

Droughts

Low profitability

Demography

Social distrust

Transformative actions, needed or in progress:

- all require a **coordinate action** in the value chain, and the **support of other actors** (e.g., policymakers, associations, cooperatives), **research**.
- Are not strictly monetary (but mostly **related to environment and society**).

- Change of the practices to make the system more drought resistant.
- Agroforestry

Engage a dialogue with the civil society for making citizens more aware of the reality of the Bourbonnais

Livestock systems are characterized by:

MULTIPLE SCALES

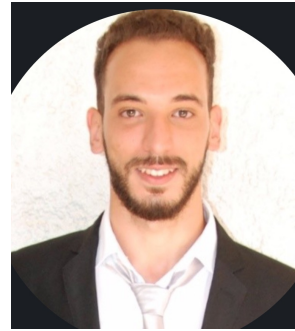
CONTEXT-DEPENDENCY

MULTIPLE DIMENSIONS

INTERACTIONS WITH OTHER SECTORS

LIVESTOCK IS **NOT** AN
ISLAND

Which factors interact with achievement of food self-sufficiency?

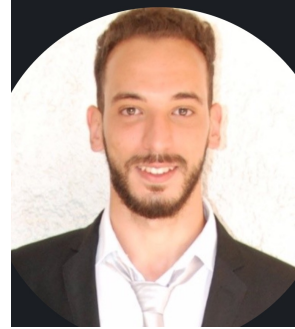


Achraf Mamassi

Mamassi et al. 2024 – Global Food Security

Mamassi et al. 2026 – Global Food Security

Which factors interact with achievement of food self-sufficiency?



Achraf Mamassi

Examples:

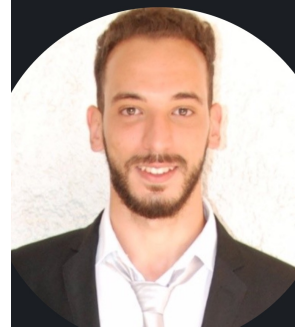
Urbanisation

Dietary shift, rural depopulation

Mamassi et al. 2024 – Global Food Security

Mamassi et al. 2026 – Global Food Security

Which factors interact with achievement of food self-sufficiency?



Achraf Mamassi

Examples:

Urbanisation

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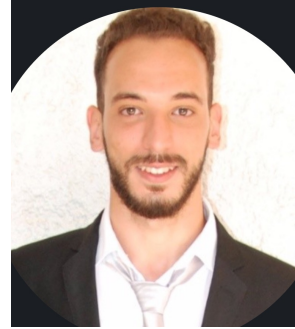
Water management

Conflict with other usages (civil, industry)

Mamassi et al. 2024 – Global Food Security

Mamassi et al. 2026 – Global Food Security

Which factors interact with achievement of food self-sufficiency?



Achraf Mamassi

Examples:

Urbanisation

Dietary shift, rural depopulation

Water management

Conflict with other usages (civil, industry)

Infrastructures

Affect input costs

Mamassi et al. 2024 – Global Food Security

Mamassi et al. 2026 – Global Food Security

Livestock systems are characterized by:

MULTIPLE SCALES

Livestock systems are characterized by:

Connect scales and look at interactions between them

Livestock systems are characterized by:

Connect scales and look at interactions between them

CONTEXT-DEPENDENCY

Livestock systems are characterized by:

Connect scales and look at interactions between them

Embrace diversity; no one-fits-all solutions

Livestock systems are characterized by:

Connect scales and look at interactions between them

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MULTIPLE DIMENSIONS

Livestock systems are characterized by:

Connect scales and look at interactions between them

Embrace diversity; no one-fits-all solutions

Build resilience collectively (farmers, value chain actors, actors from other sectors, policy makers) and bring dimensions together

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INTERACTIONS WITH OTHER SECTORS

Livestock systems are characterized by:

Connect scales and look at interactions between them

Embrace diversity; no one-fits-all solutions

Build resilience collectively (farmers, value chain actors, actors from other sectors, policy makers) and bring dimensions together

Look beyond livestock, promote skills going across sectors



Thanks for your attention

francesco.accatino@inrae.fr