Istituto Zooprofilattico Sperimentale del Mezzogiorno
Campania | Calabria



Multidimensional information system for zootechnics: the case study of buffalo farm and the dark side of outsourcing drivers

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IMPACT OF FEED OUTSOURCING ON LIVESTOCK SYSTEM VULNERABILITY: A SCENARIO ANALYSIS

OUTSOURCED (X)
UNAFFECTED
VULNERABLE (WARNING)

EXTERNAL FEED OUTSOURCING INTERRUPTED

CORE DIETARY ELEMENTS AFFECTED

KEY VULNERABILITIES





Protein
Energy
Fiber
Minerals



- How much does this affect your business?
- Which parts of the feed ration are hit the hardest?
- Do you have a Plan B?

HOW READY ARE YOU?
IMPACT ON FARM SURVIVAL VS. ECONOMIC COLLAPSE

FEED OUTSOURCING: EFFICIENCY OR SYSTEMATC VULNERABILITY?

SUBTITLE: IF THE LOGISTICS CHAIN STOPS TOMORROW...

Disrupted Logistics (X)
UNAFFECTED
VULNERABLE (WARNING)

1. Sensitivity of the Ration:
Which components would be missing first?

PROTEIN & ENERGY:
High Vulnerability

2. Farm Autonomy:
How many days of real self-sufficiency?

0 DAYS:
Real Self-Sufficiency





3. The Plan B:
LOCAL SUPPLY & CIRCULAR ECONOMY

LOCAL STORAGE
RECYCLED LOCAL

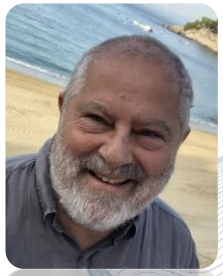
(e.g., Local Forage, Circular Economy)

LOCAL SUPPLY
(e.g. ocalll-grown

LONG-TERM IMPACT
long-term economic impact.

HOW READY ARE YOU?
IMPACT ON FARM SURVIVAL VS. ECONOMIC COLLAPSE

MuSIASEM (Multi-Scale Integrated Accounting of Societal and Ecosystem Metabolism)



Mario Giampietro

External metabolic systems

External pressures (environmental and social)

Externalization

Funds and flows externalized

Does the Jevons paradox compromise efficiency efforts?



Impredicative relationships

Holarchy
A network of interactions

Social-Ecological System (complex and adaptive)

Incentives

€

HH
SG
MC
AG
EM

Growing added value

Viability

Ecosphere
Stock
Fund
Techno-flows
Funds
Technosphere
Socio Economic System
Wastes
Eco-flows

Desirability

Feasibility

...1
...2
...3
...4
...5
...n

Livestock sector

Buffalo animal husbandry

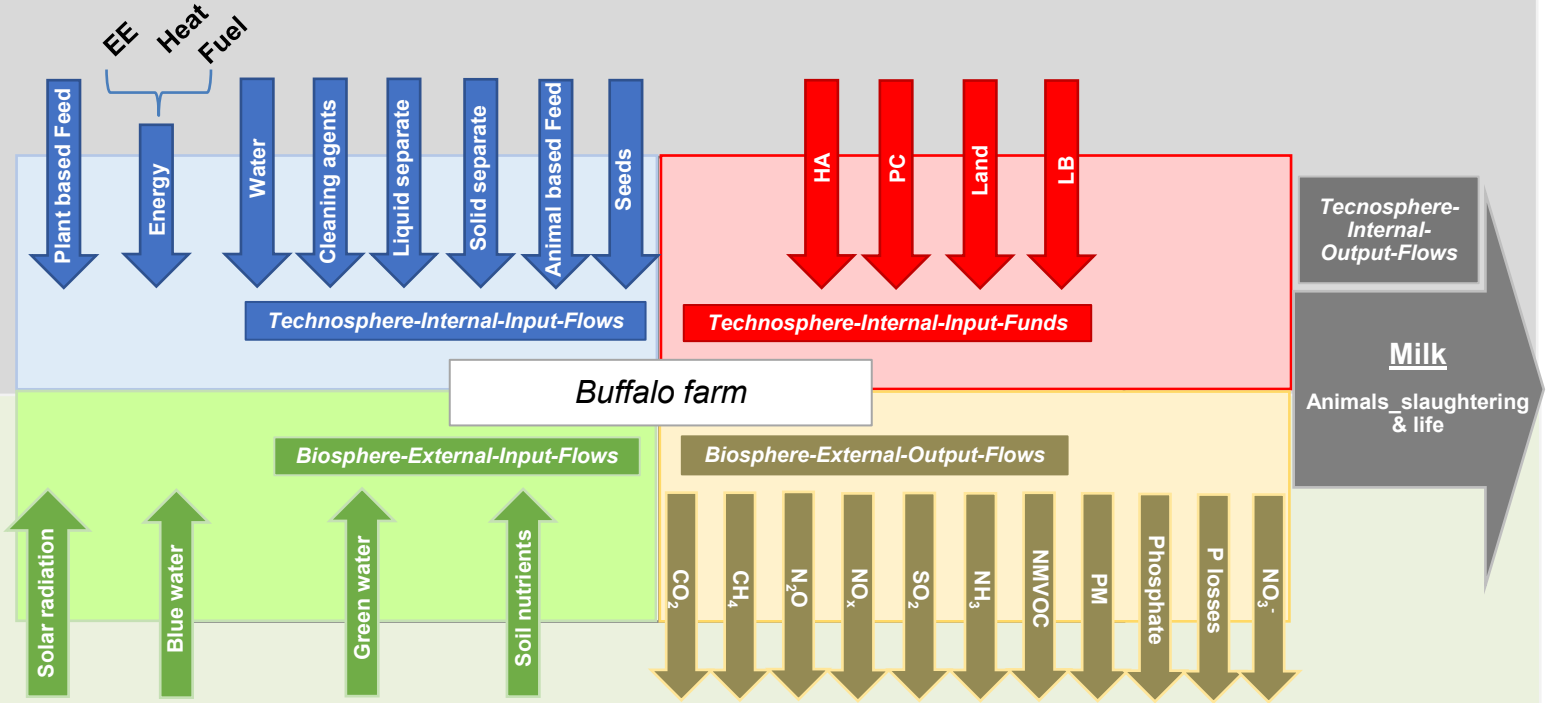
End Use Matrix

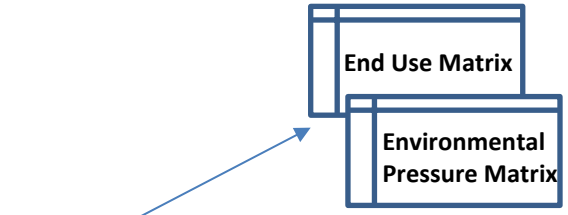
Environmental Pressure Matrix

Giampietro, M., Mayumi, K. Multiple-Scale Integrated Assessment of Societal Metabolism: Introducing the Approach. Population and Environment 22, 109–153 (2000).

Increasing levels of organization

Internal view: Internal metabolic pattern of secondary inputs (techno-carriers) by techno-funds





Numerical outputs

Quantitative Story-Telling (QST)

External view: Stability of boundary conditions

System identity



Formal identity

Semantic identity

VIABILITY
Internal techno-economic performance
Established by the relationships between funds and flows



Buffalo farm
output milk

DESIRABILITY
Normative and institutional features
Established by end use of the product and system's environmental pressure

External identity
(milk to be transformed in a popular product and profit of transformers)

Internal identity
(profit by means of a traditional product)

Why the system exists and works

What the system does
How the system works

Defined by means of the metabolic characterization

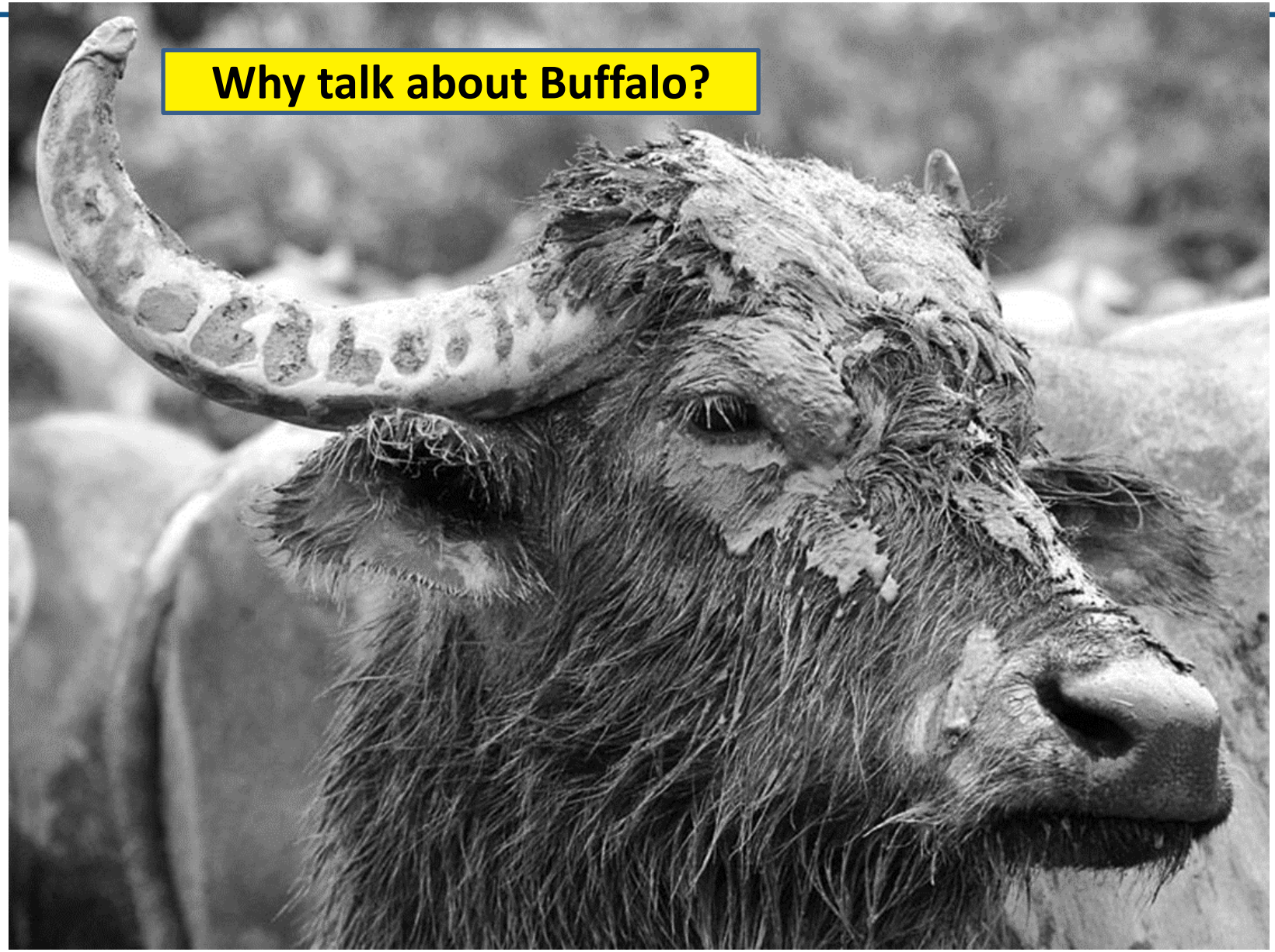
FEASIBILITY
Internal performance
Established by the relationships with ecosphere

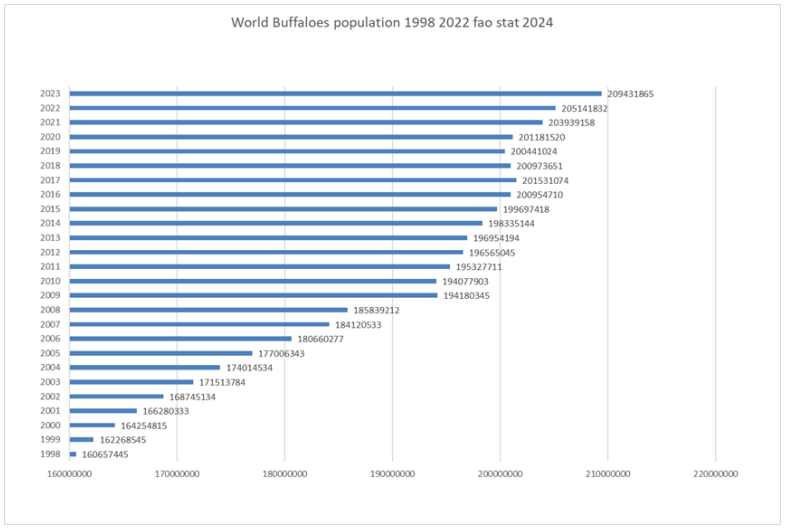
Upward causation

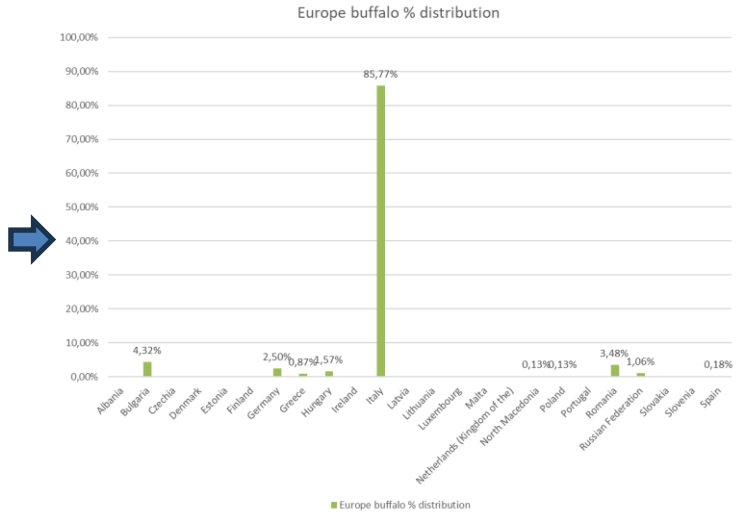
Downward causation

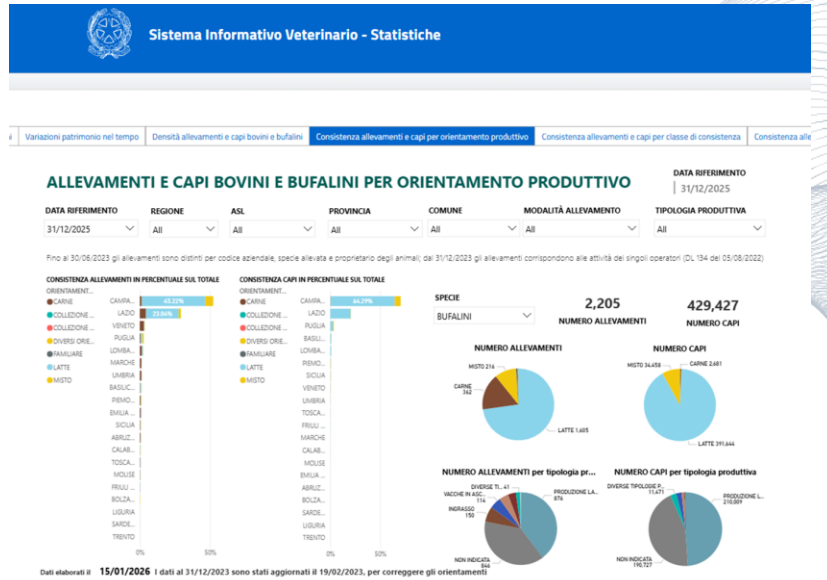
EXTERNALIZATION
Internal performance
Established by the relationships with external funds and flows

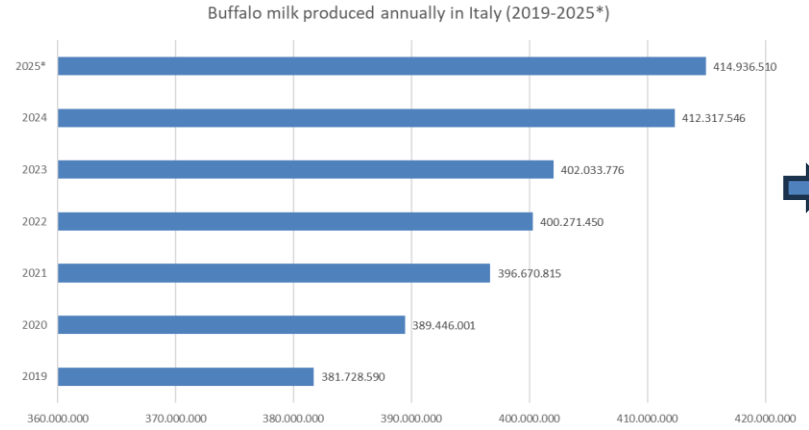
Why talk about Buffalo?

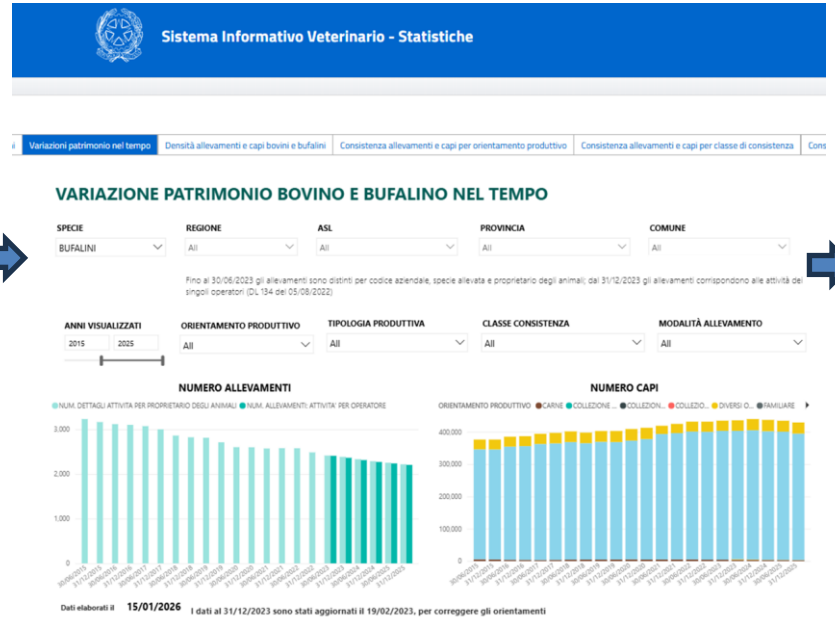












Formaggi DOP IGP STG

	PRODUZIONE CERTIFICATA (tonnellate)			VALORE ALLA PRODUZIONE (milioni di euro)			VALORE AL CONSUMO (milioni di euro)		
Prodotto	2023	2024	Var 24/23	2023	2024	Var 24/23	2023	2024	Var 24/23
Grana Padano DOP	199.197	208.100	+4,5%	1.773	2.185	+23,3%	2.924	3.767	+28,8%
Parmigiano Reggiano DOP	158.015	160.007	+1,3%	1.599	1.760	+10,1%	2.813	2.952	+5,0%
Mozzarella di Bufala Campana DOP	55.588	55.718	+0,2%	528	529	+0,2%	889	891	+0,2%
Gorgonzola DOP	58.328	63.333	+8,6%	430	460	+7,1%	712	764	+7,3%
Pecorino Romano DOP	28.742	27.836	-3,2%	387	338	-12,8%	641	599	-6,5%
Asiago DOP	20.433	20.227	-1,0%	160	155	-2,8%	220	233	+5,6%
Taleggio DOP	8.792	8.850	+0,7%	55	55	-0,5%	106	106	+0,7%
Provolone Valpadana DOP	6.424	6.844	+6,5%	50	53	+6,8%	93	97	+4,4%
Montasio DOP	6.039	5.939	-1,7%	53	53	+0,6%	95	95	+0,5%
Fontina DOP	3.055	3.112	+1,9%	41	44	+6,4%	53	58	+7,7%
Altri prodotti DOP IGP STG	23.567	23.186	-1,6%	228	226	-0,7%	405	415	+2,7%
Totale Formaggi	568.180	583.151	+2,6%	5.303	5.859	+10,5%	8.950	9.977	+11,5%

Indagine Ismea - Qualivita 2025

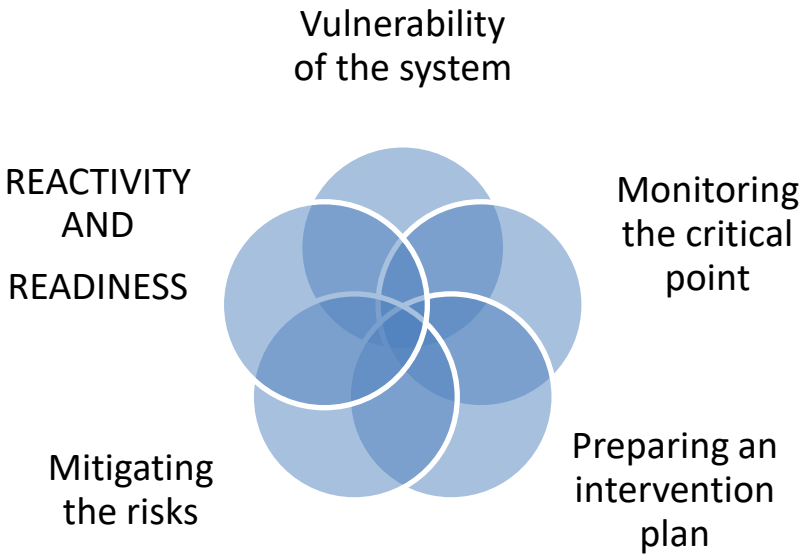
The times we live in… “Liquid” Animal Husbandry

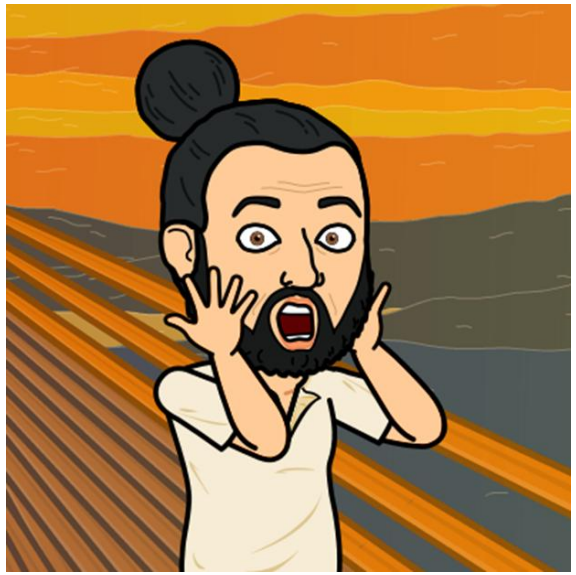
Global market, geopolitics and socio-economic drivers

Climate change, resulting in changes such as shifts in the volume and availability of feed production,

Changes in market conditions and the operating environment, with an increase in local consumption and a rise in the costs of outsourced labour (full-time equivalent workers)







Don't panic!

Do we know the extent to which our companies outsource?

Do we know which elements have the highest level of outsourcing?

Is the level of outsourcing we adopt a conscious choice or a consequence of market forces?

If market conditions were no longer favourable for outsourcing, do we have an alternative plan?

Are we ready for this new situation?

(Readiness)

A survey on feed autonomy in dairy buffalo farms in southern Italy

Design study

2024 from june o december 2024

20 farms

Total heads: 6.746

MuSIASEM Structural Mapping

Based on the Farm Questionnaire Structure

(3 macro areas; 33 questions)

- **Fund Elements (Structural Matrix)**
- **Flow Elements (Metabolic Throughput)**
- **Socio-Ecological Constraints & Performance Indicators**

Determinations



Crop production
- Quantity of Dry Matter (DM)
- Nutritional Value



Feed autonomy
- Self-produced DM consumed on the total DM intaken from the herd



Energy and protein feed autonomy
- Consumed DM Energy
- Crude protein content (purchased or self-produced)

MuSIASEM Structural Mapping Based on the Farm Questionnaire Structure

1. Fund Elements (Structural Matrix)

- **Human Activity (HA):** Total hours allocated to farm operation, mapped by family members and hired employees (From Sections 2 & 3).
- **Land Matrix (LU):** Biophysical categories of land use including Total Agricultural Area (TAA), Utilized Agricultural Area (UAA), owned vs. rented land, and stable footprint (From Section 6).
- **Livestock Stock (Herd Fund):** Biological fund elements classified by demographic and functional categories: lactating cows, primiparous, dry cows, heifers, calves, and adult bulls (From Section 19).
- **Capital/Technological Fund:** Fixed technical assets including milking parlors (milking points/stalls), TMR mixers, telehandlers, tractors, and storage structures (From Sections 10, 25 & 26).

2. Flow Elements (Metabolic Throughput)

- **Biophysical Inflows (Inputs):** Total external and internal inputs required to sustain the fund elements, including purchased/produced green forage, hay, straw, silage, concentrates, water volume, and fuels (From Sections 6, 18, 22, 23, 24 & 32).
- **Biophysical Outflows (Outputs):** Total volume of milk delivered (PDO vs. non-PDO) and herd dynamics output (slaughtered, dead, or sold animals) (From Section 12 & 21).
- **Monetary Flows (Financial Metabolism):** Contract prices per kg of milk, insurance costs, professional services fees, registration fees, and incoming subsidies/incentives (From Sections 14, 15, 16, 17, 27, 28 & 33).

Found Elements

Category	Variable / Element	Questionnaire Reference
Human Activity (HA)	Family labor	Section 3
Human Activity (HA)	Hired employees	Section 3
Land Matrix (LU)	Total Agricultural Area (SAT)	Section 6
Land Matrix (LU)	Utilized Agricultural Area (SAU)	Section 6
Land Matrix (LU)	Owned vs. Rented land	Section 6
Land Matrix (LU)	Stable footprint / Spreading area	Section 6
Livestock Stock (Herd Fund)	Adult females (Lactating, Primiparous, Dry)	Section 19
Livestock Stock (Herd Fund)	Heifers & Calves (0-180 days, 180-1st calving)	Section 19
Livestock Stock (Herd Fund)	Adult bulls	Section 19
Capital/Technological Fund	Milking parlor system & stalls	Section 10
Capital/Technological Fund	Machinery (Mixer wagons, tractors, telehandlers)	Section 26
Capital/Technological Fund	Storage structures (Silos, warehouses, bunkers)	Section 25

Flow Elements

Category	Variable / Element	Questionnaire Reference
Biophysical Inflows	Forage & Feed (Green forage, hay, straw, silage)	Sections 23 & 24
Biophysical Inflows	Concentrates & Feed tags	Section 22
Biophysical Inflows	Irrigation water volume	Section 18
Biophysical Inflows	Fuel consumption	Section 32
Biophysical Outflows	Total milk delivered (PDO vs. non-PDO)	Section 12
Biophysical Outflows	Herd dynamics (Slaughtered, dead, or sold animals)	Section 21
Monetary Flows	Milk contract prices (Flat, summer, winter rates)	Sections 14 & 15
Monetary Flows	Insurance & Registration fees	Sections 16 & 17
Monetary Flows	Professional services fees	Sections 27 & 28
Monetary Flows	Subsidies and incentives	Section 33

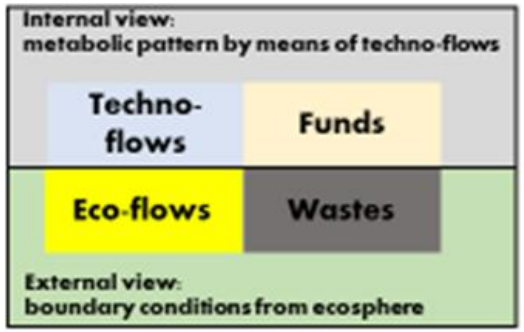
Constraints & Indicators

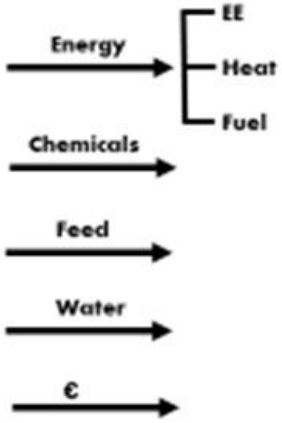
Category	Variable / Element	Questionnaire Reference
Feasibility (Ecosystem)	Manure/slurry spreading capacity	Section 6
Feasibility (Ecosystem)	Nitrogen/environmental limits	Section 6
Viability (Socio-Economic)	Milk yield per cow per lactation (270 days)	Section 20
Viability (Socio-Economic)	Labor productivity / efficiency metrics	Section 3 & 20
Technological Typology	Farming system (Conventional vs. Organic/Biodynamic)	Section 4
Technological Typology	Housing system (Free-stall vs. Tie-stall)	Section 8

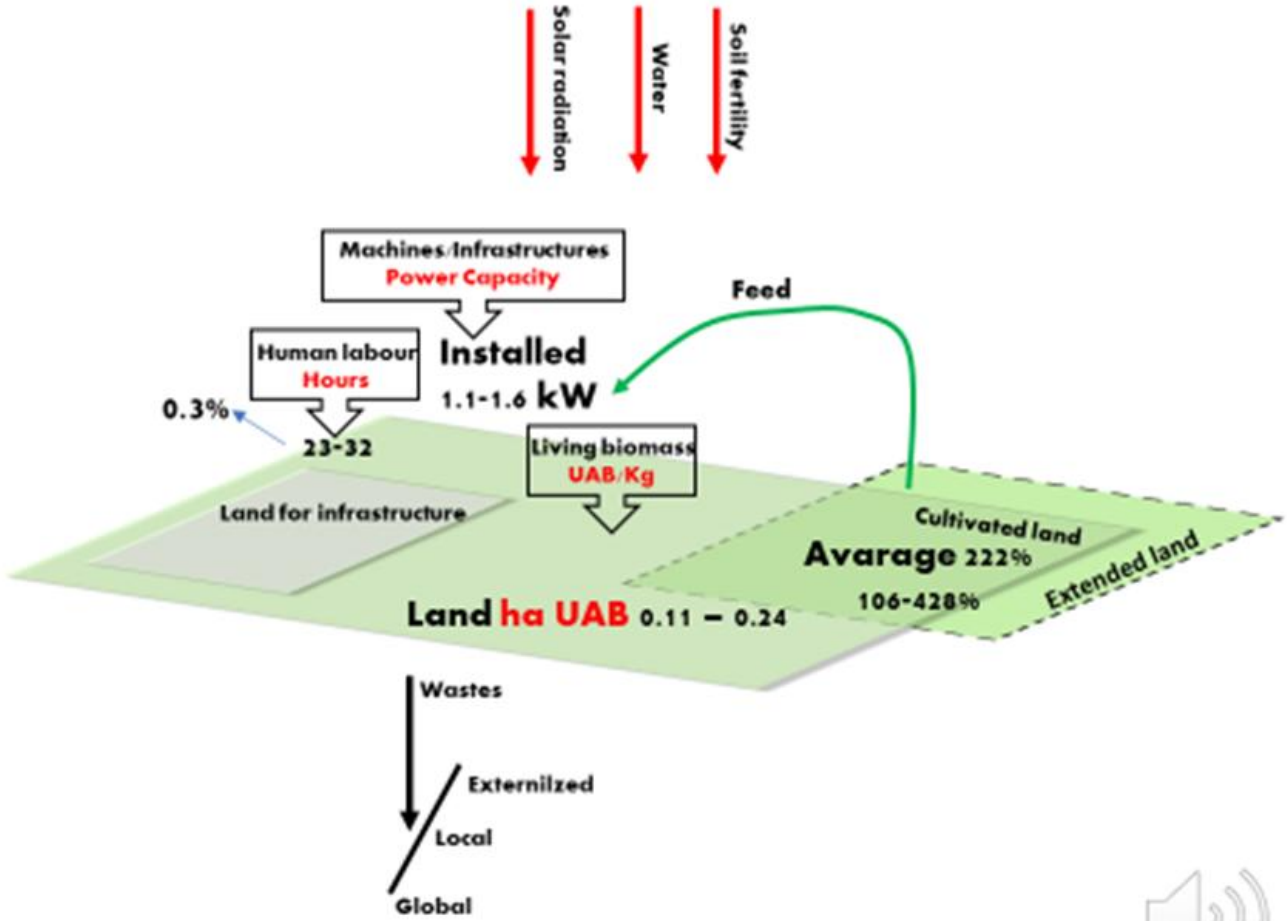
Analytical formalization

Time window_ 1 year

Processor





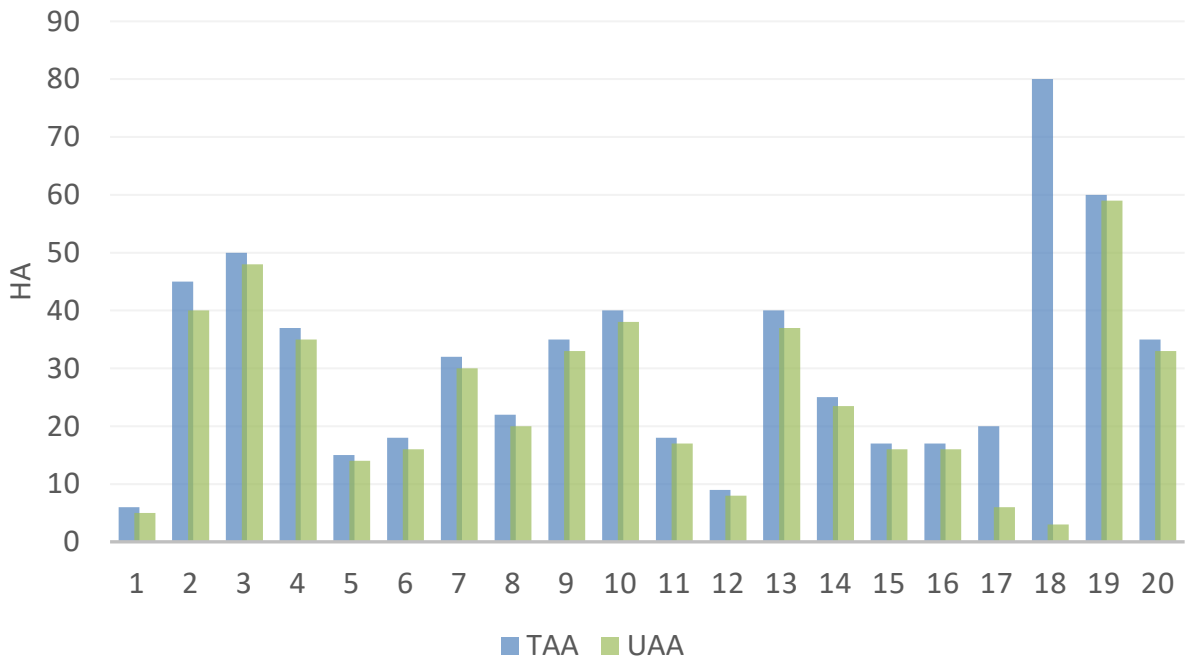


Efficiency – Flow/Fund

Extensive variables – products flows to consumption

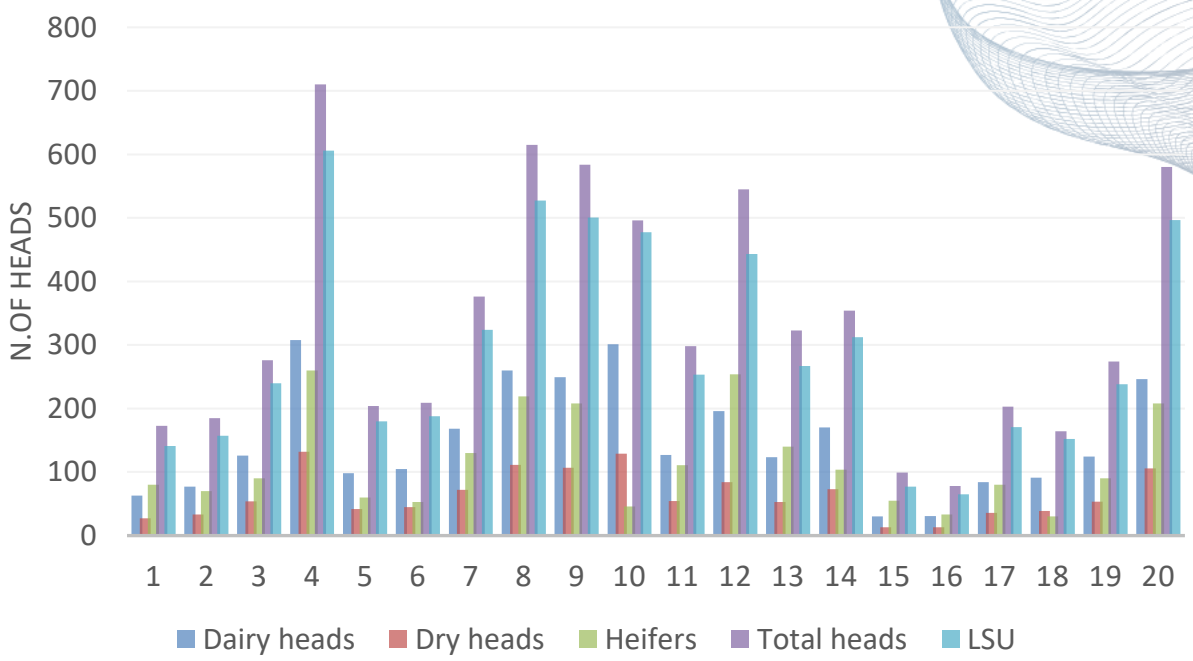
Results scenario

Land Matrix



LAND MATRIX	Mean	SD
Total Agricultural Area (ha)	31,05	18,30
Usable Agricultural Area UAA (ha)	24,88	15,33
Usable Agricultural Area UAA % for rent	32,30%	22,72%

Herd Found



Herd Found	Mean	SD
Total number of head	337,3	188,053
Livestock Units (LSU)	290,88	162,637
Incidence of Dairy animal on herd %	46,05%	7,24%
Incidence of Dry Animal on Herd %	18,75%	2,90%
Incidence of Heifers on herd %	35,20%	10,13%
Livestock density index (LSU/UAA)	17,10	14,47

Components of feed
Corn silage
Spring grass silage
Hay
Straw
Concentrates
mineral-vitamin supplement

Table 1. Average daily feed intake of DM, UFL, CP and NFC by each animal category.

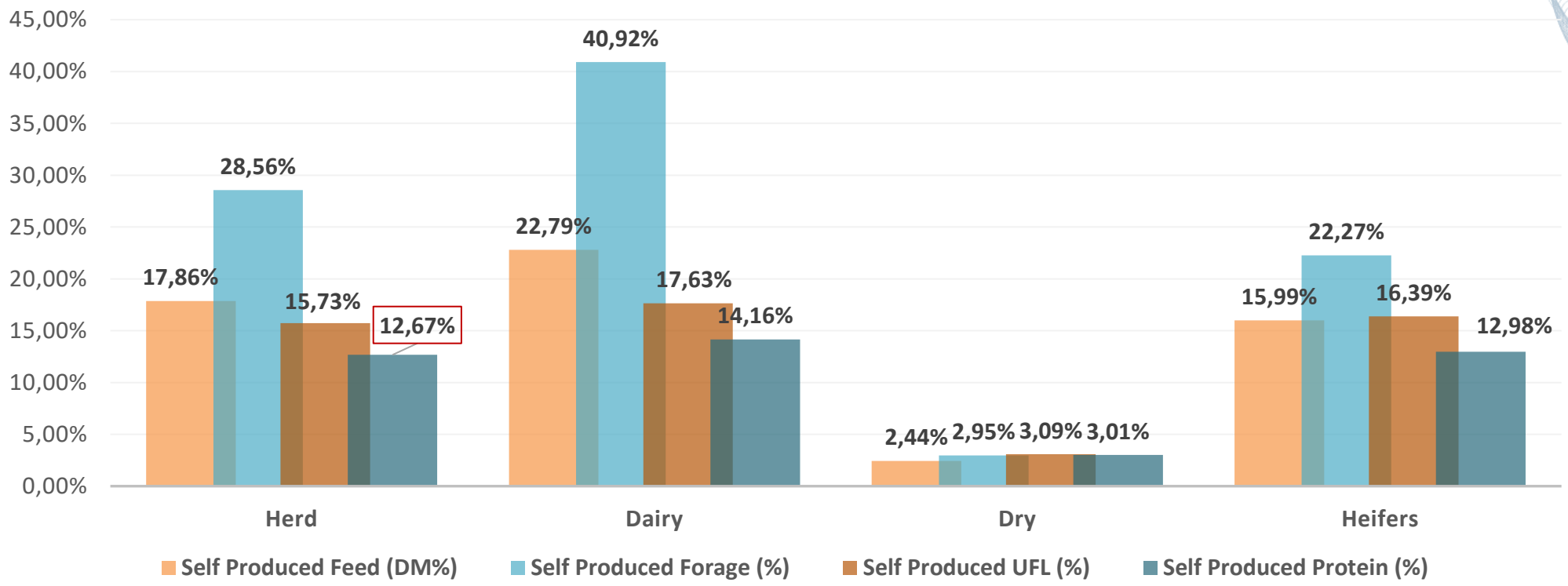
CATEGORY	DFI, kg DM	UFL/kg DM	CP, % DM	NFC, % DM
Dairy	16,9±1,0	0,9±0,03	14,6±0,5	22,2±3,8
Dry	10,0±0,7	0,5±0,02	8,0±0,5	6,2±1,2
Young	8,1±1,6	0,7±0,1	11,7±1,4	11,2±2,8

Table 2. Average daily feed intake of DM, UFL, CP and NFC by each animal category present on the dairy buffalo farms, categorized as self-produced and purchased feeds.

	Self produced forages			Purchased forages			Self produced grains			Purchased concentrates			Self produced feeds			Purchased feeds		
	Dairy	*Dry*	*Young*	*Dairy*	*Dry*	*Young*	*Dairy*	*Dry*	*Young*	*Dairy*	*Dry*	*Young*	*Dairy*	*Dry*	*Young*	*Dairy*	*Dry*	*Young*
DM, kg	3,8±2,4	0,2±0,8	1,2±1,0	5,5±2,4	7,5±0,8	4,6±1,8	-	-	-	7,5±0,7	2,3±0,5	2,4±0,6	3,8±2,4	0,2±0,8	1,2±1,0	13,0±2,4	9,8±1,0	6,9±2,2
UFL	2,8 ±1,8	0,2 ±0,5	0,9±0,7	3,6±1,5	3,0±0,3	2,2±0,7	-	-	-	9,3±0,90	2,3±0,5	2,6±0,7	2,8±1,8	0,2±0,5	0,9±0,7	12,9±1,8	5,3±0,6	4,8±1,3
CP, kg	0,3 ± 0,2	0,02±0,1	0,1±0,1	0,4 ±0,2	0,3±0,3	0,3±0,1	-	-	-	1,6±0,2	0,5±0,1	0,6±0,1	0,3±0,24	0,02±0,1	0,1±0,1	2,1±0,3	0,8±0,1	0,8±0,2
NFC, kg	0,5 ± 0,5	0,01±0,04	0,1±0,1	0,4 ±0,5	-	0,1 ±0,1	-	-	-	2,8±0,3	0,6±0,1	0,7±0,2	0,5±0,5	0,01±0,04	0,1±0,1	3,1±0,5	0,6± 0,1	0,8±0,2

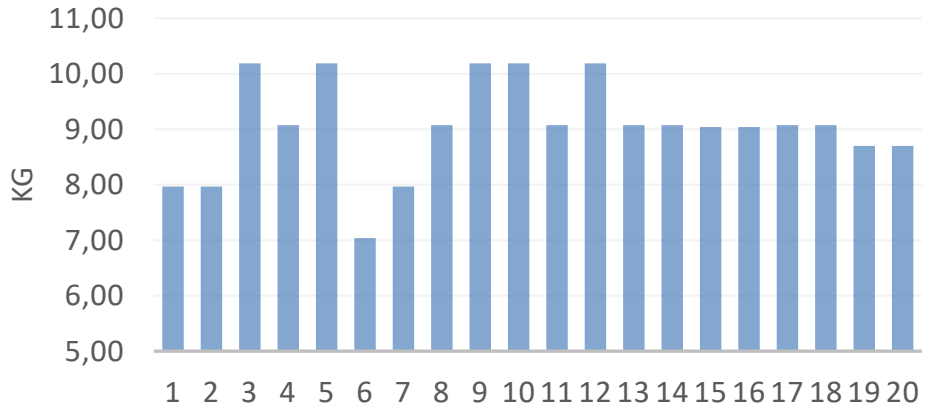
The average daily feed intake (DFI) per head was quantified and classified into two categories: self-produced (S) and purchased (B). The data were expressed in terms of dry matter (DM, Kg), feed units for lactation (UFL), crude protein (CP), and non-fiber carbohydrates (NFC). The dietary sources utilized were further stratified into four specific classes: self-produced forage (SF), self-produced concentrate (SC), purchased forage (BF), and purchased concentrate (BC

Feed automony on herds need (%)

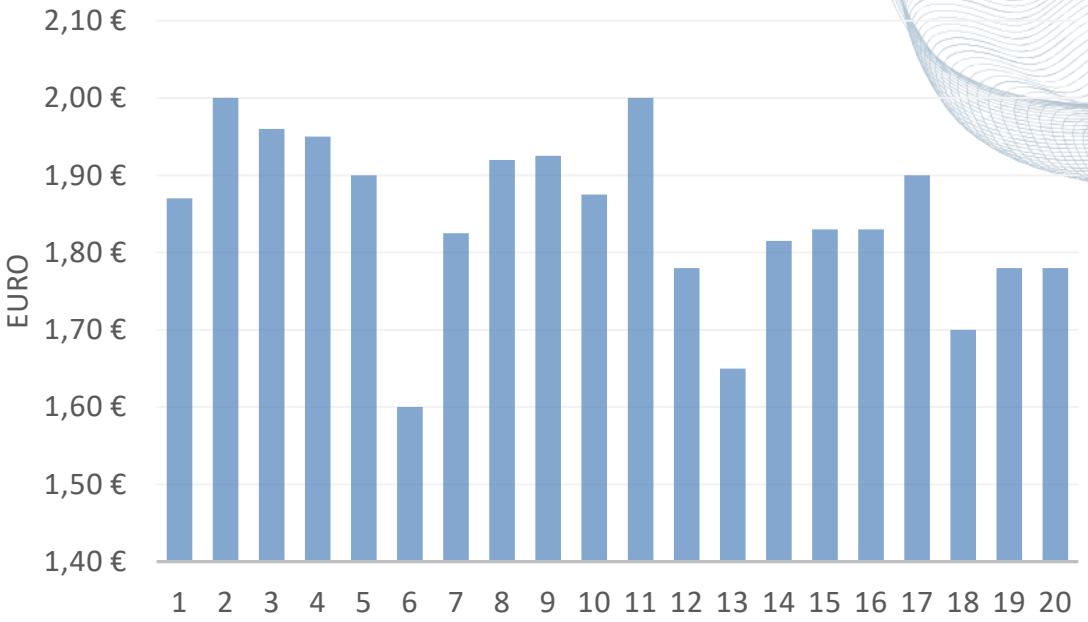


Outsourcing herd's Feed	Mean	SD
DM %	82,14%	12,14%
Forage	71,44%	19,03%
Concentrate	100,00%	0,00%
UFL	84,27%	10,72%
Protein	87,33%	9,02%

Average daily milk yield per lactating cow

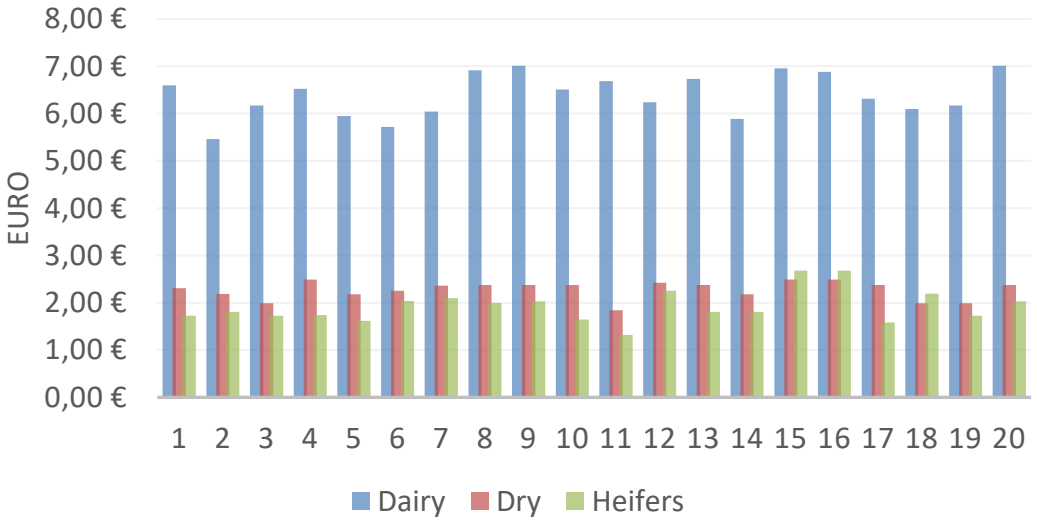


Milk Price (euro/kg)*



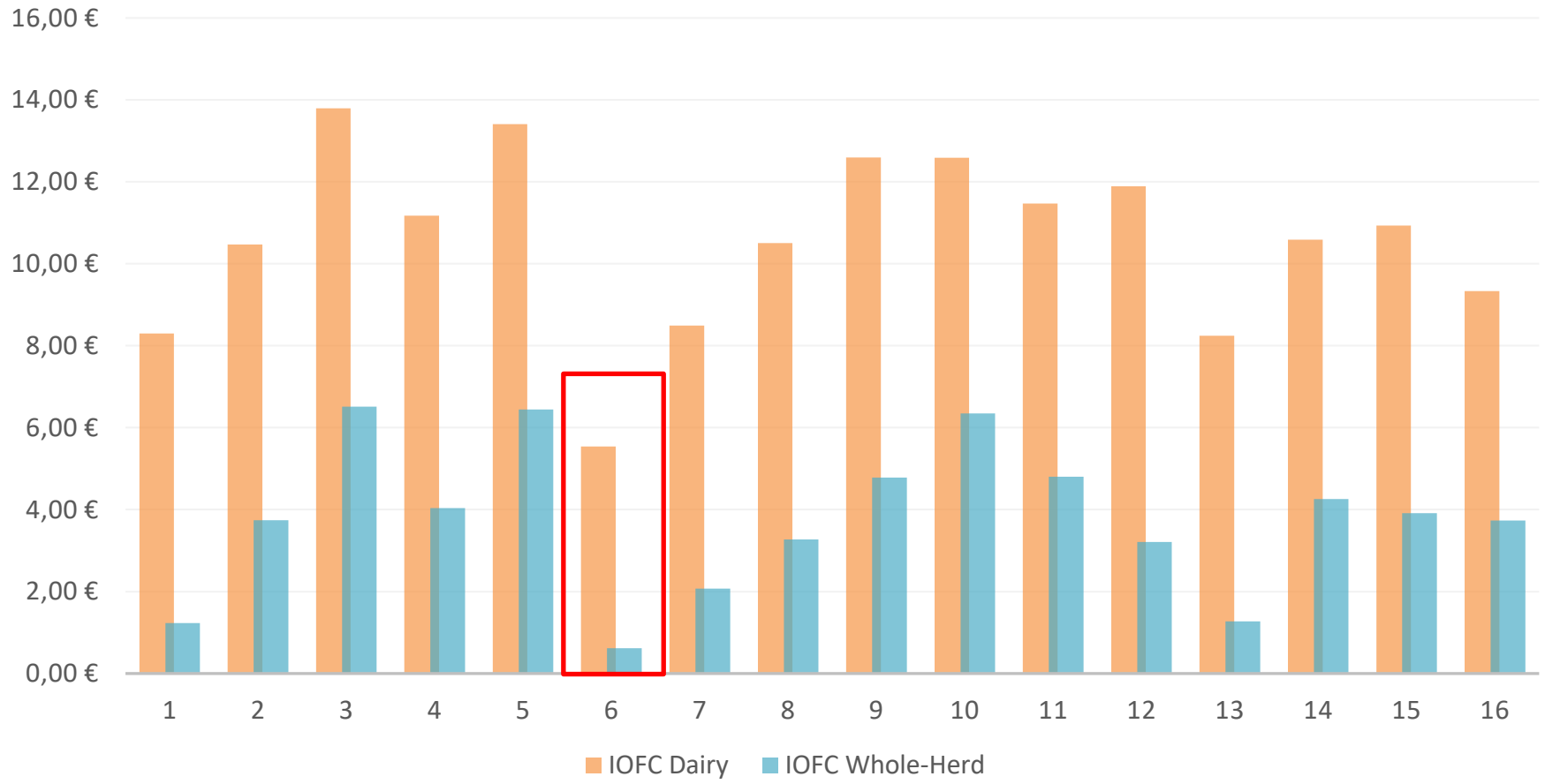
*The average price of milk was calculated taking into account the degree of seasonal variation in the herd and the winter and summer prices of milk

Daily Fedd cost



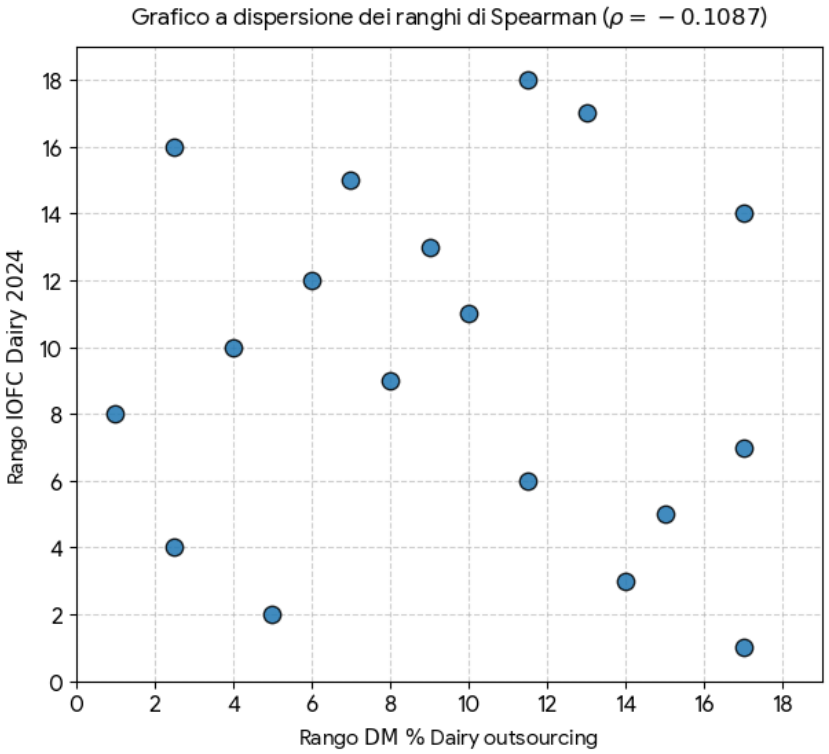
Farm variables outpt	Mean	SD
Daily milk yield/cow (kg)	9,04	0,87
Daily feed cost Dairy (euro/Head/daily)	6,39	0,46
Daily feed cost Dry (euro/Head/daily)	2,27	0,19
Daily feed cost Heifers (euro/Head/daily)	1,93	0,34
Milk Price (euro/kg)	1,84	0,11

Income over Feed Cost

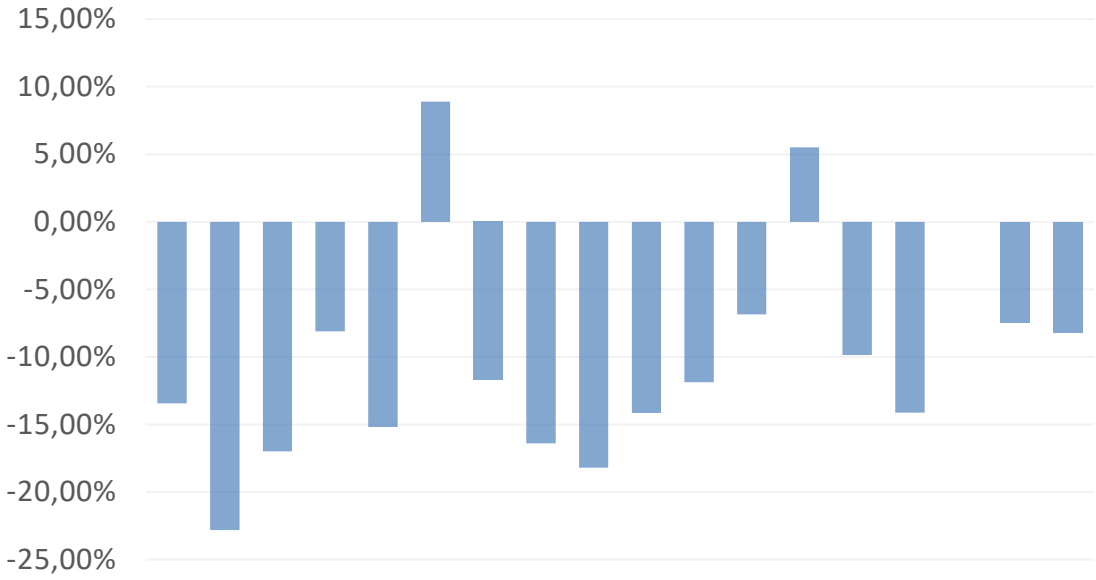


$$\textbf{IOFC Dairy} = \frac{income\ from\ milk\ (€/d) - feed\ cost\ of\ lactating\ cows\ (€/d)}{(lactating\ cows,\ n)} = \mathbf{10,58\ €} \pm 2{,}18$$

$$\textbf{IOFC Whole Herd} = \frac{income\ from\ milk\ (€/d) - feed\ cost\ of\ herd\ (€/d)}{(lactating\ cows,\ n)} = \mathbf{3,77\ €} \pm 1{,}82$$



IOFC Dairy 2024 vs 2025

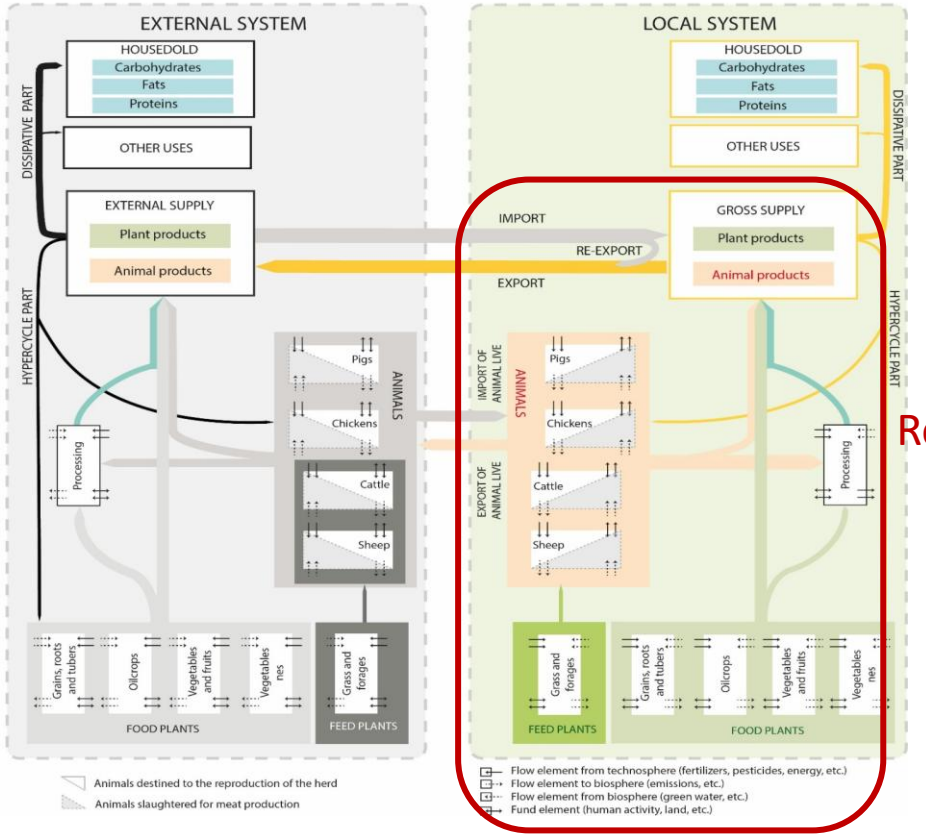


	Mean	SD
Iofc dairy 2024 vs 2025	**-10,33%**	8,,60%

The MAGIC tool-kit

Virtual
supply systems

Externalized socio-economic and environmental pressures

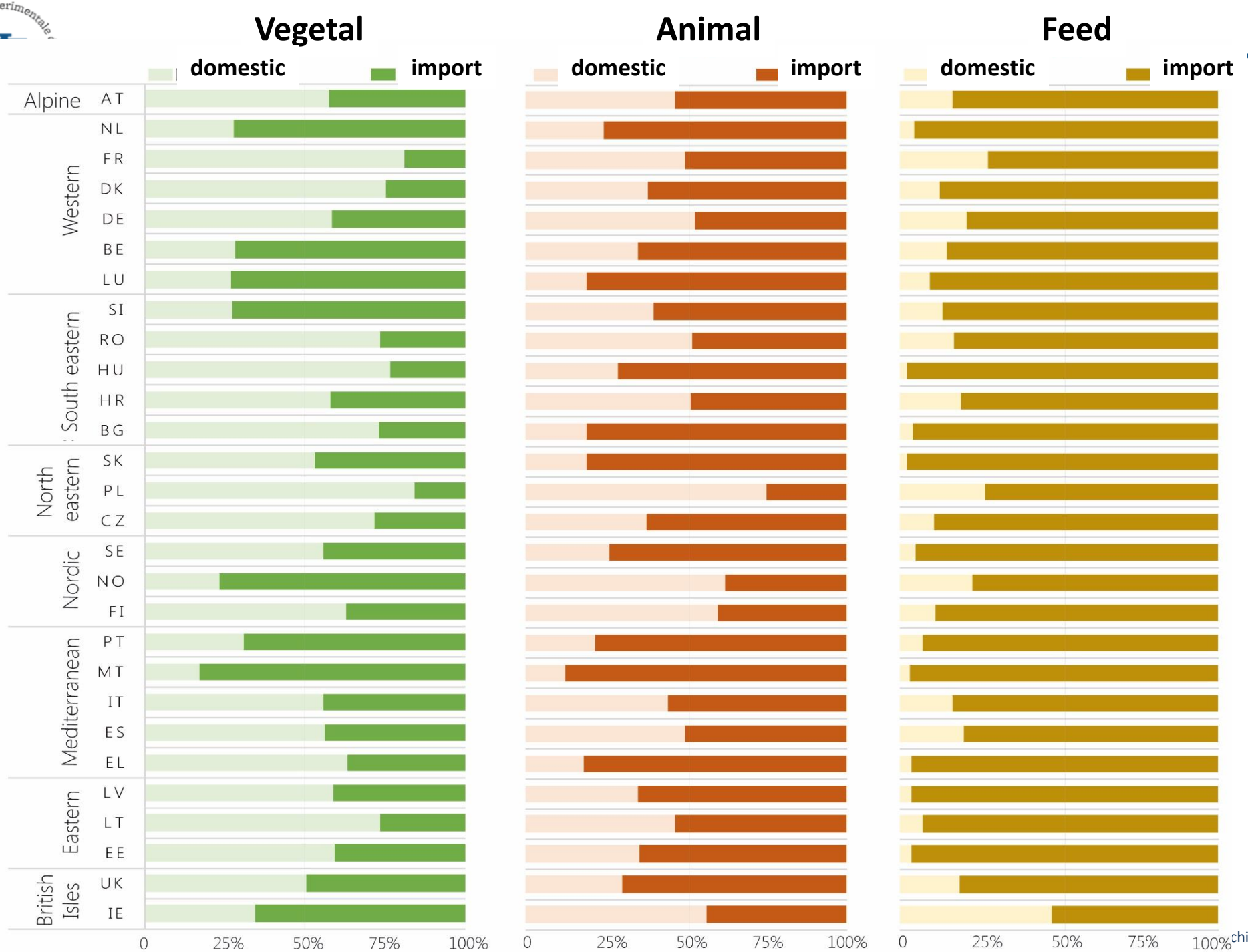


Required supply in the diet

Actual
supply systems

Local socio-economic and environmental pressures

What's wrong?	Improvement strategies:	Future perspectives:
Low feed autonomy	Optimizing forage crops	Investing in more resilient and self-sufficient farming models
High Impact on sustainability	Precision feeding tecnhnologies	
Structural limitation	Crop rotation and efficient land use	



Externalization of production in EU agriculture by country

Cadillo-Benalcazar et al 2020 https://doi.org/10.1016/j.jenvman.2020.110944

Back to the Elefant in the room



today agriculture is heavily (and dangerously) depending on externalization, and the buffalo sector is no exception.

- How to manage the current land externalization due to the imported feeds?
- Is there enough internal human labour?
- What about the product cost?
- Is the system able to work without public subsides?
- To what extent will the subsidies be able to offset the system's shortcomings?

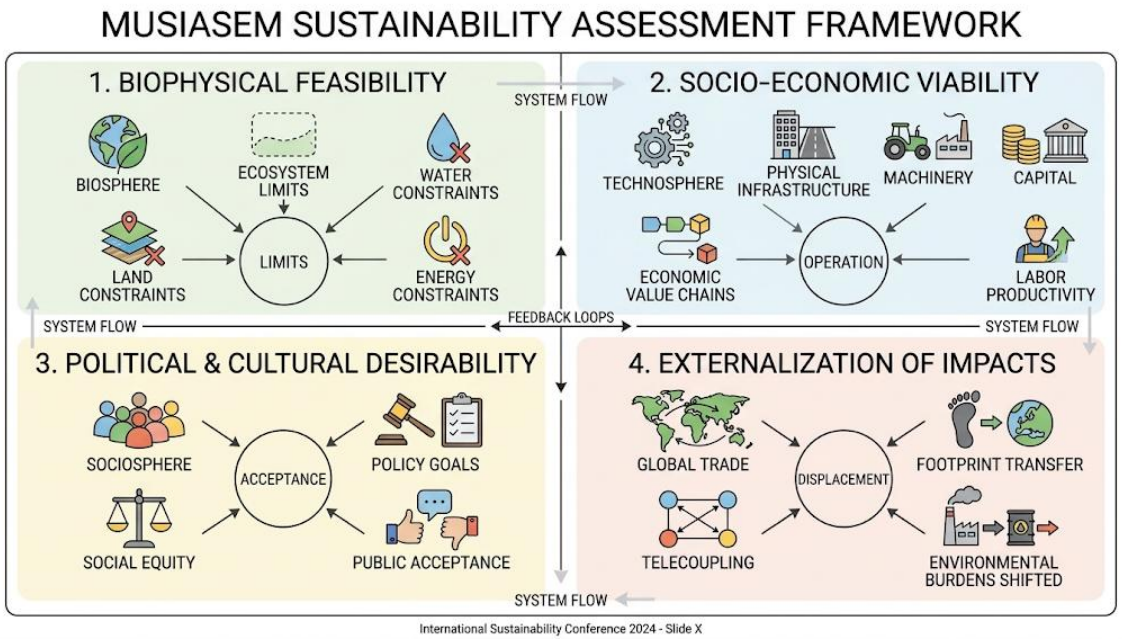
But things are starting to happen…

EUROPEAN COMMISSION

Brussels, 7.7.2026
COM(2026) 355 final

Action Plan

for resilience, strategic autonomy and sustainability of the EU protein system



The transition towards a resilient and sustainable protein system requires improved policy coordination aiming at:

- increasing open strategic autonomy by expanding sustainable EU protein supply through incentives for farmers to adopt diversified production systems with reduced fertiliser needs, enabling farmers to cultivate healthy and resilient protein crops;

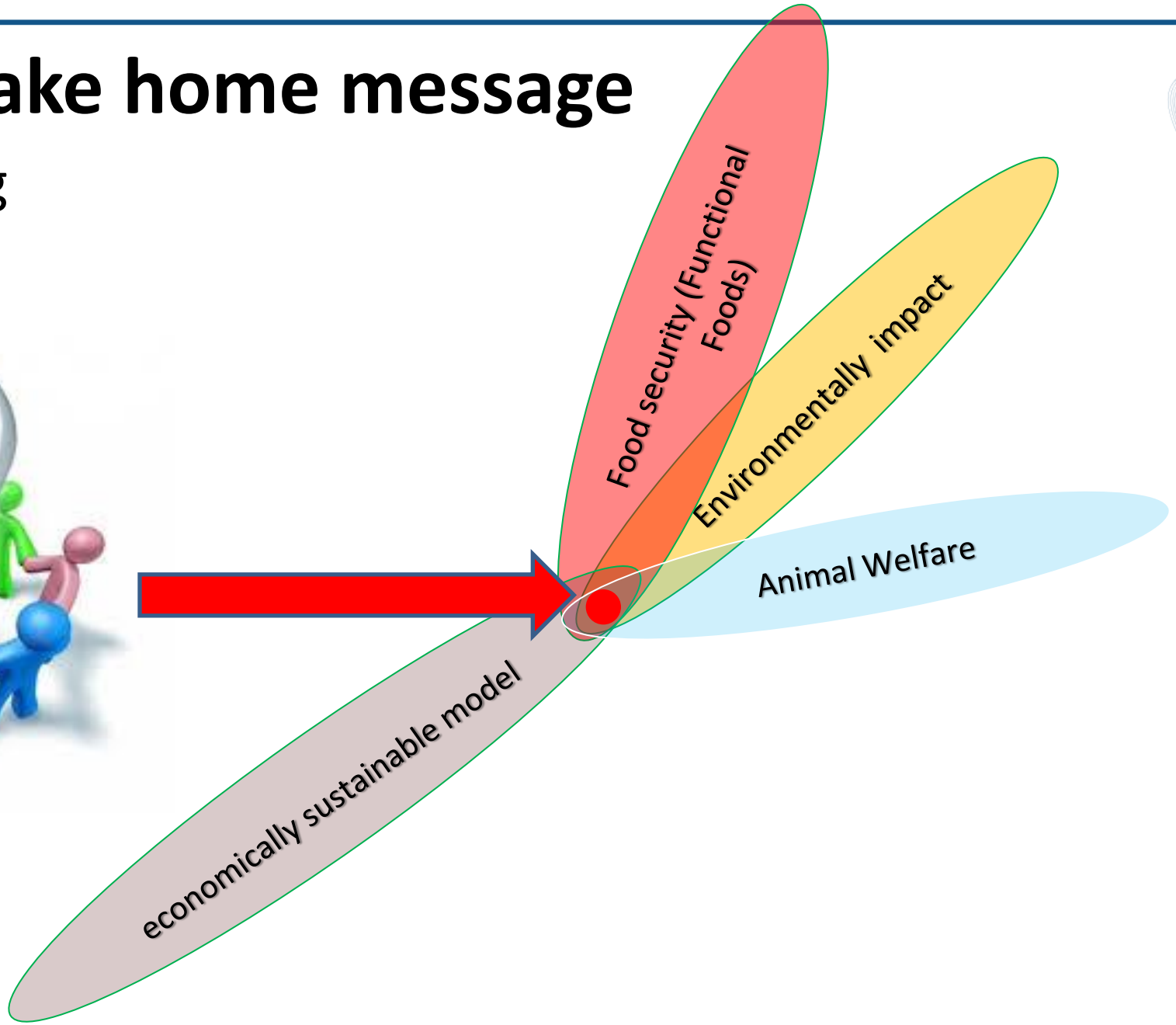
- improving the resilience, competitiveness and preparedness of the wider EU protein system, including the feed industry, by advancing research and innovation and scaling up investments;

- strengthening EU protein value chains by improving market attractiveness and incentivising demand and promoting local solutions and short supply chains.

Take home message

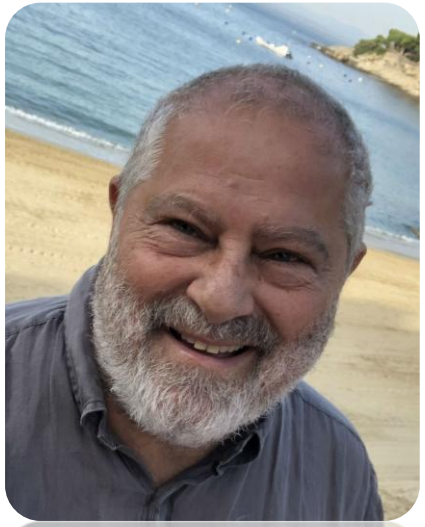
BrainStorming













" Caminante no hay camino, se hace camino al andar"

[Antonio Machado]

...TO BE CONTINUED...

- *Luigi Bertocchi*
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- *Salvatore Catania*
- *Antonio Maisano*
- *Davide Pintus*
- *Antonio Barberio*
- *Federico Scali*
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- *MINSA*

Thanks for your attention



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