



Measuring farm resilience attributes: The study of three small ruminant systems

RUMIRES Project

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**AGRIFOOD RESEARCH AND TECHNOLOGY CENTRE OF
ARAGON**

INTRODUCTION

“Ability of farms to ensure the provision of their **functions** in the face of increasingly complex and accumulating **economic, social, environmental and institutional shocks and stresses**, through the capacities of **robustness, adaptability and transformability**”

Meuwissen et al., 2019



Increasing interest in improving farm resilience

INTRODUCTION

“Ability of farms to ensure the provision of their **functions** in the face of increasingly complex and accumulating **economic, social, environmental and institutional shocks and stresses**, through the capacities of **robustness, adaptability and transformability**”

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Increasing interest in improving farm resilience



Farm resilience needs to be assessed before being improved

Focus on crisis outcomes



Focus on **resilience attributes**

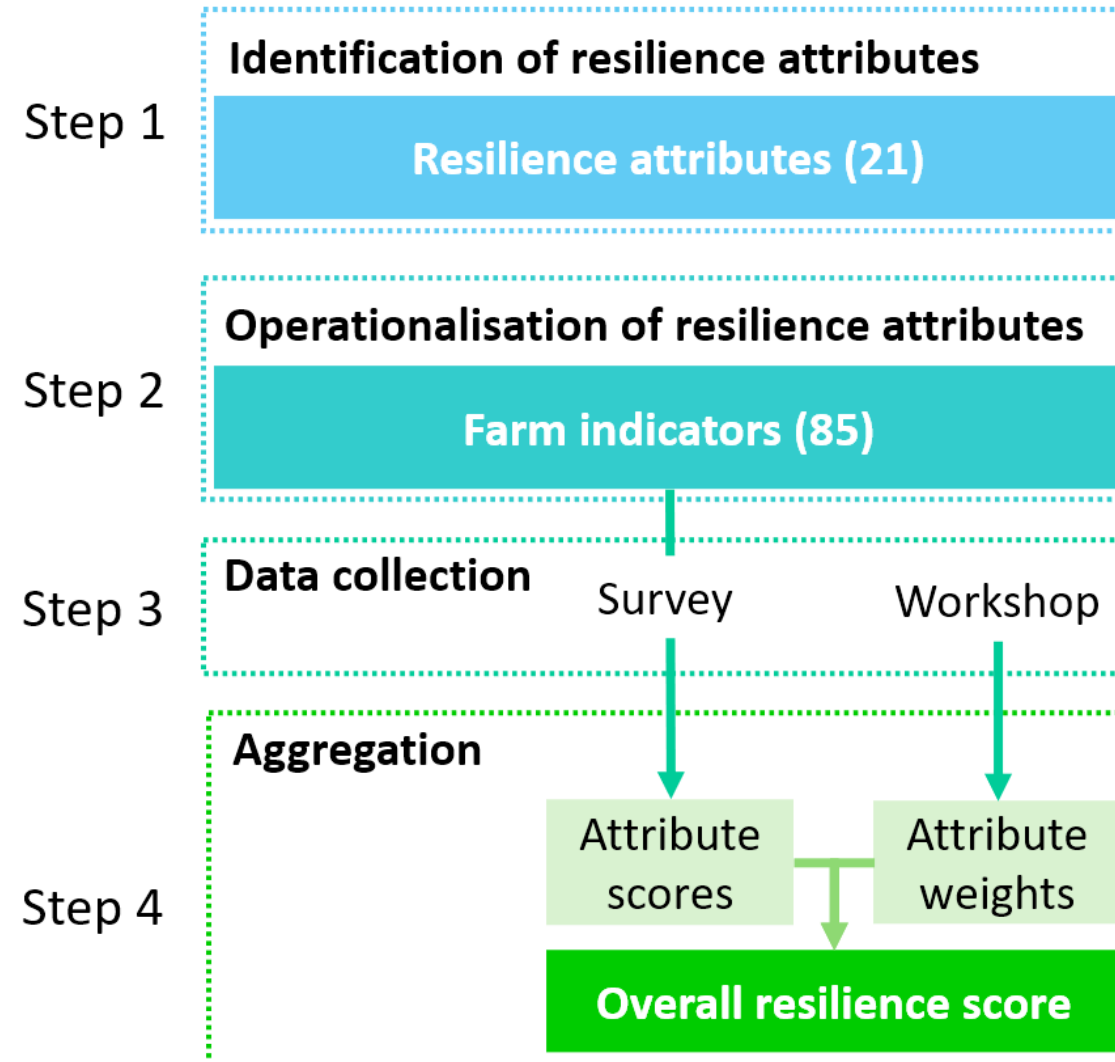
i.e. the system characteristics that contribute to building resilience

OBJECTIVE

- ◆ To **assess the resilience attributes** of livestock farms based on indicators
- ◆ To **calculate an overall resilience score** per farm to reflect the overall resilience status



MATERIALS AND METHODS



MATERIALS AND METHODS: Case studies

1. Meat sheep in Aragon



Farms are usually mixed crop-livestock systems and closely linked with the territory.

2. Dairy sheep of Latxa breed



Feeding management is based on local resources, which are valley and/or mountain pastures and/or on on-farm fodders.

3. Dairy goats in Andalusia



There are farms that rely on natural resources supplemented with some concentrates and there are farms with no access to land and heavily rely on purchased forages and concentrates.

MATERIALS AND METHODS: Identification of indicators

Principles (5)	Attributes (21)	Indicators (85)
System reserves	Financial capital	
	Access to natural capital	
	Farm infrastructure	
	Infrastructure of the living area	
	Human capital	
	Social support	
	Honors legacy	
Diversity	Work and life quality	
	Functional diversity	
	Response diversity	
Modularity	Spatial and temporal heterogeneity	
	Optimally redundant	
	Globally autonomous	
	Sanitary isolation	
Openness	Organized and structured sector	
	Knowledge and innovation networks	
Tightness of feedbacks	Exposed to disturbances	
	Organizations feedback	
	Locally interdependent	
	Ecologically self-regulated	
	Coupled with natural capital	

MATERIALS AND METHODS: Identification of indicators

Principles (5)	Attributes (21)	Indicators (85)
System reserves	Financial capital	• Percentage of FTE units of family members • Farm succession secured
	Access to natural capital	
	Farm infrastructure	
	Infrastructure of the living area	
	Human capital	
	Social support	
Diversity	Honors legacy	• The possibility of selling the products directly to the consumer • Absence of legal obligations that prevent switching buyers
	Work and life quality	
	Functional diversity	
Modularity	Response diversity	
	Spatial and temporal heterogeneity	
	Optimally redundant	
	Globally autonomous	
Openness	Sanitary isolation	
	Organized and structured sector	
	Knowledge and innovation networks	
Tightness of feedbacks	Exposed to disturbances	
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MATERIALS AND METHODS: Data collection and aggregation

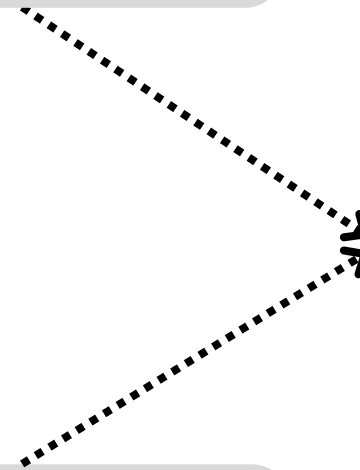
Surveys to 144 farmers

Data on farm indicators

Numerical and categorical data



Attributes scores



Overall resilience
score

Weighted sum
of the attributes
scores

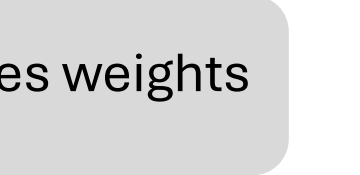
Workshops with 21 stakeholders

Attributes importance for resilience

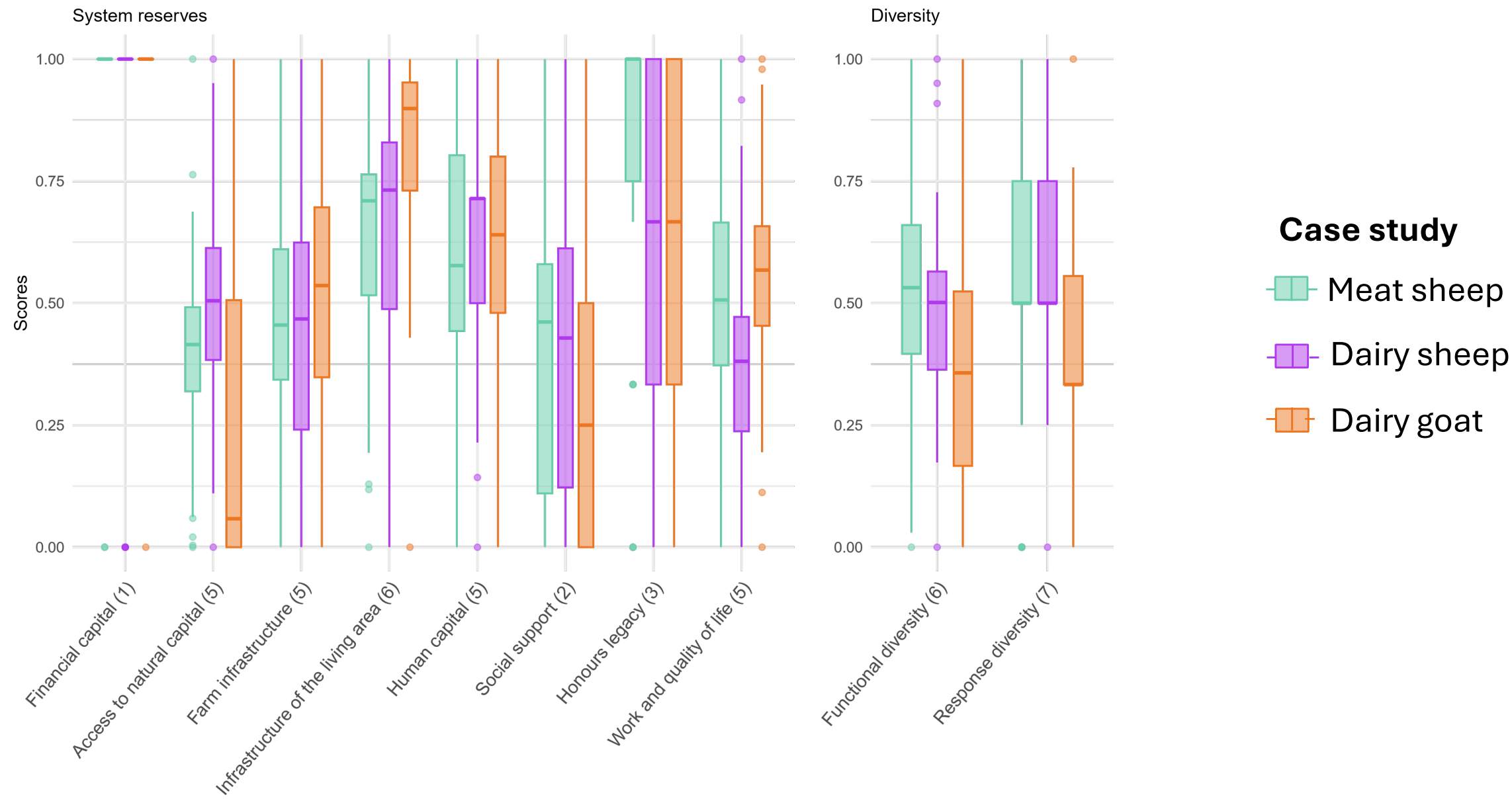
In a scale from 0 to 10



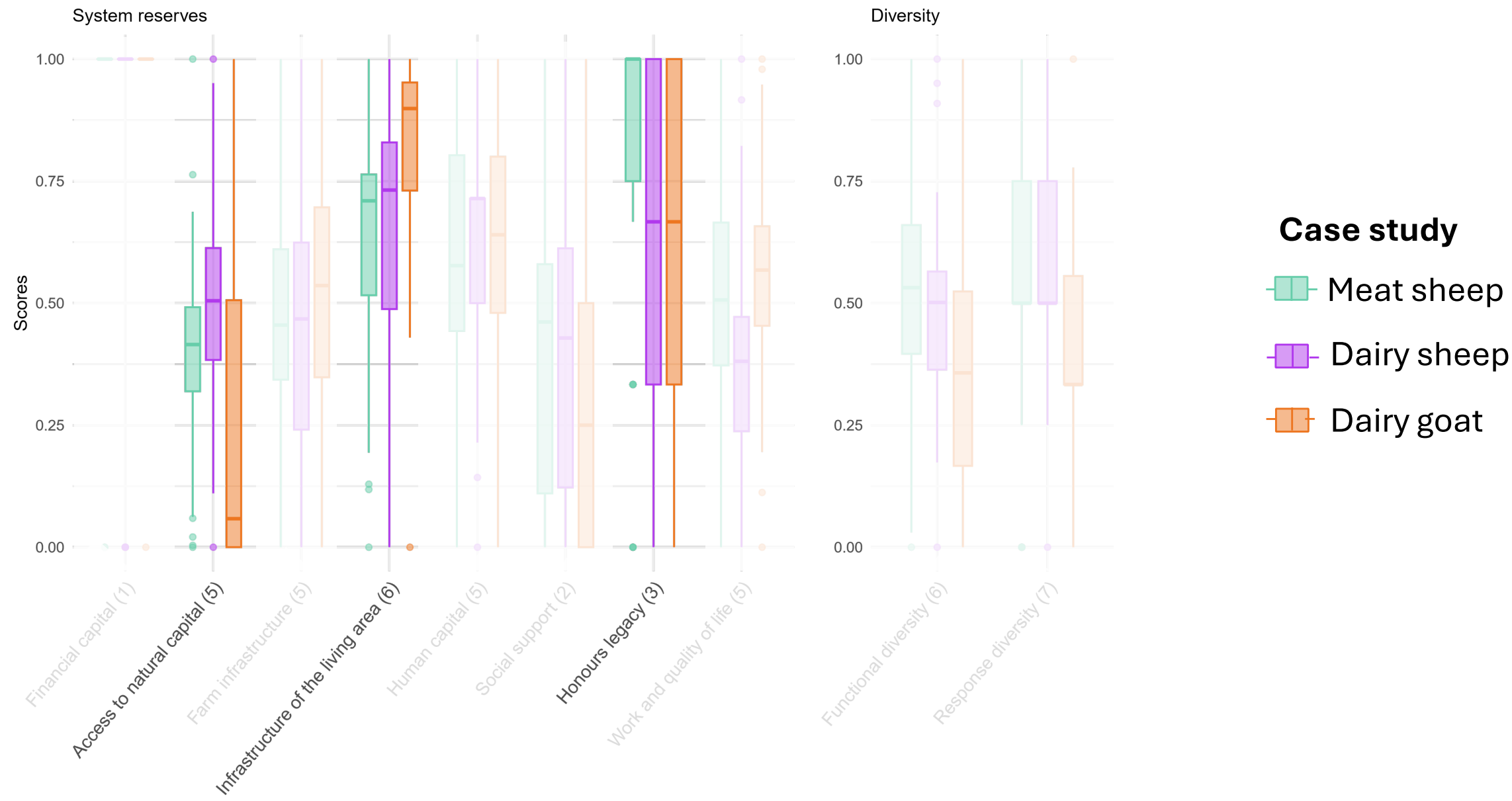
Attributes weights



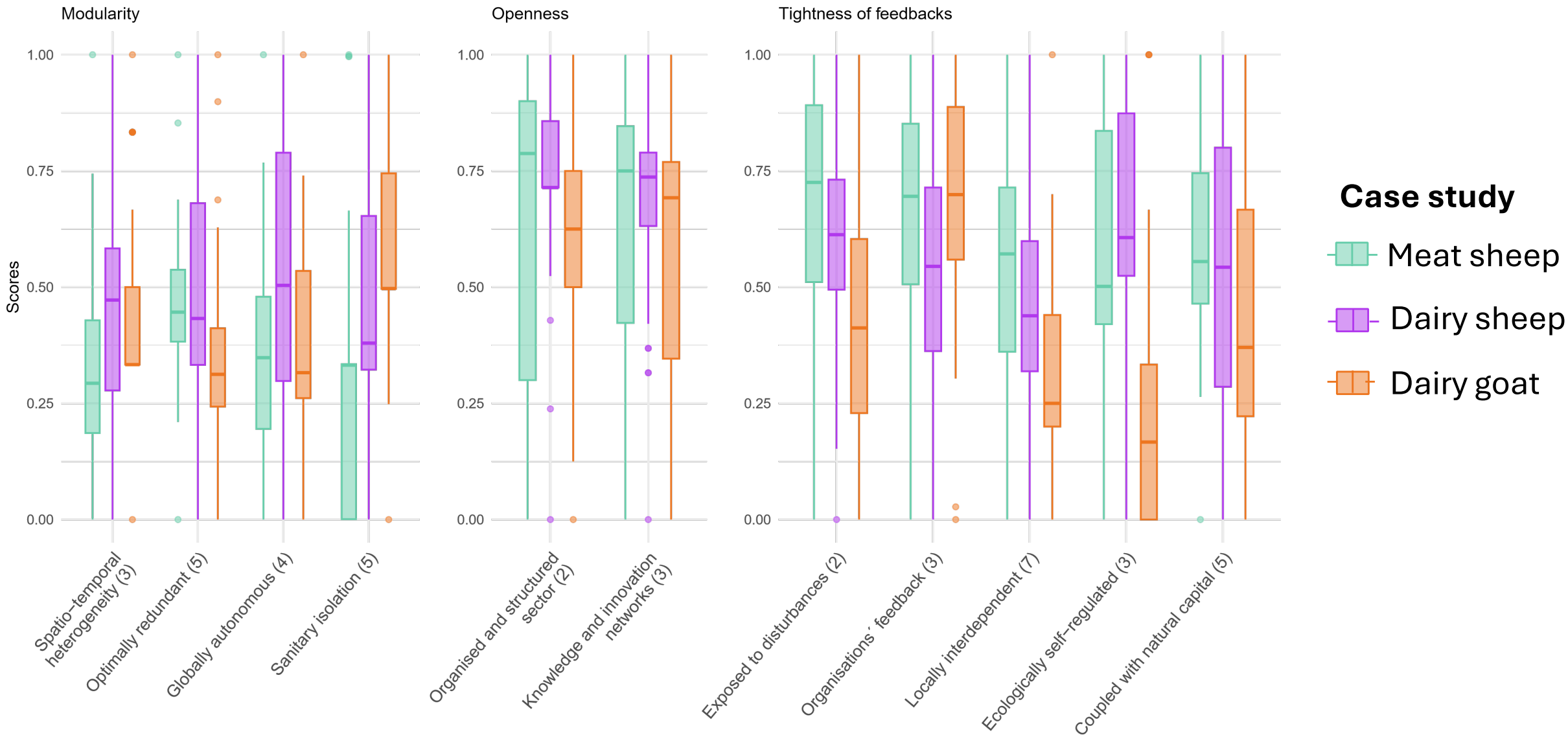
RESULTS AND DISCUSSION: Attributes scores



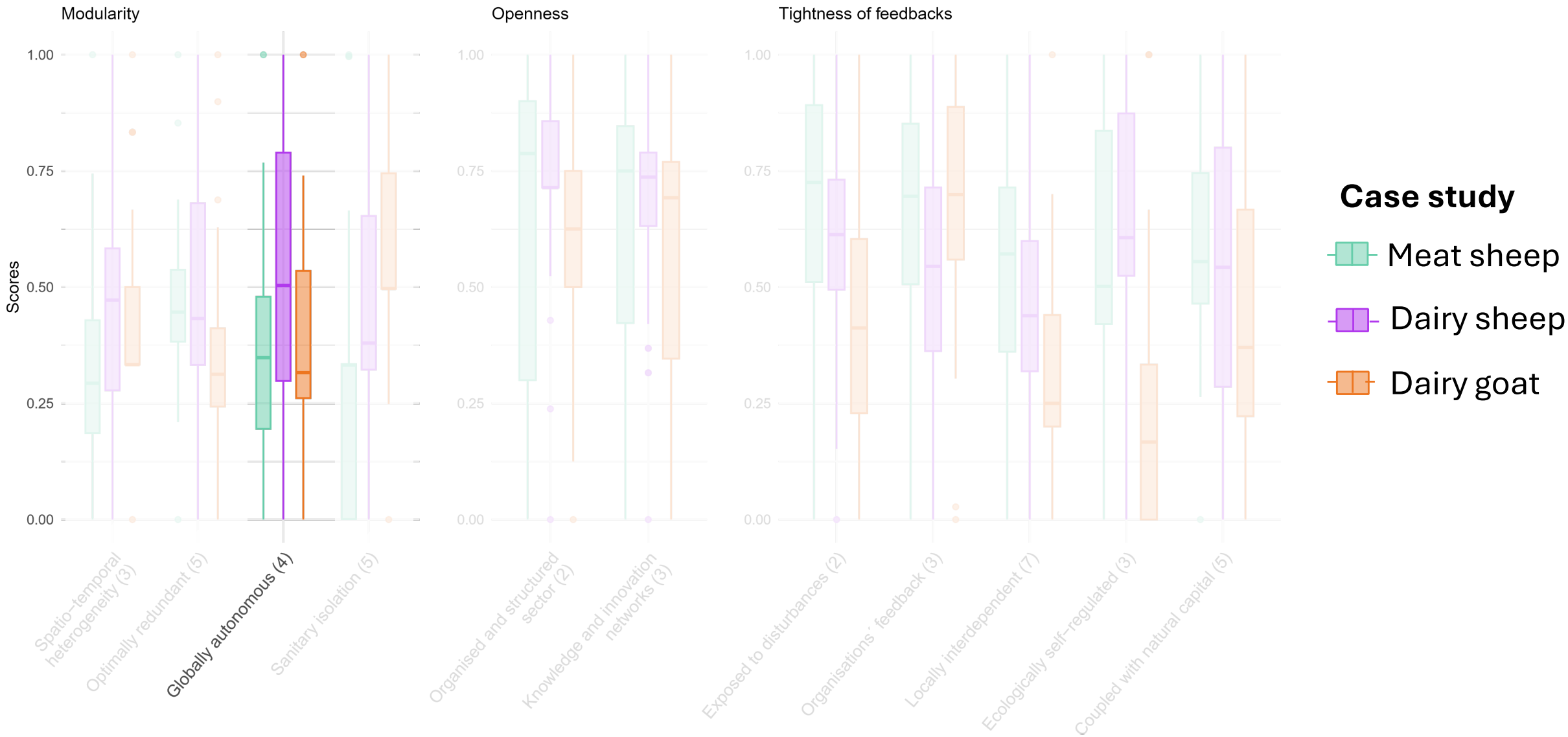
RESULTS AND DISCUSSION: Attributes scores



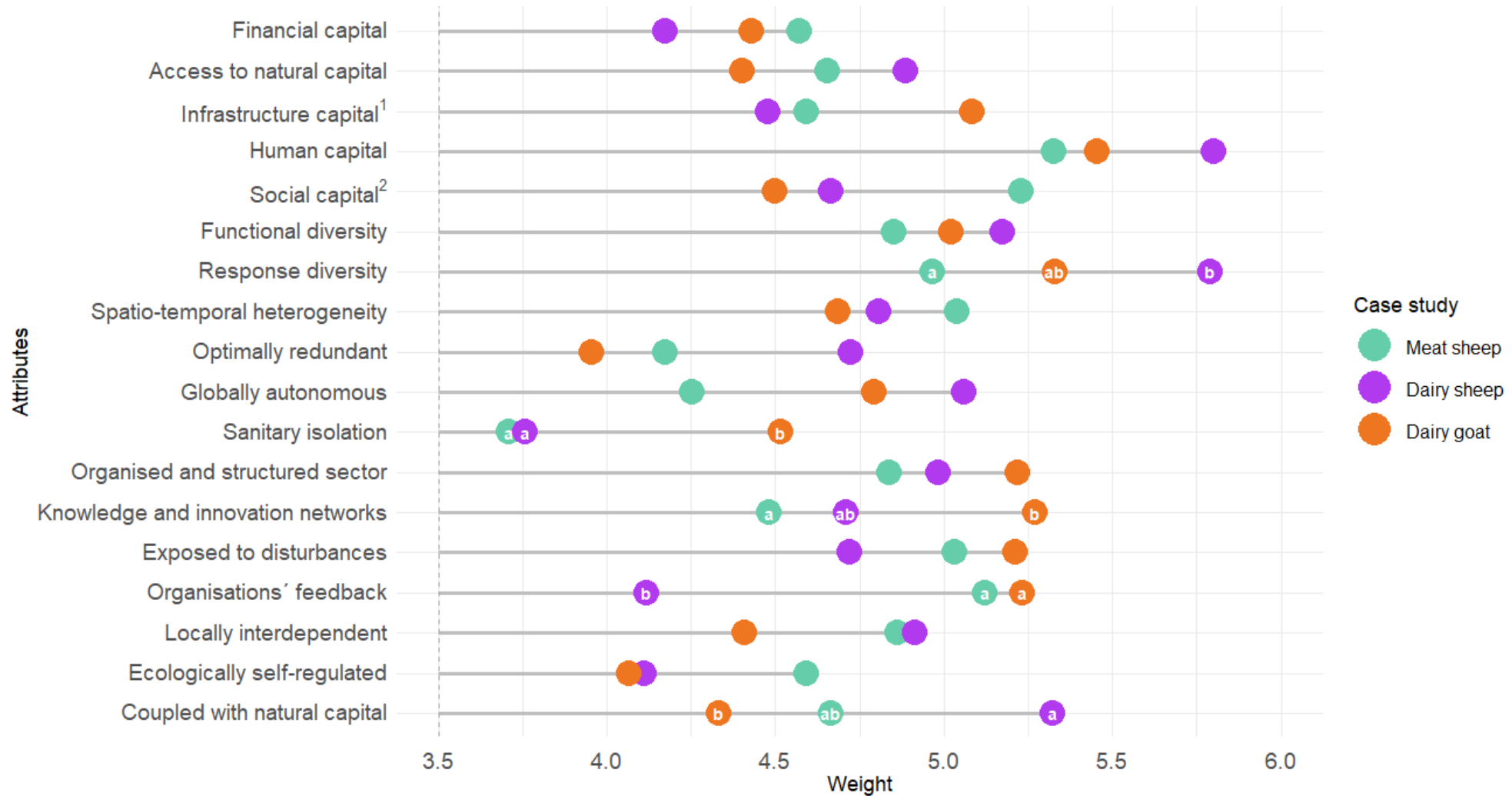
RESULTS AND DISCUSSION: Attributes scores



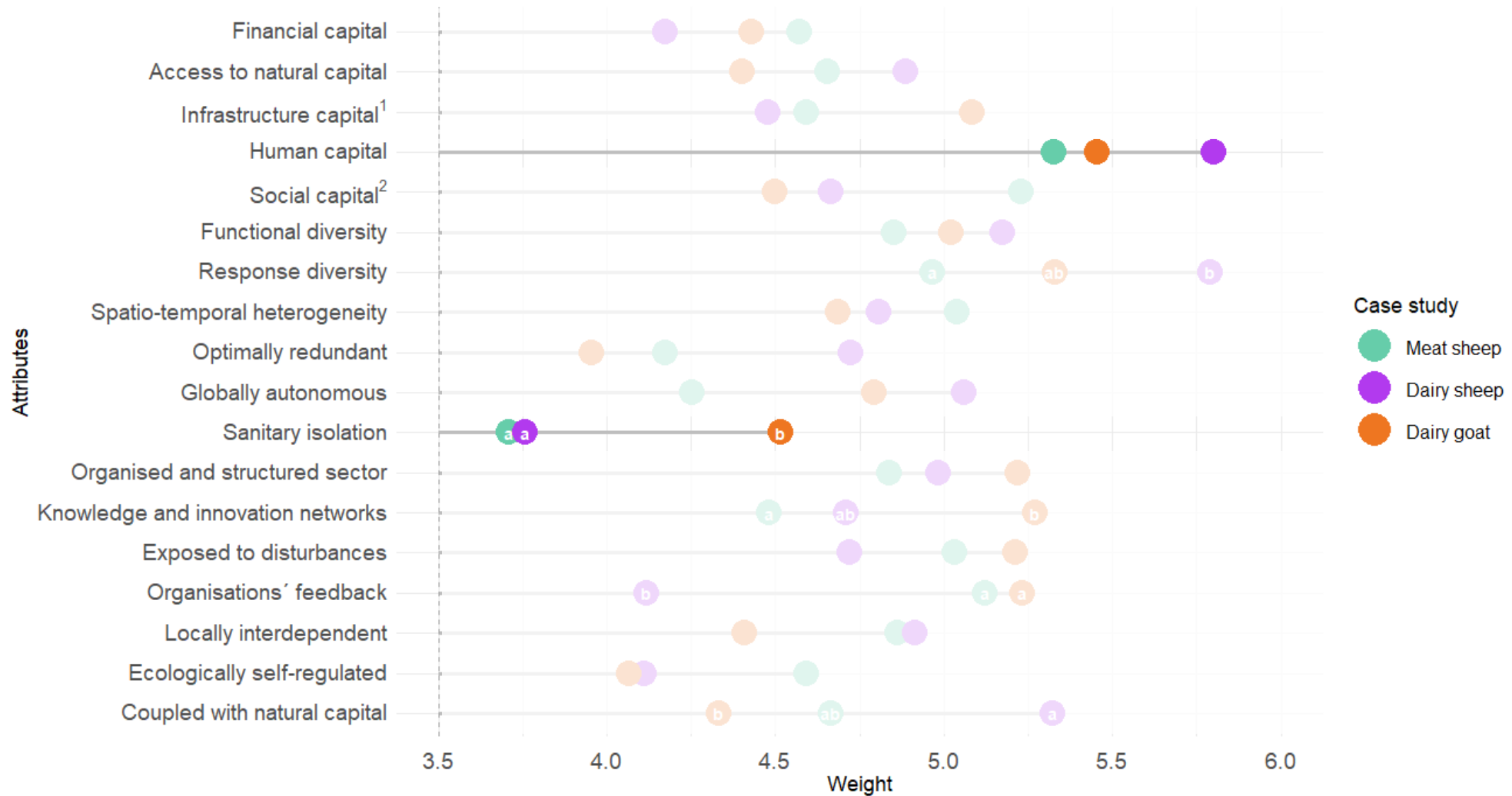
RESULTS AND DISCUSSION: Attributes scores



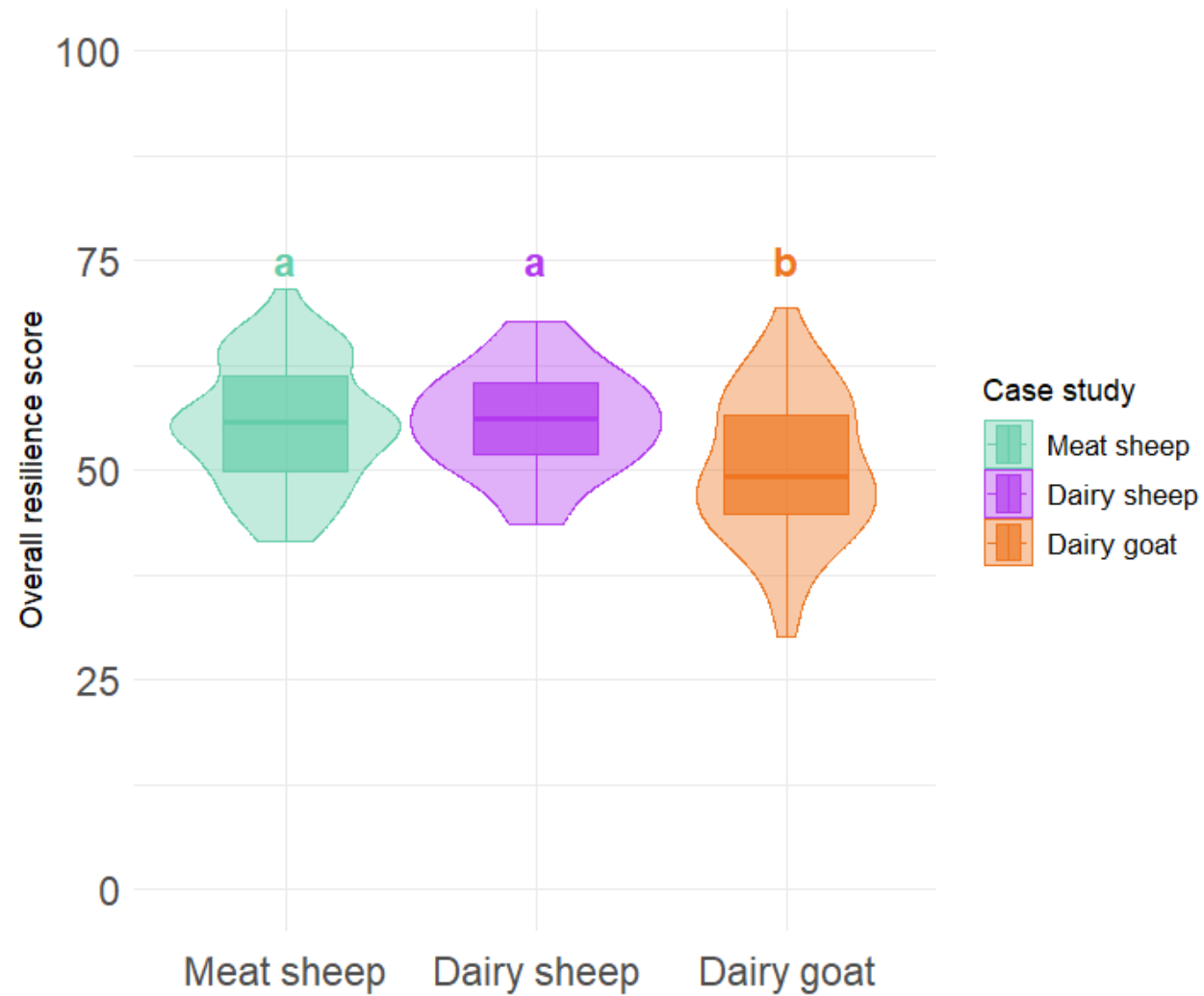
RESULTS AND DISCUSSION: Attributes weights



RESULTS AND DISCUSSION: Attributes weights



RESULTS AND DISCUSSION: Resilience scores



CONCLUSIONS

1. Our approach was able to **identify the domains in which a system performs better** or worse than others in terms of resilience attributes
2. Some indicators could form part of **farm data collection protocols** to support private and public decision makers in their efforts to improve farm resilience and its disclosure
3. Quantitative assessments of resilience in farming are still a rather new scientific domain and **further research is needed**



THANKS FOR YOUR ATTENTION

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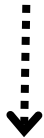
Principle (5)	Attribute (21)	Selected indicators (85)
1. System reserves	1. Financial capital	1.1. Access to loans
	2. Access to natural capital	2.1. Total number of hectares for forage; 2.2. Grazing surface per animal; 2.3. Percentage of owned surface to feed the herd; 2.4. Use of communal pastures to feed the herd; 2.5. Percentage of arable surface to feed the herd
	3. Farm infrastructure	3.1. Distance to a slaughterhouse or gathering centre*; 3.2. Percentage of relevant buildings built in the last 10 years; 3.3. Percentage of relevant buildings renovated in the last 10 years; 3.4. Percentage of relevant machinery bought in the last 10 years; 3.5. Automatic systems available to feed animals
	4. Infrastructure of the living area	4.1. Medical centre available in the town of the farm's location; 4.2. Distance to a hospital*; 4.3. Existence of shops in the town of the farm's location; 4.4. Existence of a school in the town of the farm's location; 4.5. Existence of a secondary education school in the town of the farm's location; 4.6. Access to the Internet and a phone signal
	5. Human capital	5.1. Percentage of FTE aged under 40; 5.2. Highest level of education; 5.3. Learning farm skills from predecessors; 5.4. Agricultural education 5.5. Learning from consultants
	6. Social support	6.1. Percentage of FTE of family members; 6.2. Secured farm succession
	7. Honours legacy	7.1. Start farming through inheritance; 7.2. Traditional livestock farming family; 7.3. Traditionally sheep or goat farming family
	8. Work and quality of life	8.1. Average of non-working hours per day a year; 8.2. Average of free days per week; 8.3. Number of holiday days per year; 8.4. No health problems that prevent a farmer from working; 8.5. Number of animals on farm per FTE*

Principle (5)	Attribute (21)	Selected indicators (85)
2. Diversity	9. Functional diversity	9.1. Mixed crop-livestock farm; 9.2. Transformation of the main product on the farm; 9.3. Number of livestock species other than reared small ruminants; 9.4. Number of different surfaces used for feeding animals ¹ ; 9.5. Number of products sold; 9.6. Percentage of family income made from non-agricultural activities
	10. Response diversity	10.1. Grazing land or crops available to feed livestock next to the farm; 10.2. Percentage of distribution channels currently used with alternative options; 10.3. Percentage of feed supply channels currently used with alternative options; 10.4. Possibility of selling products directly to consumers; 10.5. No contracts that prevent switching buyers; 10.6. No mandatory buyer requirements to accept products; 10.7. No contracts that prevent switching providers
3. Modularity	11. Spatio-temporal heterogeneity	11.1. Grazing in different geographical areas; 11.2. Number of different surfaces used for feeding animals ¹ ; 11.3. Number of months per year that feed is bought
	12. Optimally redundant	12.1. Total number of purchasers of the main products; 12.2. Total number of suppliers for animal feed; 12.3. Distribution of calving at various times of the year; 12.4. Number of FTE; 12.5. Number of FTE per animal
	13. Globally autonomous	13.1. Number of months per year that feed is not bought on the farm; 13.2. Percentage of livestock feed produced on the farm; 13.4. Percentage of energy used from renewable sources ² ; 13.5. Percentage of farm income that does not come from subsidies
	14. Sanitary isolation	14.1. Distance to the nearest farm; 14.2. No pastures shared with other flocks of any species; 14.3. No areas shared with wildlife; 14.4. Implementation of quarantines to introduce animals into livestock; 14.5. Periodic analysis of the sanitary water quality

Principle (5)	Attribute (21)	Selected indicators (85)
4. Openness	15. Organised and structured sector	15.1. Percentage of data collected on the farm that are shared with other entities; 15.2. Number of livestock association/institution memberships
	16. Knowledge and innovation networks	16.1. Regular participation in sector forums or meetings; 16.2. Participation in research or educational projects; 16.3. Number of channels to obtain sector news
5. Tightness of feedbacks	17. Exposed to disturbances	17.1. Time working as a farmer; 17.2. Years the farm has operated
	18. Organisations' feedback	18.1. Level of trust in the institutions to which a farmer belongs; 18.2. Level of participation in the institutions to which a farmer belongs; 18.3. Level of usefulness of the institutions to which a farmer belongs
	19. Locally interdependent	19.1. Livestock work in collaboration with other farmers; 19.2. Equipment/infrastructure shared with other farmers; 19.3. Dialogue on common problems with other farmers; 19.4. Percentage of products sold directly to consumers; 19.5. Percentage of products sold at local markets/fairs; 19.6. Percentage of product sold with a quality label; 19.7. Number of non-livestock sectors with which the farmer cooperates
	20. Ecologically self-regulated	20.1. Livestock grazing in conservation areas; 20.2. Possibility to feed herds using only local resources if necessary; 20.3. Percentage of grazed forage area
	21. Coupled with natural capital	21.1. Number of months per year with livestock on pasture; 21.2. Percentage of natural pasture area used for feeding; 21.3. Percentage of water used on the farm that comes from natural sources; 21.4. Percentage of energy used from renewable sources ² ; 21.5. Percentage of livestock by-products used in nearby areas

MATERIALS AND METHODS: Aggregation

We transform the **indicators** using a min-max procedure per case study



We sum all the indicators per attribute, and we transform the sum using a min-max normalisation per case study in a range 0-1

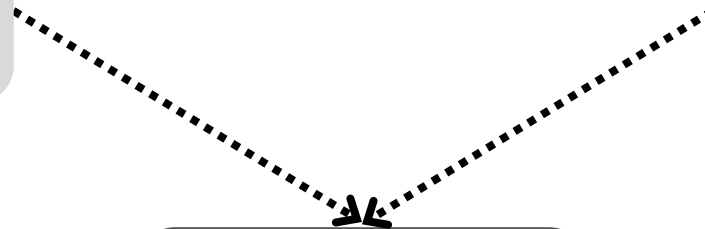


Attributes scores

We transformed **attributes importance** by a budget allocation process that makes them sum up to 100



Attributes weights



Overall resilience
score

Weighted sum of the
attributes scores