

Life cycle assessment of two common dairy cattle farming systems in an Alpine area

Thomas Zanon

Greta Fichter, Stefan Hörtenhuber, Giovanni Peratoner, Werner Zollitsch, Markus Gatterer, Matthias Gauly

Table of Content

- Comparison of Dairy Farming Systems (CODA) in Dietenheim
- Life cycle assessment for system comparison
- Results & discussion
- Conclusion

Research Trial in Dietenheim ?

High-input system (high milk yield, predominantly concentrate feed, maize silage ration, year-round housing) based on the Fleckvieh breed → maximum production

Vs.

Low-input system (milk yield mainly from forage, seasonal grazing) based on Tyrolean Grey cattle → forage-based production

Objective

Collection and evaluation of all system-relevant data (including animal health, performance, milk quality, working hours, material flows, N-efficiencies, feed production and quality, vegetation dynamics, market opportunities for specialised products, economy)

Data collection in the barn

Continuous recording:

- Basic and concentrated feed intake, kg DMI
- Water intake, liters
- Milk yield, kg
- Milking time, sec.
- milk flow rate, kg/min.
- Elect. Conductivity, mS/mm
- Working times

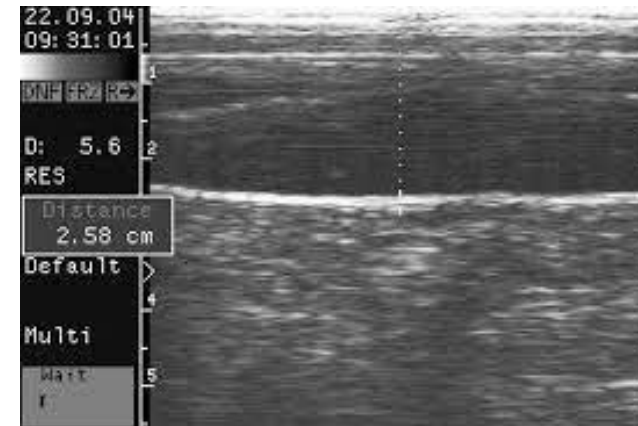


Monthly recording:

Body Weight, kg

BCS (1-5)

Back fat thickness via ultrasound measurement (mm)



Feed ration

Feed components DM/d	Production System					
	high-input		low-input			
	Yearround		Winter Feeding*		Grazing Season**	
	Daily ration (kg DM d ⁻¹)	Proportion (%)	Daily ration (kg DM d ⁻¹)	Proportion (%)	Tagesration (kg DM d ⁻¹)	Proportion (%)
Hay	2.8	12.9	12.5	76.5	4.9	74.7
Grass silage	5.4	25.3	0.0	0.0	0.0	0.0
Maize silage	5.6	25.8	0.0	0.0	0.0	0.0
Concentrates	7.5	34.9	3.5	21.3	1.6	23.9
Mineral feed	0.2	0.9	0.3	2.1	0.1	1.4
Estimated pasture intake	0.0	0.0	0.0	0.0	11.3	63.1
Feed intake barn***	21.5	100.0	16.4	100.0	6.6	36.9
Total feed intake	21.5	100.0	16.4	100.0	17.9	100.0

Life cycle assessment for system comparison

Aim

Assessment of the environmental impact per kg of fat- and protein-corrected milk (ECM) for the low- and high-input system

- Global warming potential (GWP100)Acidification potential (AP)Marine Eutrophication Potential (MEP)Land use (LU)

Determination of the environmental impact per m² of agricultural land for the low- and high-input system.

Data collection 2019-2022

Daily

- Effective amount of feed ingested per animal
- Milk yield per animal

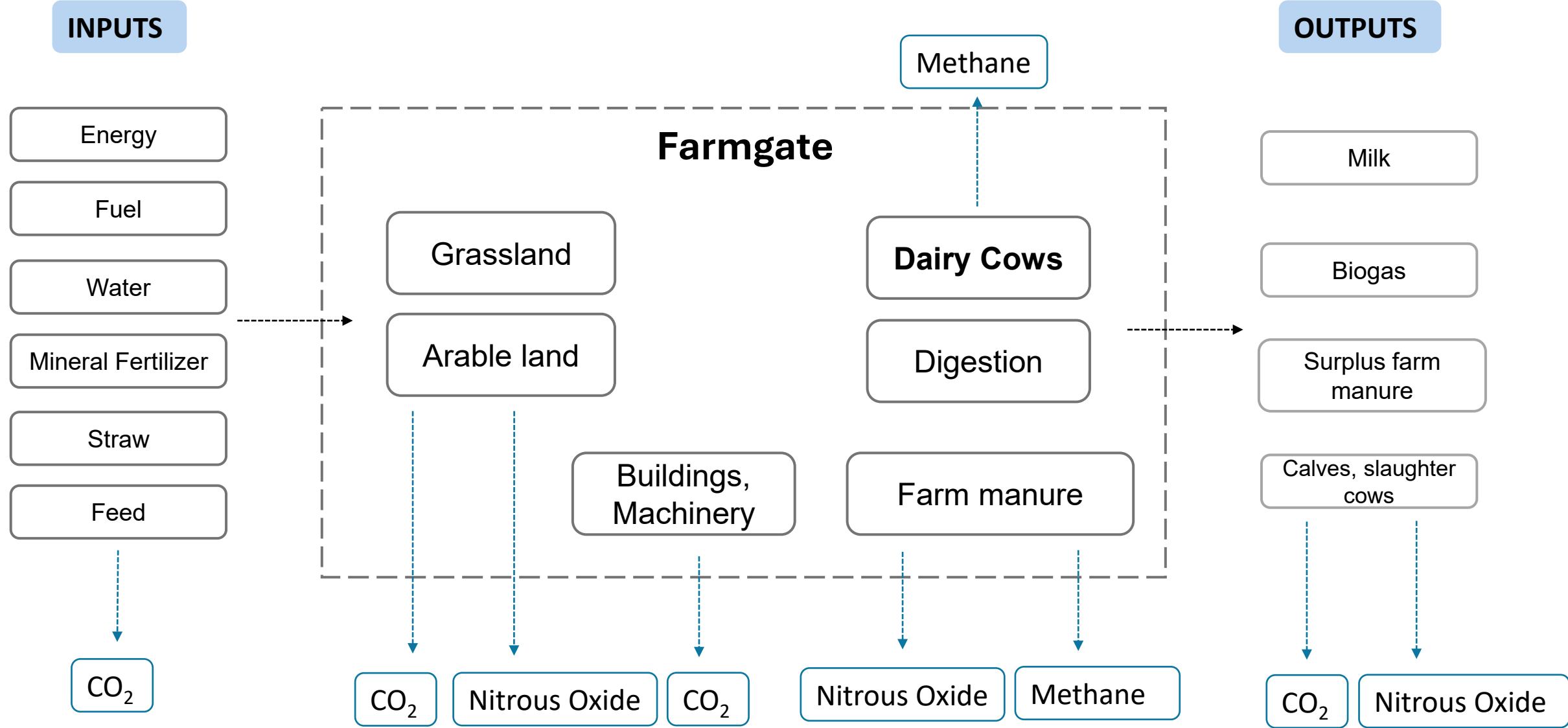
Monthly

- Body weight
- Back Fat Thickness

Annually

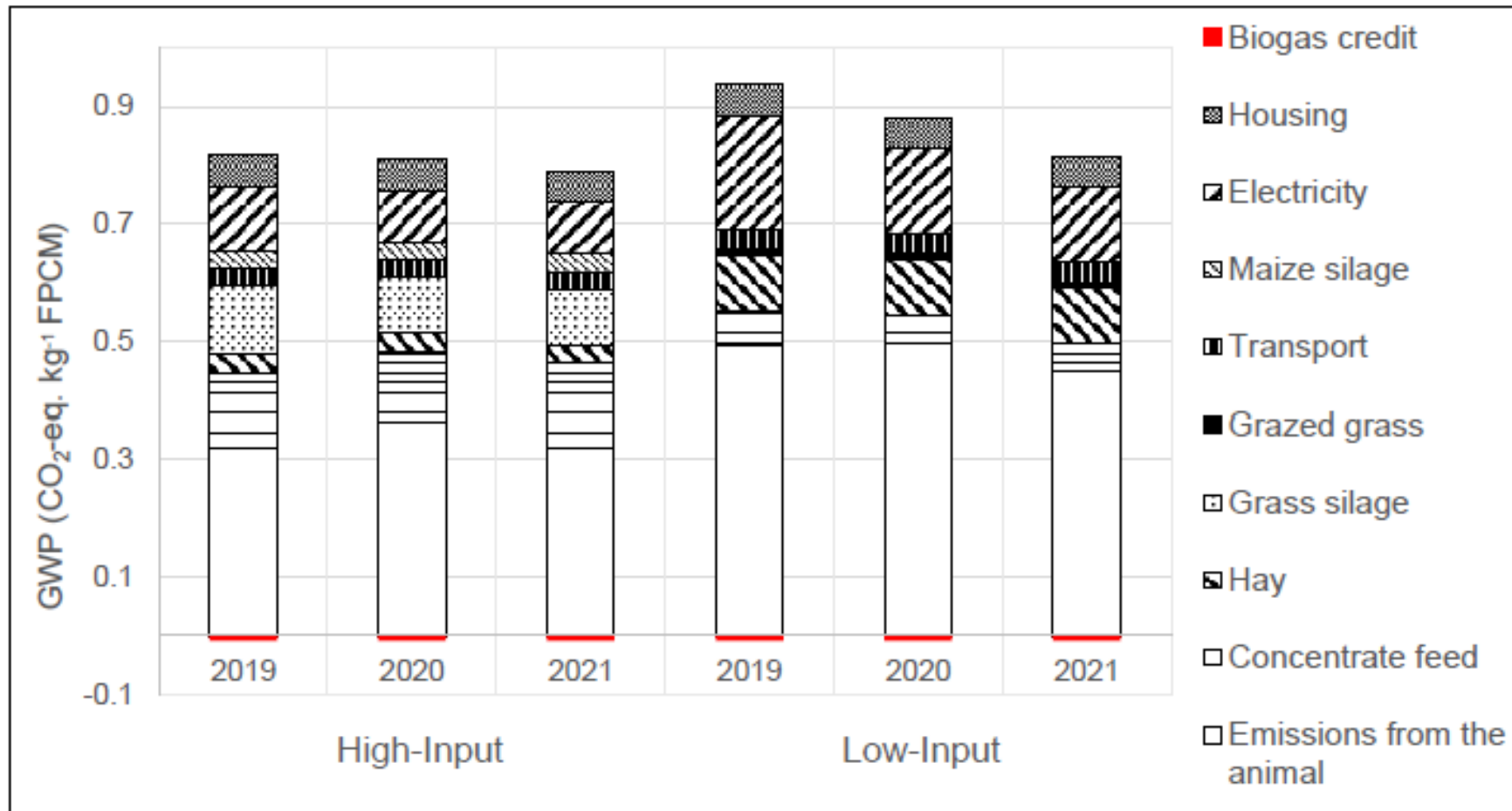
- Purchases: Straw, feed
- Sales: Calves & slaughter cows
- Fertilisation
- Energy consumption (machinery & buildings)

Material & Methods

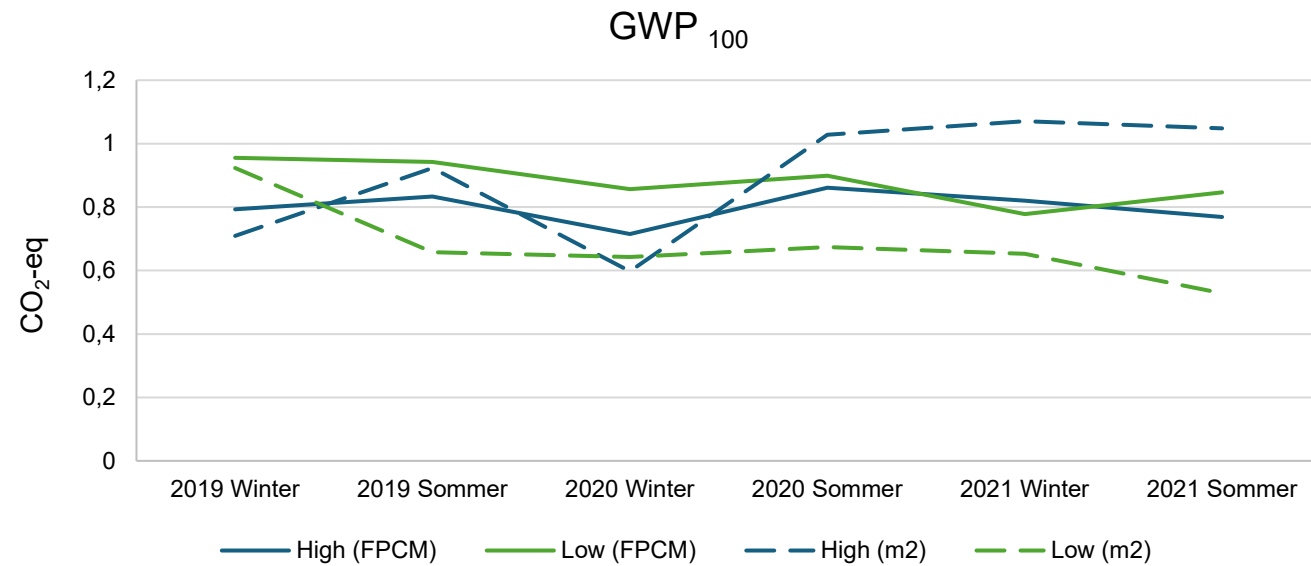


Results

Individual contribution factors influencing total GWP_{100} kg FPCM⁻¹, during the years 2019, 2020, 2021 for the high-input system (left) and the low-input system (right).

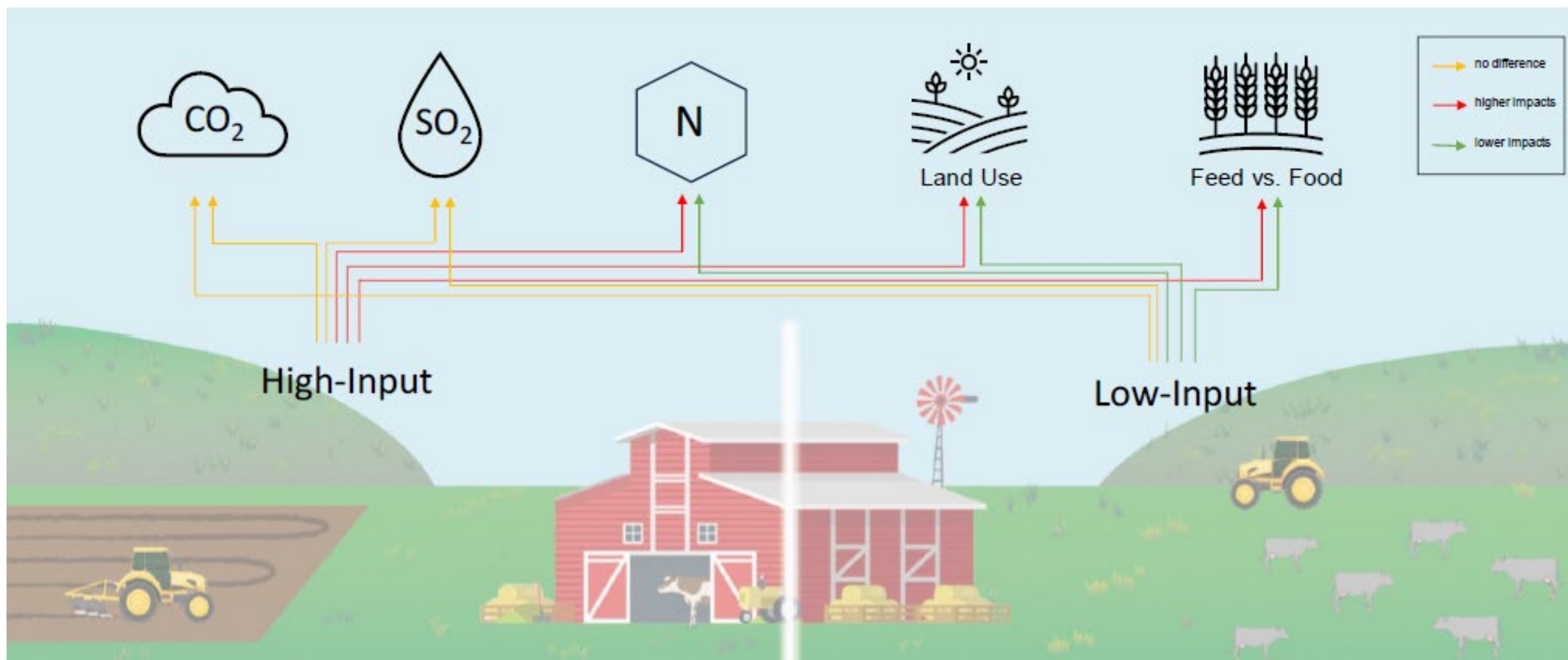


Results



Lower CO₂ emissions for high-input at output level (per kg of milk)

Lower CO₂ emissions for low-input per m² farm area



Feed-Food Competition

	High-Input						Low-Input					
	2019		2020		2021		2019		2020		2021	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
Protein content g/kg milk	37	37	37	36	37	36	35	36	35	36	35	36
ECM (kg)	58,782	84,902	46,683	80,570	56,997	85,207	33,953	46,126	34,588	53,486	45,084	51,098
heP in feed ration (kg)	2,207	3,229	1,720	3,001	2,441	3,315	680	398	595	445	671	305
heP in feed ration (g) / kg ECM	37.5	38	36.8	37.2	42.8	38.9	20	8.6	17.2	8.3	14.9	6
Netto protein (g)/kg milk	-0.5	-1	0.2	-1.2	-5.8	-2.9	15	27.4	17.8	27.7	20.1	30

Netto protein = Protein content in milk (xP kg ECM-1) - human consumable protein in feed (heP * kg FPCM-1).*

Conclusions

- The low-input strategy has advantages in terms of an ecological sustainable production (especially resource consumption)
- The low-input strategy minimizes competition for resources between feed and food production. In the future, a more localized approach to production will be increasingly important to enhance resilience and reduce dependence on the global market.
- For a complete assessment of both systems, economic and social sustainability must also be considered

Thank you for the attention

The project CODA is funded by the action plan for mountain agriculture of the Autonomous Province of South Tyrol

Thanks to our partners from BOKU and Laimburg Research Centre

Probability values of year and system (high-input/low-input) in the general linear models to analyse annual values of the impact categories, as well as their estimated marginal means $\pm$ standard error of mean depending on the system.

Impact category	p-value		System		Standard error of mean
	Year	System	High-Input	Low-Input	
GWP ₁₀₀ (kg CO ₂ -eq kg ⁻¹ FPCM)	0.289	0.123	0.808	0.883	0.0206
AP (kg SO ₂ -eq kg ⁻¹ FPCM)	0.264	0.123	0.016	0.014	0.0004
MEP (kg N-eq kg ⁻¹ FPCM)	0.552	0.008	0.005	0.002	0.0001
LU (m ² yr kg ⁻¹ FPCM)	0.439	0.007	1.074	0.698	0.0224
LU (Pt kg ⁻¹ FPCM)	0.364	0.005	60.155	39.087	1.0444
GWP ₁₀₀ (kg CO ₂ -eq m ⁻²)	0.949	0.137	0.931	0.665	0.0782
AP (kg SO ₂ -eq m ⁻²)	0.859	0.066	0.018	0.011	0.0181
MEP (kg N-eq m ⁻²)	0.626	0.036	0.005	0.002	0.0004

Abbreviations: GWP₁₀₀ = Global Warming Potential, AP = Acidification Potential, MEP = Marine Eutrophication Potential, LU = Land Use, CO₂-eq = Carbon dioxide equivalents, SO₂-eq = Sulfur dioxide equivalents, N-eq = Nitrogen equivalents, FPCM = fat and protein corrected milk.