SUSTAINABLE
RESILIENT
EU FARMING
SYSTEMS

A dynamic perspective to farming system resilience and its trade-offs

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UNIVERSITY OF BERGEN

Objective:

To explore potential benefits of adopting a dynamic perspective in the resilience management process.

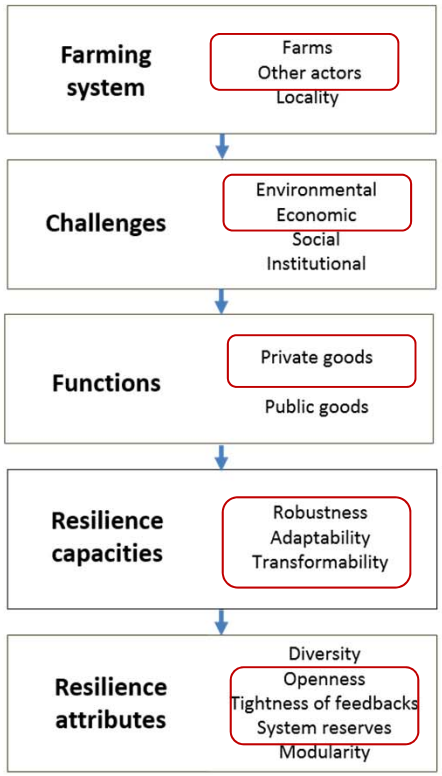
1. Resilience *of what*?

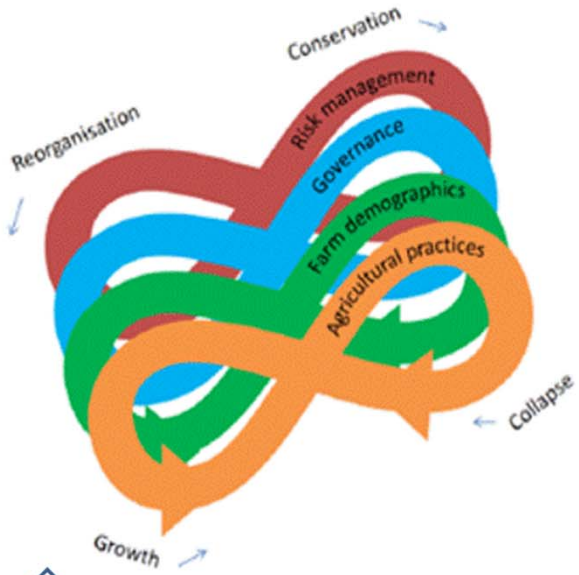
2. Resilience *to what*?

3. Resilience *for what purpose*?

4. What *resilience capacities?*

5. *What enhances* resilience?





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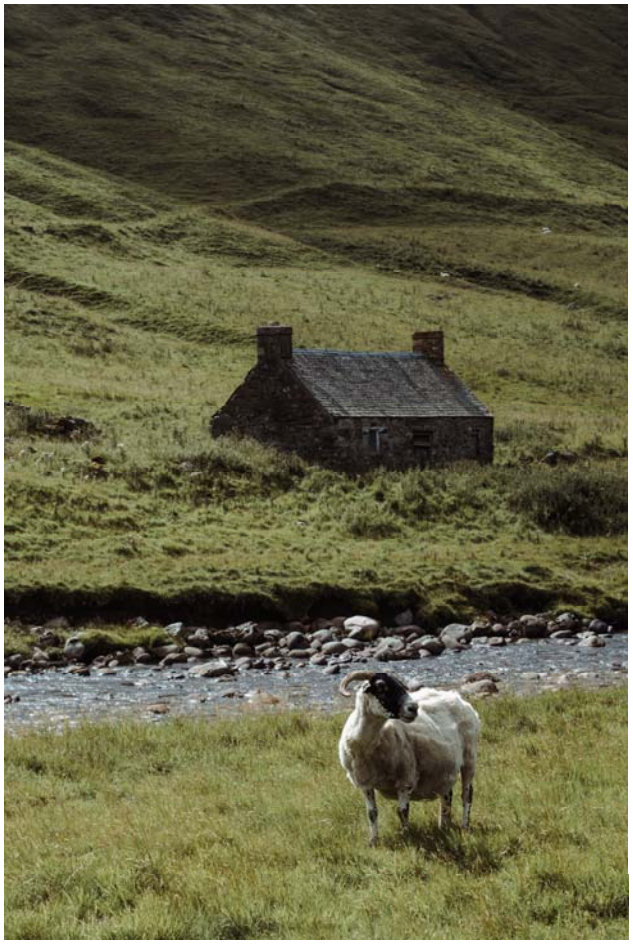
Resilience management

Resilience management is the active modification of a system with the explicit aim to improve its capacity to absorb and adapt to change

Aims of resilience management are:

a) to prevent a system from transitioning into undesirable configurations in the face of external shocks and

b) to **cultivate the conditions that facilitate system adaptability** following a massive change.



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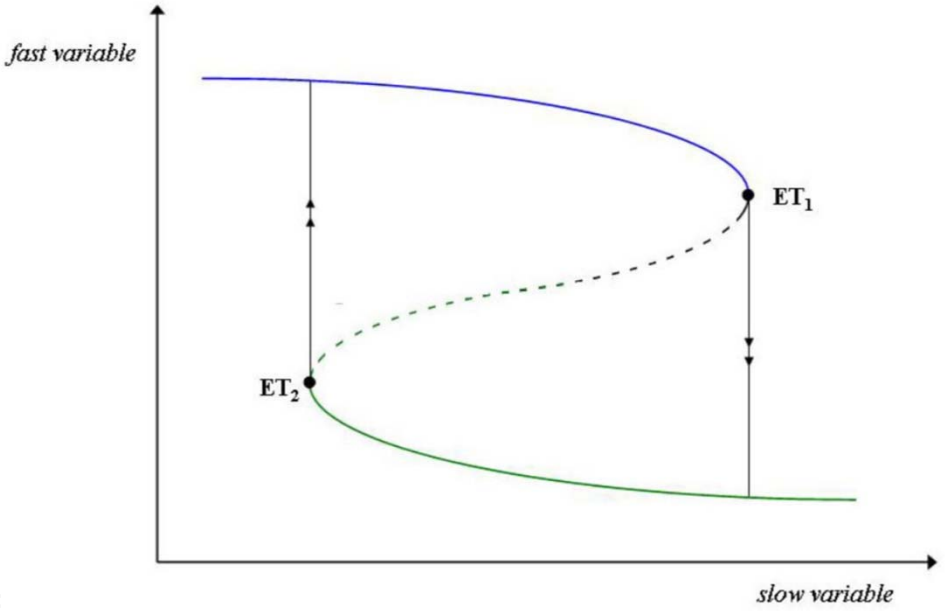
A dynamic perspective

In simple terms, a dynamic perspective focuses on:

a) aggregated relations among systems' components,

b) systems' outcomes as indicators of their performance and

c) control variables as drivers of systems' behaviour



ET1 and ET2 represent ecological threshold points (modified from Scheffer and Carpenter 2003)

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A dynamic perspective

To overcome these challenges, we propose to use a dynamic perspective to operationalise systems' resilience **through the behaviour of their outcomes** and their response to shocks (Bruijn et al., 2017; Walker et al., 2004). Whereas each outcome is likely to exhibit its own particular response, for simplicity, these responses can be clustered into three big groups:

a) stability and robustness

b) adapting capacity,

c) transformation

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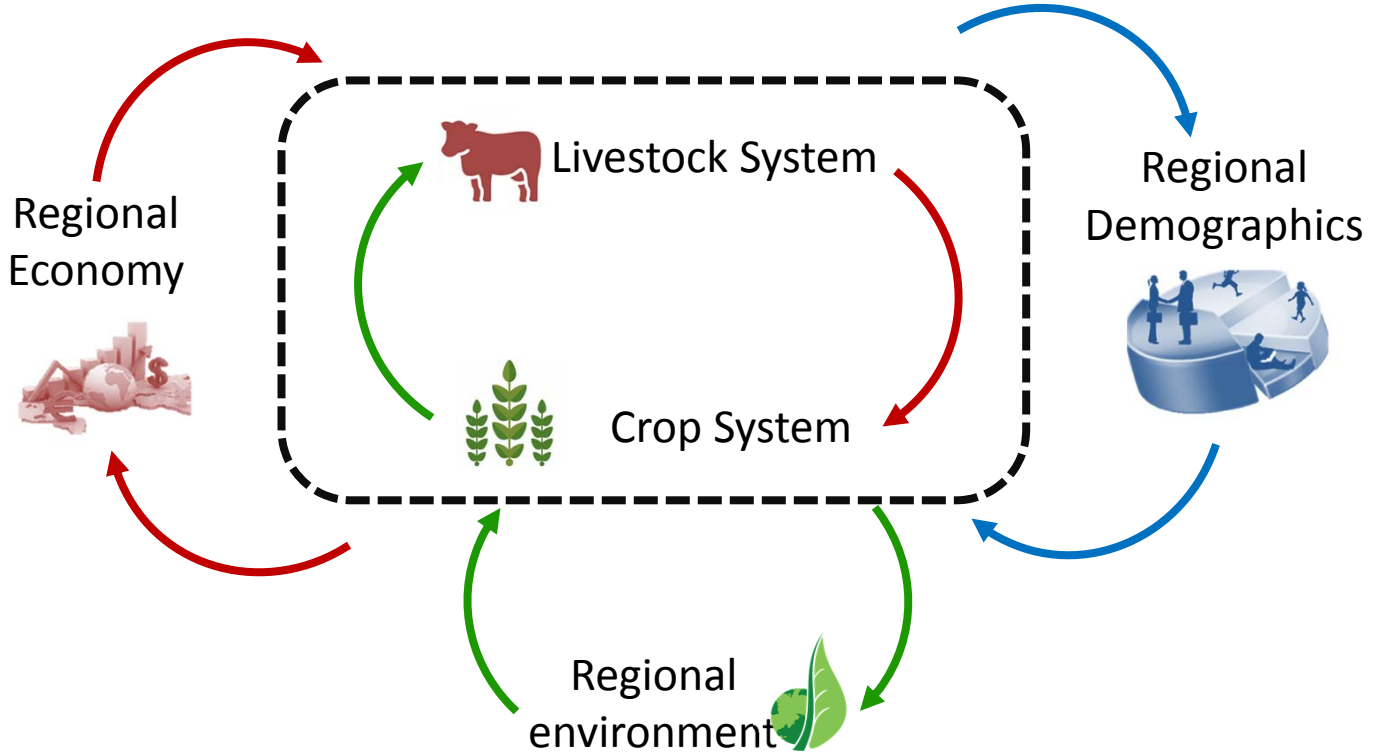
A conceptual model



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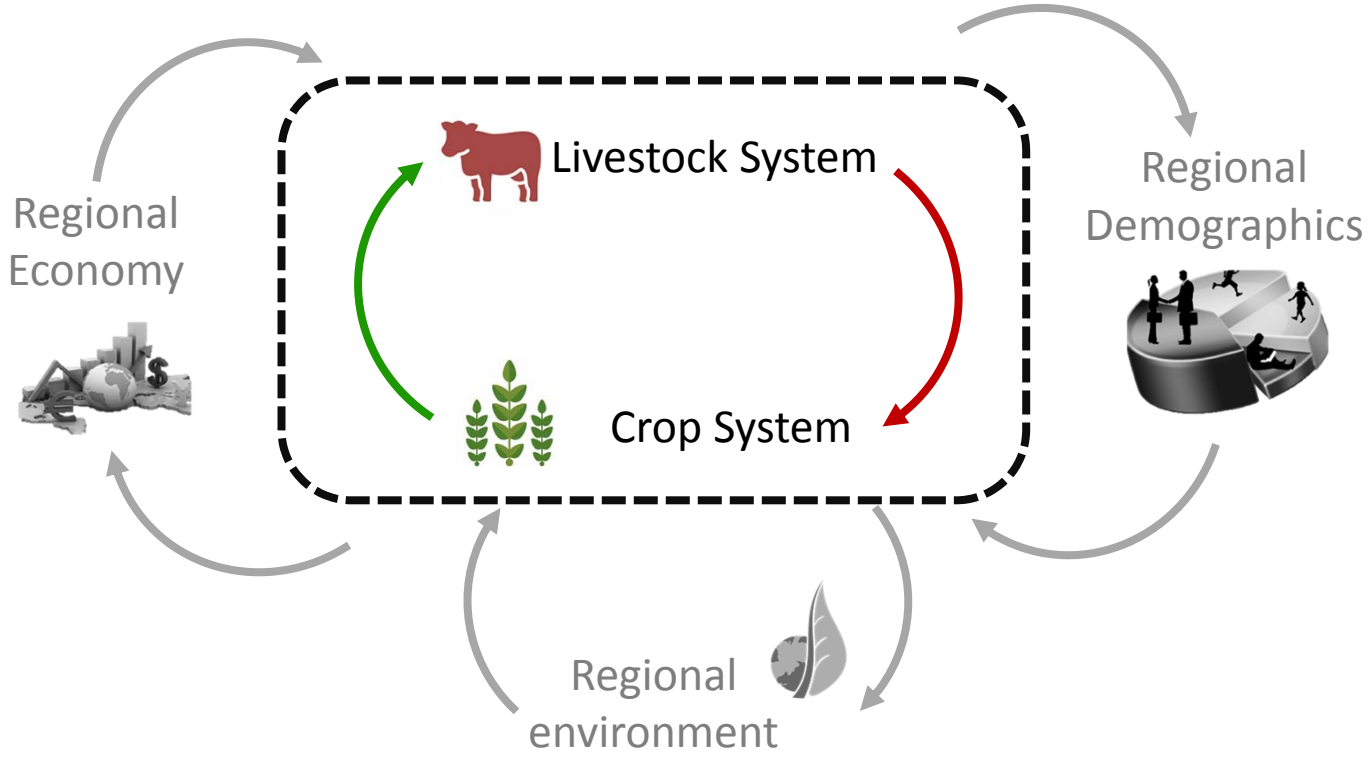

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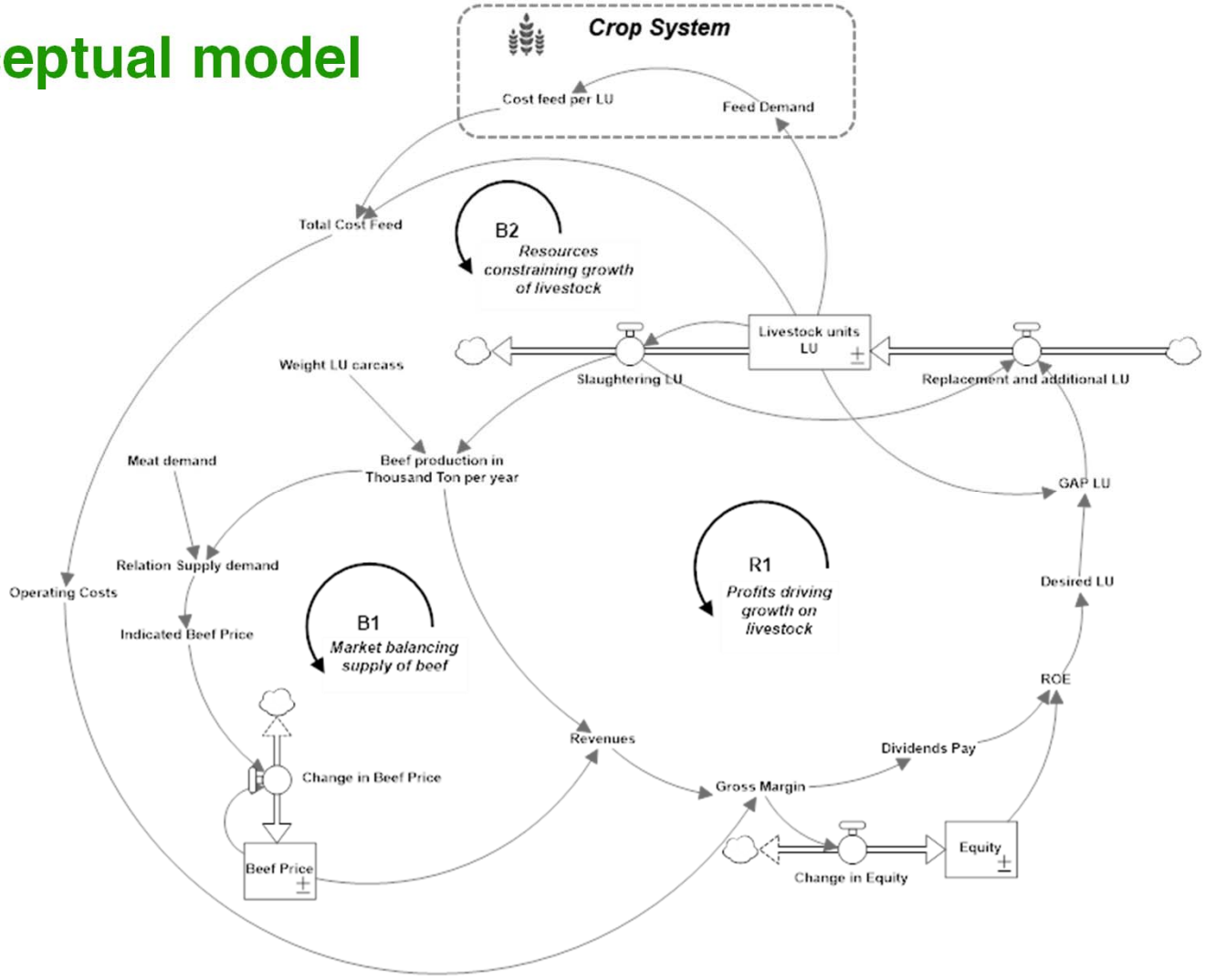

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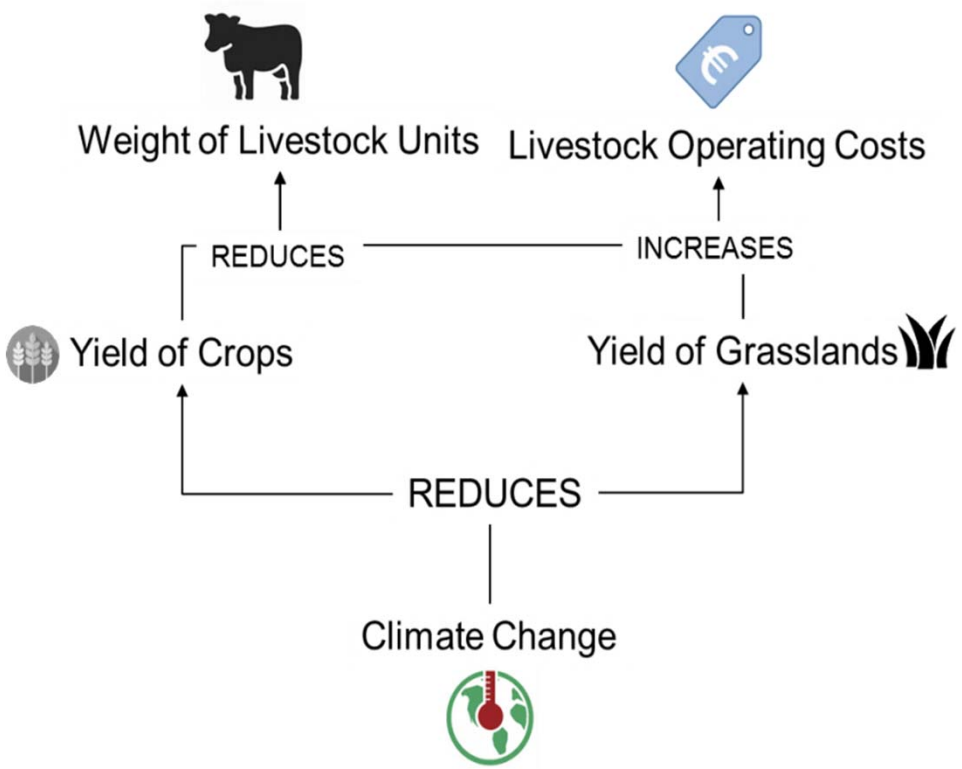

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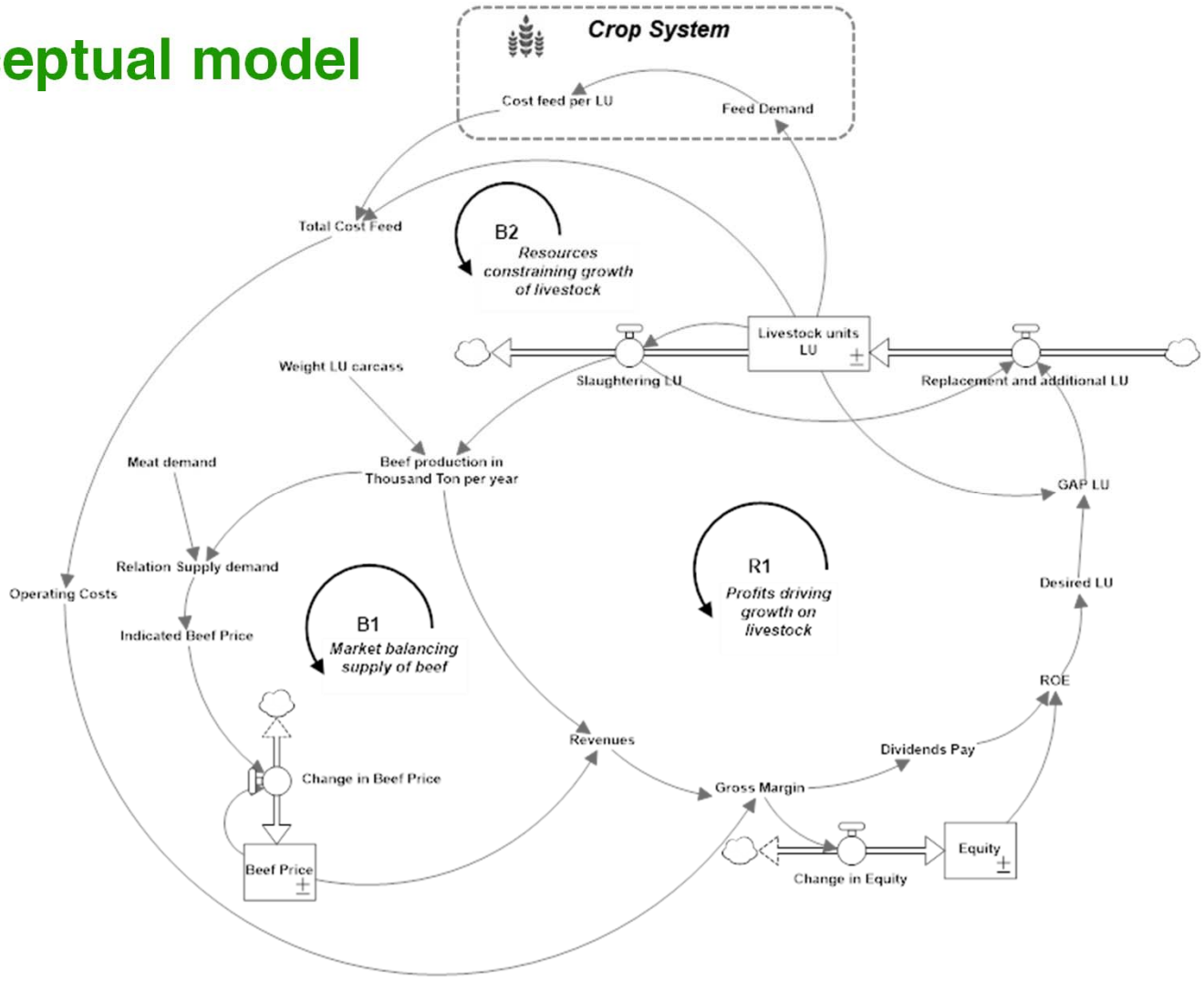

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Exploring the impact of climate change

Outcome functions	Proxy variable
i) Delivery of healthy and affordable food products	Beef production
ii) Economic viability	Price per carcass paid to producer

For analysis purposes we considered that changes in weather conditions and an increase in pests could broadly manifest in two ways:

a) shocks in weather conditions that will temporarily reduce crop yield

b) and an increase in weather variably that leads to fluctuations in crop yield

For our analysis we considered two shocks, a moderate shock reducing crop yield by 20% and an extreme shock reducing crop yield by 50%. For simulating weather variability we assumed random variations between 10% and -50% on crop yield constantly for the simulated time horizon.

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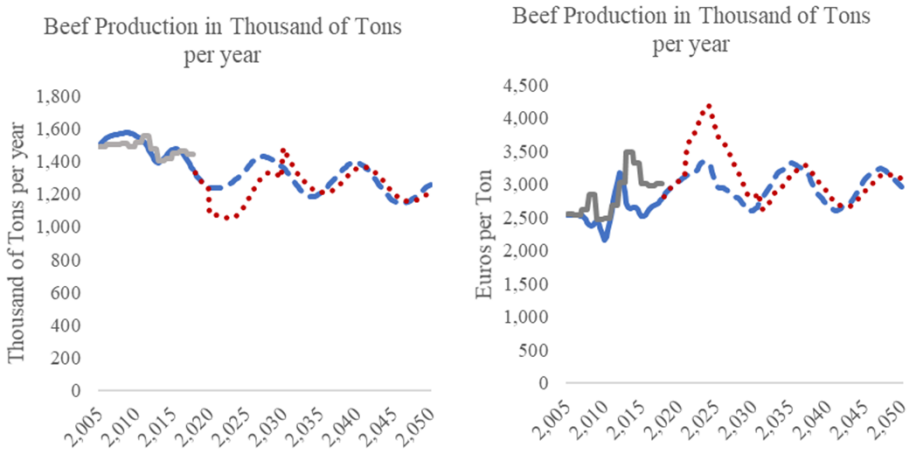
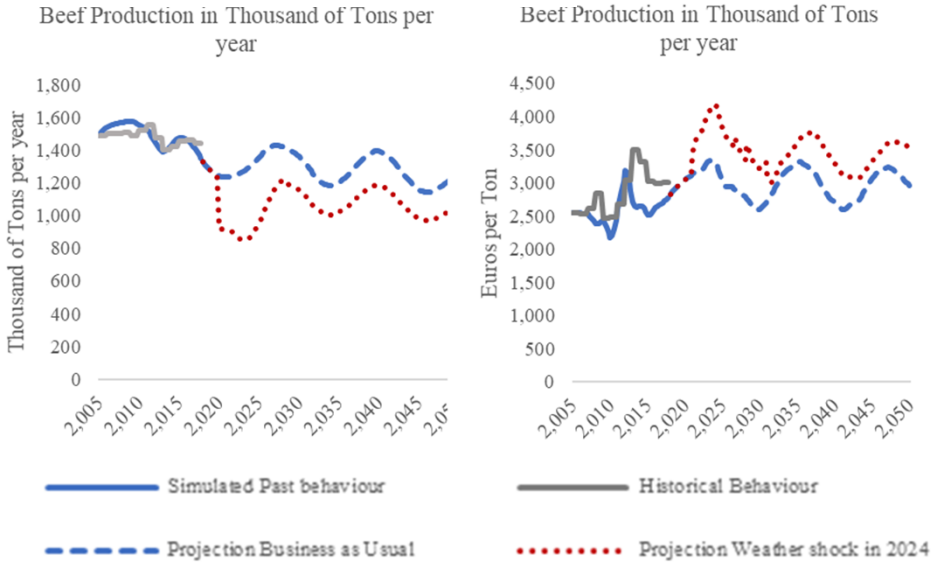
Model Results

Reaction to a moderate shock



Reaction to an extreme shock



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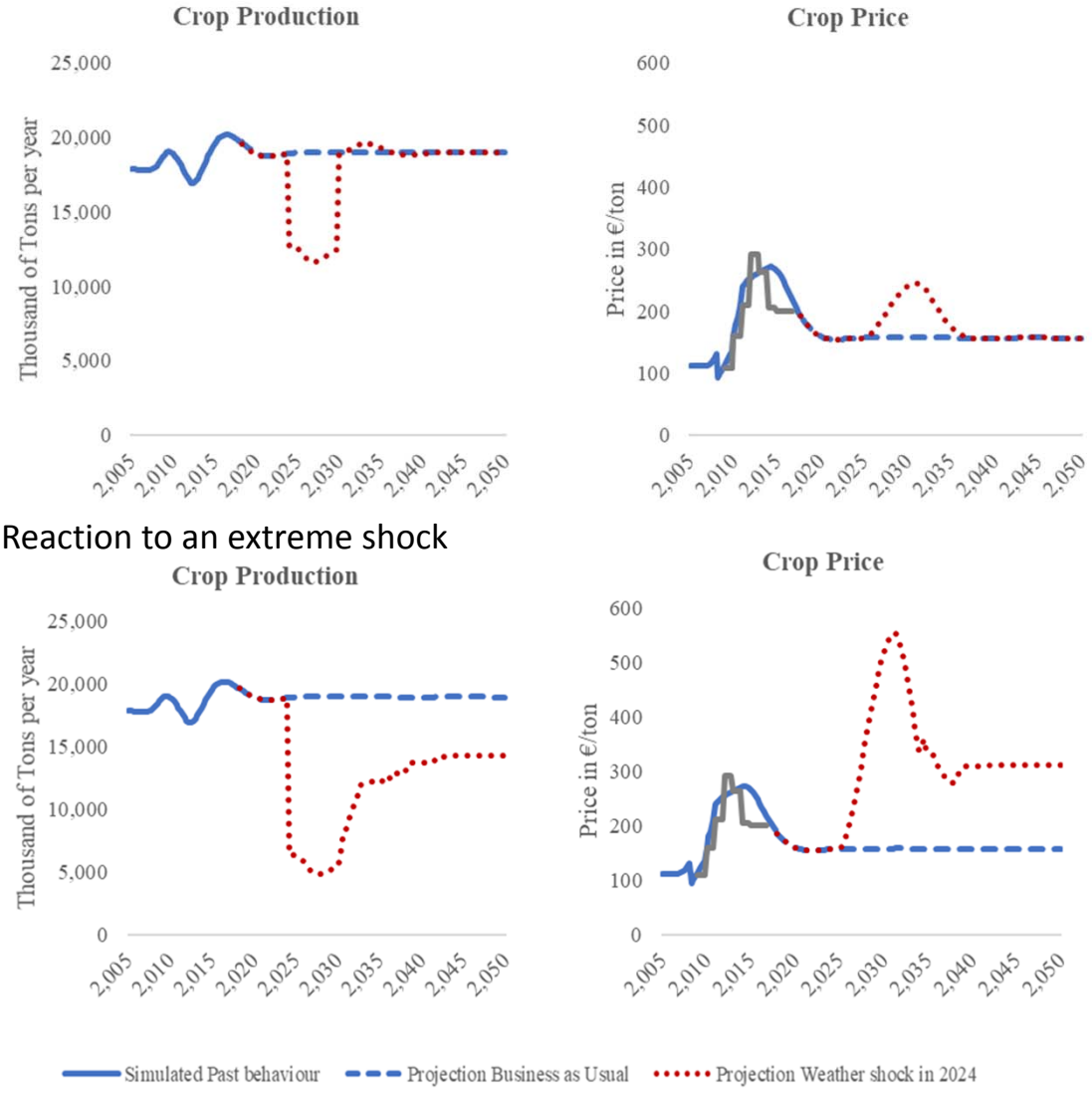

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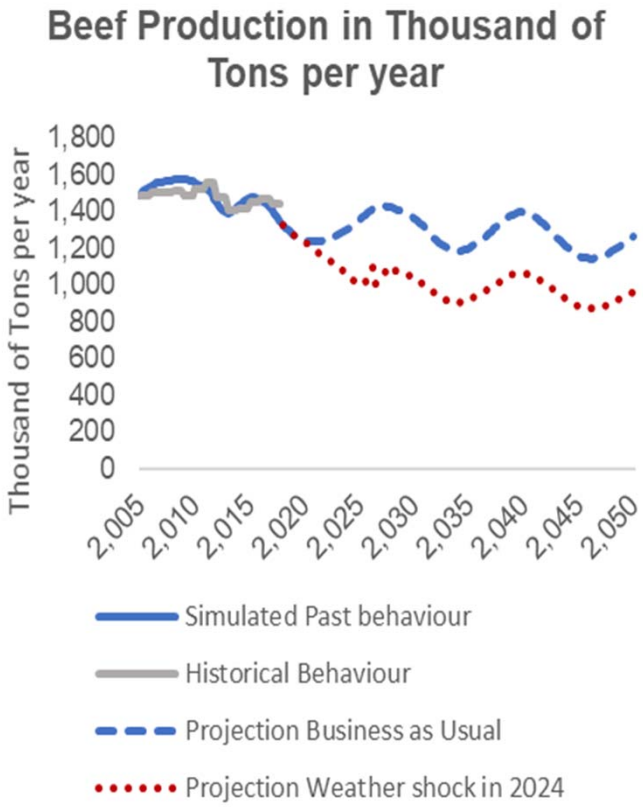
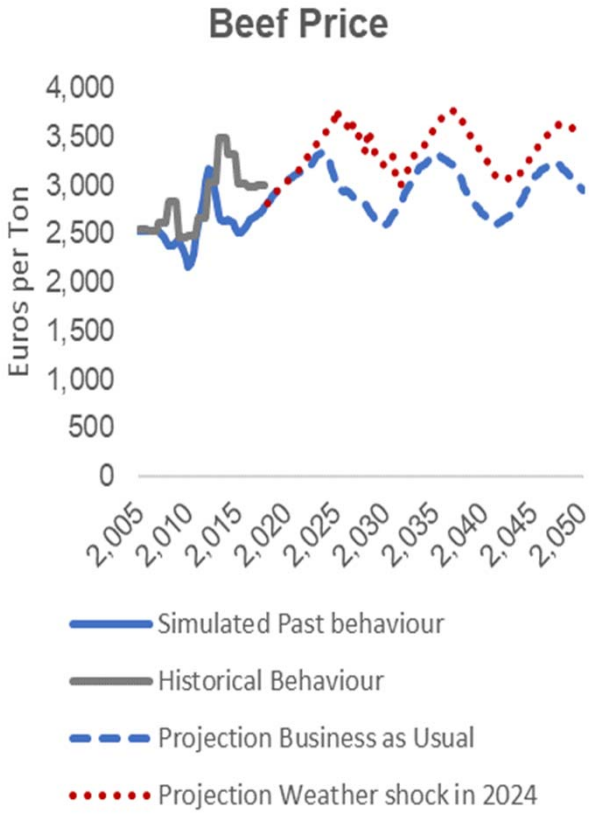
Model Results-Weather variability





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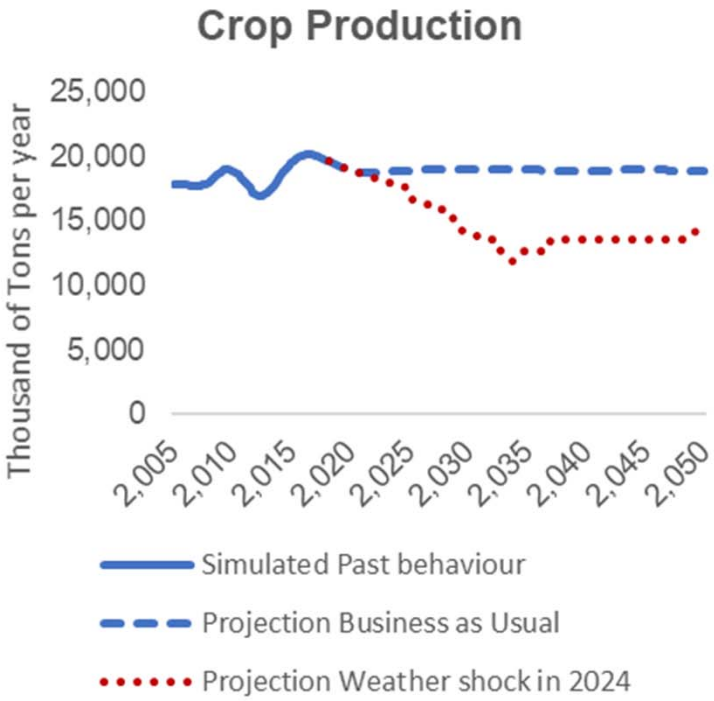

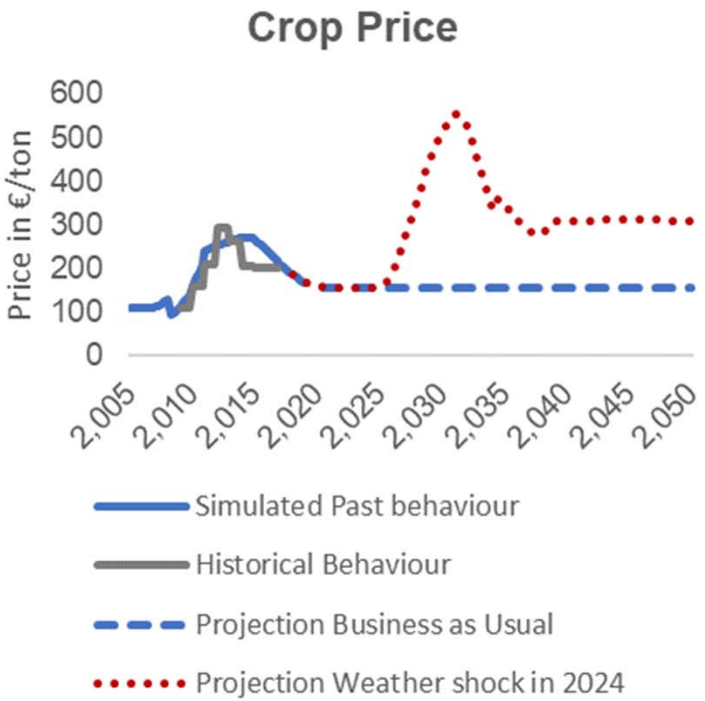

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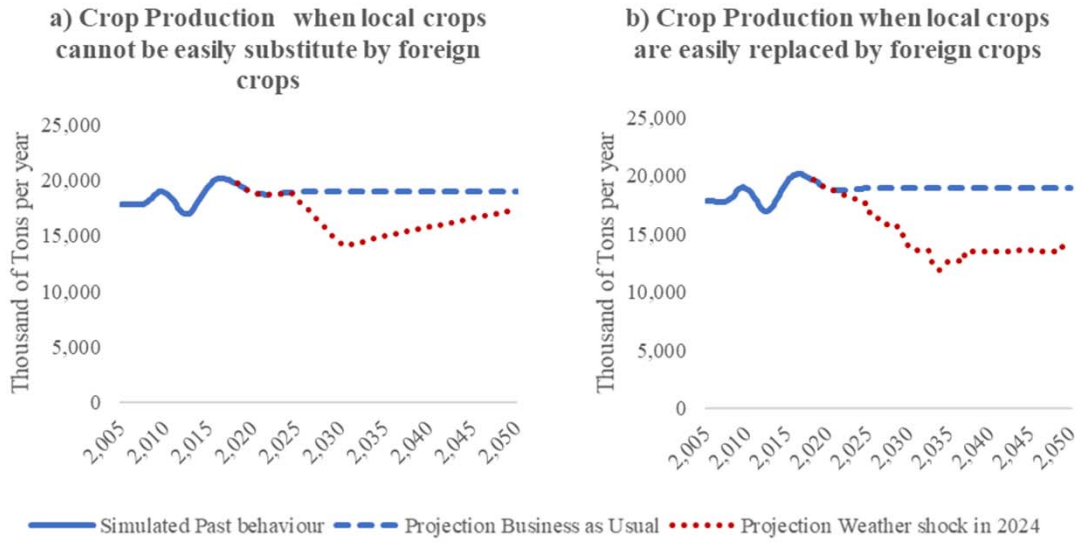
Trade-offs and management strategies

Both reduction of yields and increase dependency on crops result on higher costs than otherwise for livestock producers, however, they have opposite effects for crop producers who could see a reduction in their throughput but an increase in their price. The long term response of crop farmers is then governed by the elasticity of the markets and heavily influenced by market openness to foreign crops and logistic constraints.



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Trade-offs and management strategies

An alternative to ease the financial drain on farmers and shareholders is ensuring farms have access to credit during the periods climate change is inflicting a higher pain in their accounts. Access to credit, long term debt and the costs of borrowing can be included in the model by adding additional structure like the one illustrated in the figure.

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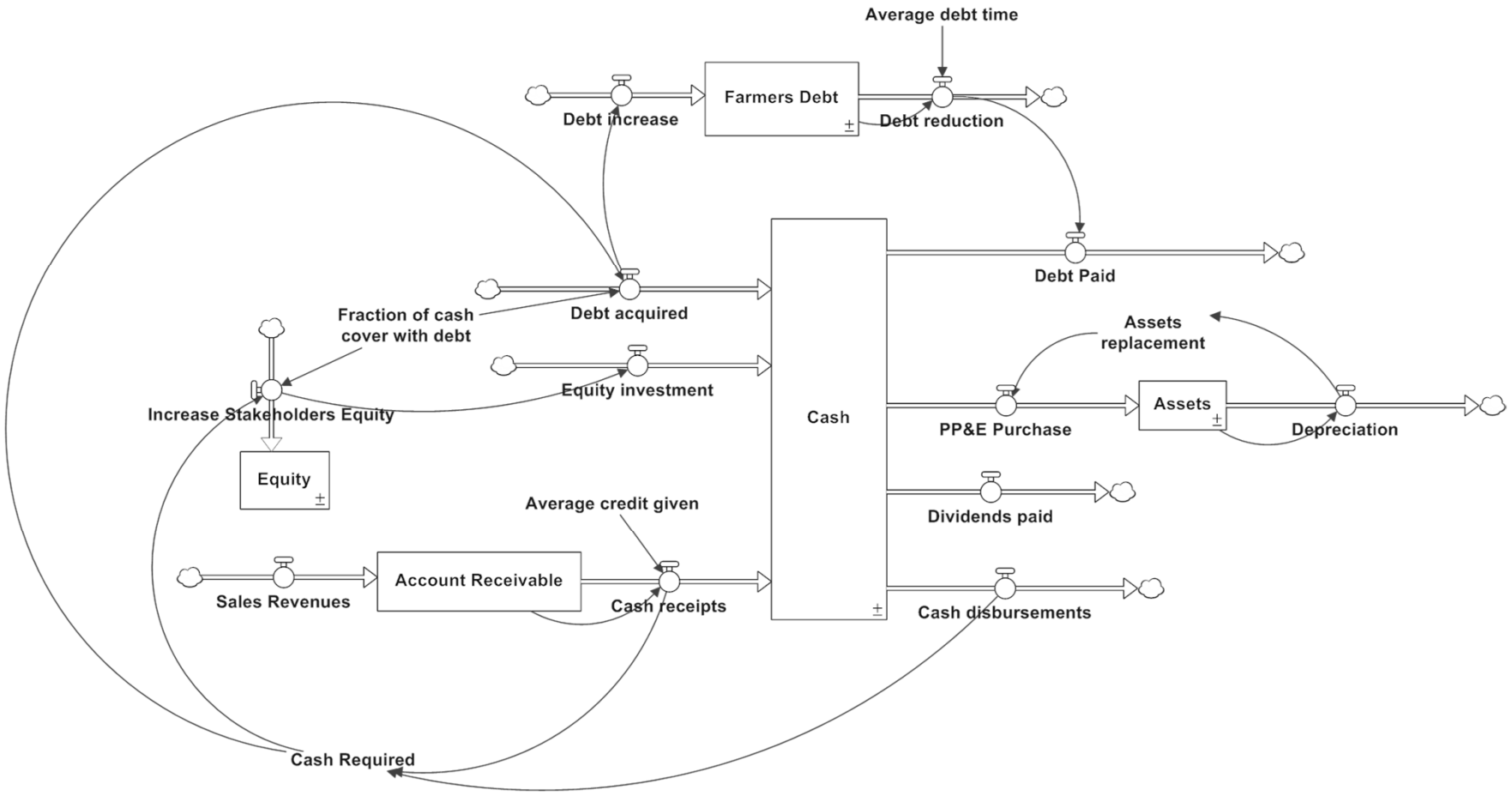
Trade-offs and management strategies



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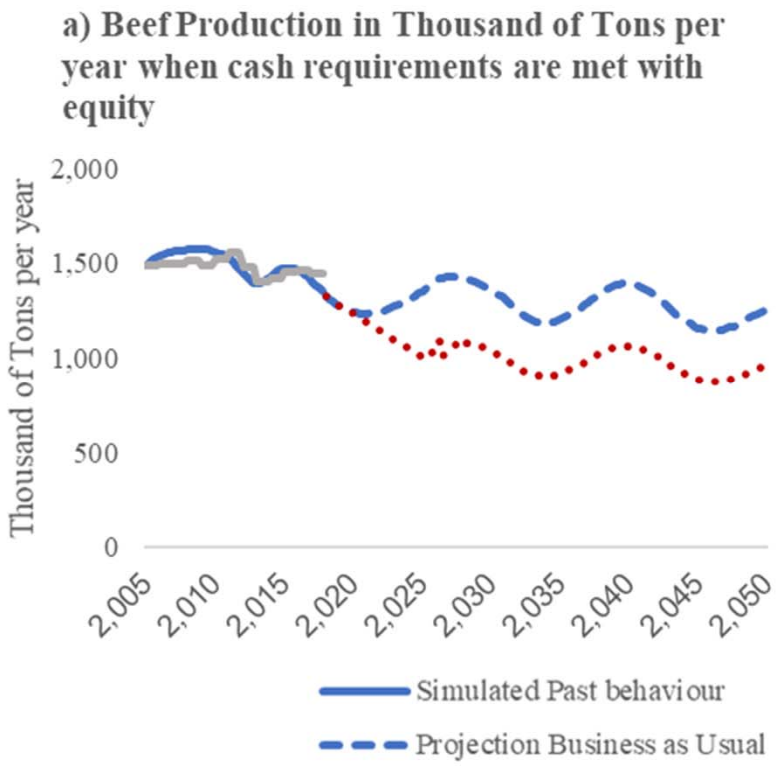

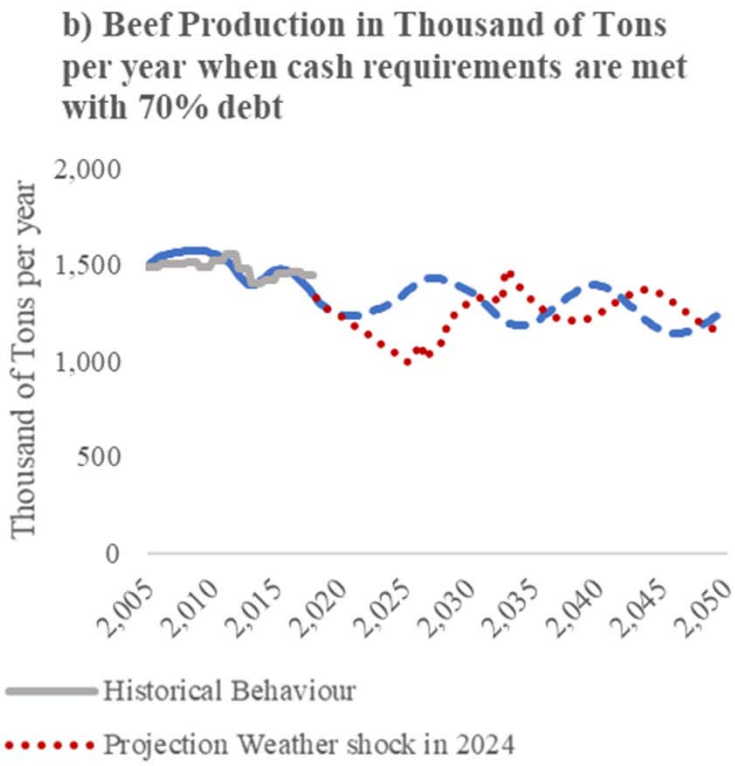

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Conclusions

First, by adopting a dynamic perspective it is possible to aggregate complex system processes into their main dynamics and foster understanding about the underlying mechanisms driving system behaviour.

Second, the simplicity and transparency of the models used also ease the analysis and discussion of potential points for intervention and strategies that can enhance resilience.

Third, having a dynamic model helps to understand trade-offs between different types of resilience resulting from different strategies. Model analyses reveal, for example, trade-offs between resilience to climate change and resilience to fluctuations in commodity markets. The results also highlight the presence of conflicting objectives between crop farming and livestock farming.

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