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A Comparative Analysis of Resilience of Livestock Farming Systems Across Intensification Gradients

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🐷 Pig | 🐄 Beef Cattle | 🐐 Dairy Goat | 🐑 Dairy Sheep | 🐑 Meat Sheep

CONTEXT

Environmental

Rising temperatures, wildlife conflicts

Institutional

CAP reforms creating uncertainty for long-term planning

Economic

COVID-19 and Ukraine war: input prices, market instability

Social

Labor shortages and changing consumer perceptions

Knowledge Gap

Limited evidence on resilience attributes and capacities across livestock systems with different intensification levels

Study Objectives

i) Identify attributes linked to specific challenges

ii) Detect trade-offs between resilience principles and capacities along the intensity gradient

iii) Identify distinct resilience configurations/ strategies

CONCEPTUAL FRAMEWORK

RESILIENCE

Robustness
Short-term ability to absorb disturbances

Adaptability
Medium-term capacity to adjust practices

Transformability
Long-term ability to reorganize the system

5 Resilience Principles (Resilience Alliance 2010; Meuwissen et al. 2019; Prat-Benhamou et al. 2024)

System Reserves	Diversity	Modularity	Openness	Tightness of Feedbacks
9 attributes	*3 attributes*	*6 attributes*	*3 attributes*	*6 attributes*

27 resilience attributes assessed via 7-point Likert-scale statements (farmers' self-assessment)

STUDY DESIGN & CASE STUDIES (Spain)

◀ INTENSIVE — PRODUCTION INTENSITY GRADIENT — EXTENSIVE ▶

	Pig	Dairy Goat	Dairy Sheep	Meat Sheep	Beef Cattle
	n = 46	*n = 53*	*n = 41*	*n = 55*	*n = 46*
	Aragón	Andalusia	Basque Country	Aragón	Mountain areas Iberian Peninsula
Land base:	≈0.00 ha/LU	≈ 0.02 ha/LU	≈ 0.03 ha/LU	≈ 0.09 ha/LU	≈ 13.6 ha/LU
Grazing:	≈ 0.6 mo/yr	≈ 5.2 mo/yr	≈ 10.3 mo/yr	≈ 10.2 mo/yr	≈ 10.6 mo/yr
Purchased feed :	≈ 11.5 mo/yr	≈ 11.3 mo/yr	≈ 6.2 mo/yr	≈ 7.9 mo/yr	≈ 8.4 mo/yr
Automated feed:	100%	≈ 23%	≈ 51%	≈ 47%	≈ 23%

METHODOLOGY

Data Collection

- Face-to-face interviews
- May 2022 – July 2025
- 241 farms across 5 systems
- Multiple regions in Spain

Survey Instrument

7-point Likert-score covering:

- 27 resilience attributes
- 3 resilience capacity
- 7-9 perceived challenges

Statistical Analysis

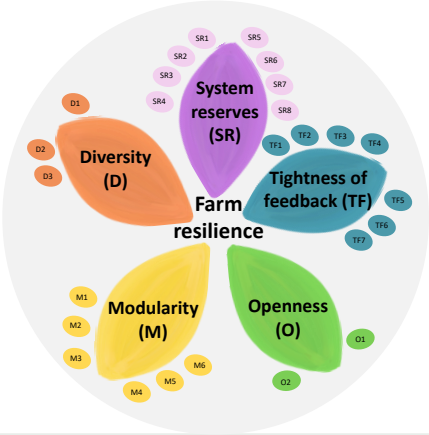
- Descriptive statistics (mean, SD, median)
- Kruskal-Wallis test (group differences)
- Dunn test + Bonferroni correction

Subjective Resilience Assessment Approach

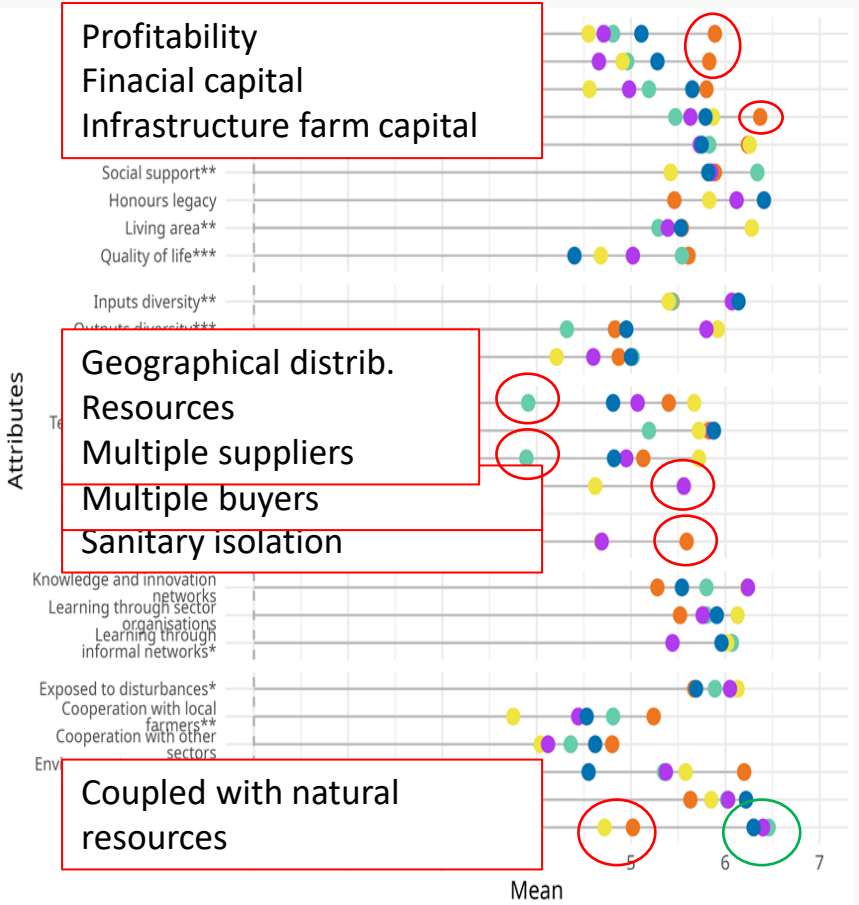
Prat-Benhamou et al. (2024), (Clare et al., 2017)

Assess farmers' perceptions of farm characteristics and coping capacities

Advantages: Useful for context-sensitive, low-burden and cross-system comparisons



RESULTS: RESILIENCE ATTRIBUTES



Key Findings

🐷 Pig: highest profitability, financial capital and sanitary isolation

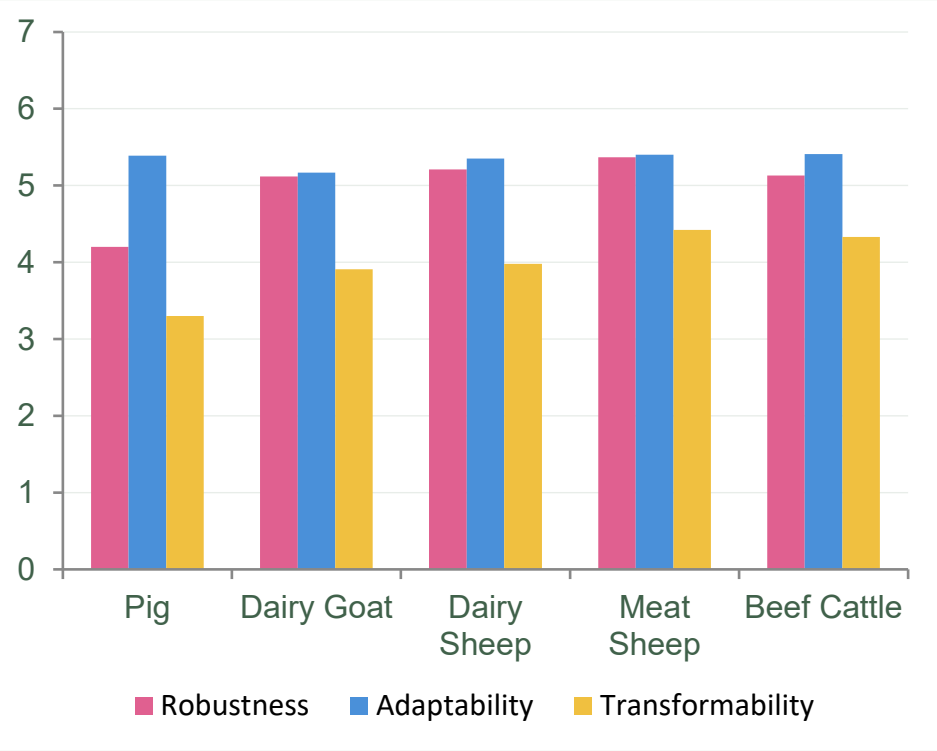
🐐 Dairy sheep: most diversified market channels (multiple buyers)

🐄 Beef cattle: fewest suppliers and most geographically concentrated resources

🌿 Grazing systems: strongest coupling with natural resources

↑ Intensive ↑ economic resources
↑ Extensive ↑ ecological coupling

RESULTS: RESILIENCE CAPACITIES



Scale 1–7 (Likert). Dashed line at 4 = neutral

Robustness

★ *Significant*

Pig farms lowest (4.2 vs ~5.1–5.4). Intensive systems more vulnerable to sudden shocks — continuous input dependency limits short-term absorption.

Adaptability

No significant differences

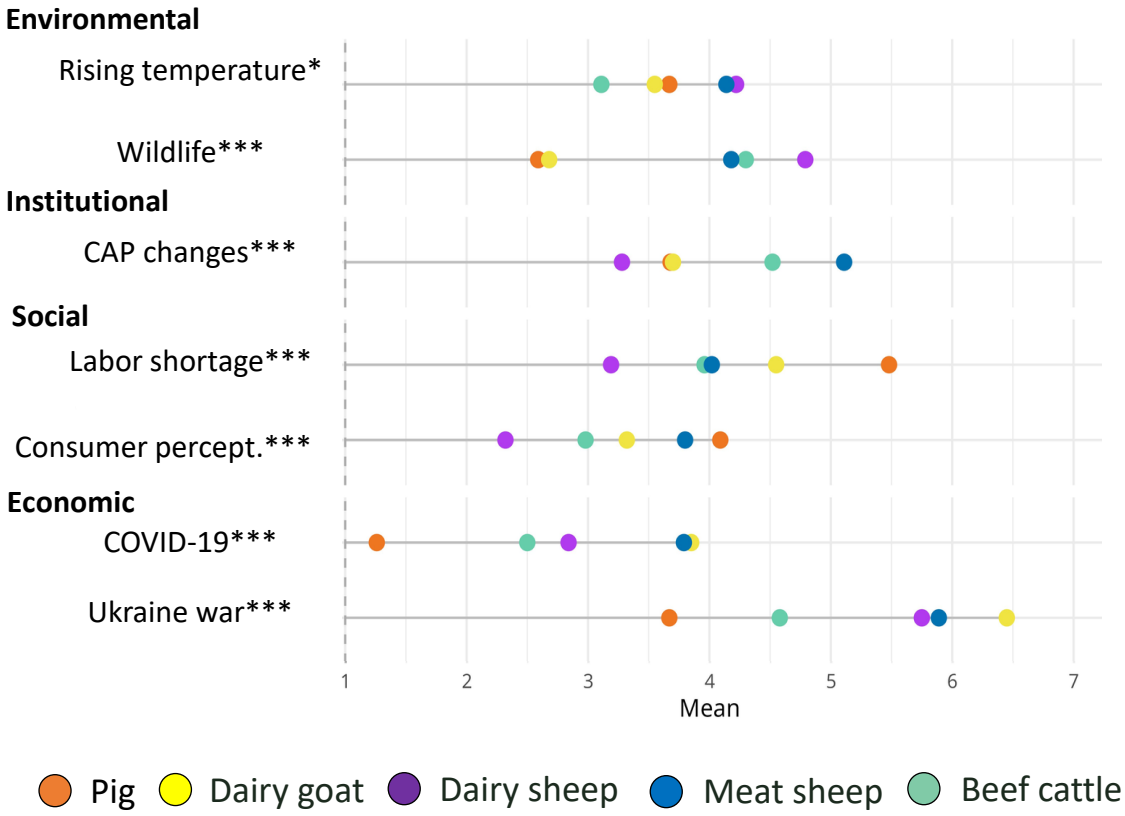
All systems report similar medium-term adjustment capacity (~5.2–5.4). Experience-based rather than structure-dependent.

Transformability

★ *Pig < Meat Sheep*

Generally low across all systems (3.3–4.4). Structural change perceived as constrained by external conditions.

RESULTS: PERCEIVED CHALLENGES



Key Findings

- 🌡 Rising temperature: similar across all systems
- 🦌 Wildlife: higher in extensive and lowest in dairy goat
- 📋 CAP reform: most critical for meat sheep
- 👷 Labor shortage: most critical for pig
- ⚡ Ukraine war: most severe challenge overall, highest in small ruminants (pig least affected)

DISCUSSION: DISTINCT RESILIENCE STRATEGIES

EXTENSIVE — INTENSIVE

🌿 Extensive Strategy

Beef Cattle · Meat Sheep · (Dairy Sheep)

- Strong ecological coupling and local resource use
- Lower financial capital and profitability
- Sanitary isolation more difficult to implement
- Higher robustness scores
- More exposed to wildlife and CAP reform pressures
- Resilience built through ecological embedding and territorial resources

🏭 Intensive Strategy

Pig · Dairy Goat

- High profitability, financial and infrastructural capital
- Strong biosecurity and sanitary isolation
- Diversified supply chains (multiple suppliers)
- Lower robustness (vulnerable to input disruptions)
- Greater exposure to labor shortages and sanitary risks
- Resilience built through economic buffers and supply chain control

KEY TAKEAWAYS & IMPLICATIONS

1

Different systems, different resilience pathways

Resilience follows distinct pathways along the intensification gradient.

2

Similar capacities despite structural differences

Perceived resilience capacities are largely consistent across systems.

3

Distinct challenge exposures

Intensive and extensive systems face different sets of challenges.

4

Resilience involves trade-offs

Farming systems combine strengths and vulnerabilities in different ways.

CONCLUSIONS

- First large-scale comparative resilience assessment across 5 livestock systems using a consistent framework
- Production intensity shapes distinct resilience configurations, not a single "more resilient" model exists
- Trade-offs are central to resilience across all systems.
- Across all systems, openness is consistently high and global autonomy consistently low, irrespective of production intensity.

Future Directions

- Examine whether resilience configurations reflect deliberate strategies or structural constraints or configurations
- Extend the framework to other European livestock systems
- ...

Thank you!

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