How French suckler cattle farms in mountainous areas can achieve a balance between economic, environmental, and animal welfare performance

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Which objectives are in conflict?

How can I reach a compromise?

Economics

ECO

Animal welfare

AW

Environment

ENV


Europeans want farm animal welfare

By Oscar Rousseau

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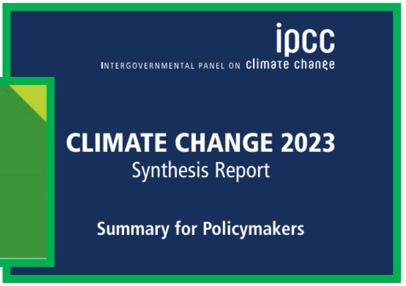
Eurogroup for Animals: time for the EU to "deliver the results so many wish to see"

END THE CAGE AGE



GREEN DEAL

CAP

NATURA 2000

NO_3

DIRECTIVE NITRATES

Methods

COMPROMISE PROGRAMMING

Test hypothesis:
€ versus RATIO

ECO € :
Max $\mathit{Animal\ sales} - \mathit{Feed\ costs}$

ECO RATIO :
$$\text{Max}\ \frac{\mathit{Feed\ margin}}{\mathit{Animal\ sales}}$$

BIOECONOMIC MODEL

Variables impacting ANIMAL FEED

→ Ration

→ Herd size and composition

AW :
Max $\mathit{Pourcentage\ of\ grazing\ time\ per\ year}$

ENV CLIM KGC :
$$\text{Min}\ \frac{\mathit{Climate\ impact}}{\mathit{kgc}}$$

ENV CLIM HA :
$$\text{Min}\ \frac{\mathit{Climate\ impact}}{\mathit{ha}}$$

ENV EUTR KGC :
$$\text{Min}\ \frac{\mathit{Eutrophication}}{\mathit{kgc}}$$

ENV EUTR HA :
$$\text{Min}\ \frac{\mathit{Eutrophication}}{\mathit{ha}}$$

Test hypothesis:
ha versus kgc

COMPROMISE PROGRAMMING

1 **Optimising each objective separately**

Ideal and anti-ideal values for each objective

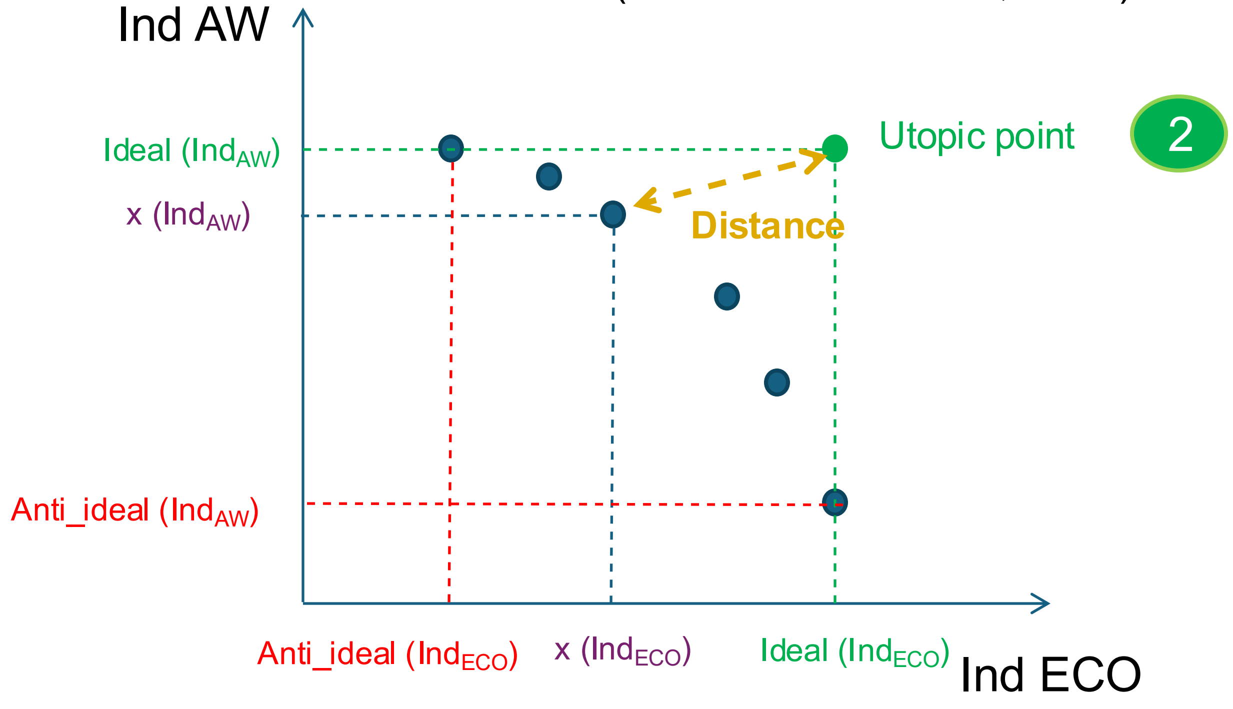
2 **Determining utopic point (ideal value for all indicators) and value normalisation**

Utopic point

3 **Minimising distance between utopic point and achievable points**

Compromise solutions

(Romero et Rehman, 2003)



Importance of indicator j

$$L_p = \left[\sum_{j}^{T} W(Ind_j) \times \left| \frac{(Ideal(Ind_j) - x(Ind_j))}{(Ideal(Ind_j) - Anti\_ideal(Ind_j))} \right|^p \right]^{1/p}$$

p=1 : longest metric

p= inf : shortest metric

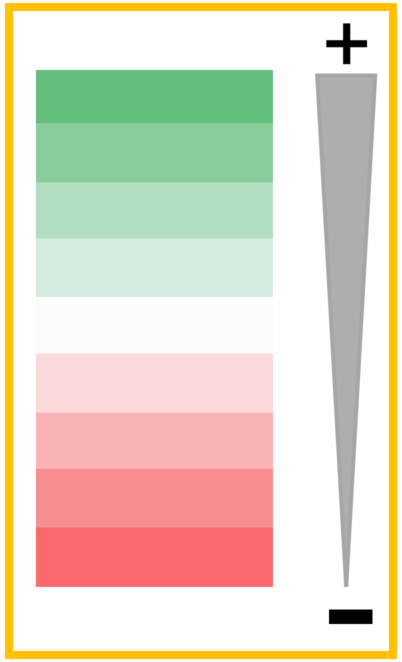
p

The higher the value of p, the greater consideration is given to the highest deviations; i.e. the solution becomes more balanced.

Confliting objectives

MOUNTAIN

		OPTIMISATION MODELS						
		ECO		ENV				BEA
		€	RATIO	CLIM		EUTR		
				KGC	HA	KGC	HA	
INDICATORS	UNITS	1	2	3	4	5	6	7
1. Feed margin	1 000 €	36	33	32	23	32	29	22
2. Feed margin	%	36	52	34	45	34	47	29
3. Climate impact	kg CO_2 eq/kgc	21	22	19	25	19	23	26
4. Climate impact	100 kg CO_2 eq/ha	43	34	42	31	41	33	43
5. Eutrophication	kg P eq/10^4 kgc	17	12	11	14	10	10	20
6. Eutrophication	kg P eq/100 ha	34	18	23	17	22	15	34
7. Grazing time	% of year	47	50	46	56	46	54	56



HA : hectare, KGC : kg carcass, CLIM : climate impact, EUTR : eutrophication

Confliting objectives

						OPTIMISATION MODELS						
					ECO		ENV				BEA
					€	RATIO	CLIM		EUTR		
							KGC	HA	KGC	HA	
			INDICATORS	UNITS	1	2	3	4	5	6	7
ECO	€		1. Feed margin	1 000 €	36	33	32	23	32	29	22
ECO	RATIO		2. Feed margin	%	36	52	34	45	34	47	29
ENV	CLIM	KGC	3. Climate impact	kg CO2 eq/kgc	21	22	19	25	19	23	26
ENV	CLIM	HA	4. Climate impact	100 kg CO2 eq/ha	43	34	42	31	41	33	43
ENV	EUTR	KGC	5. Eutrophication	kg P eq/10^4 kgc	17	12	11	14	10	10	20
ENV	EUTR	HA	6. Eutrophication	kg P eq/100 ha	34	18	23	17	22	15	34
AW			7. Grazing time	% of year	47	50	46	56	46	54	56

HA : hectare, KGC : kg carcass, CLIM : climate impact, EUTR : eutrophication

Confliting objectives

		INDICATORS	UNITS	OPTIMISATION MODELS						
				ECO		ENV				BEA
				€	RATIO	CLIM		EUTR		
						KGC	HA	KGC	HA	
				1	2	3	4	5	6	7
ECO	€	1. Feed margin	1 000 €	36	33	32	23	32	29	22
ECO	RATIO	2. Feed margin	%	36	52	34	45	34	47	29
ENV	CLIM KGC	3. Climate impact	kg CO2 eq/kgc	21	22	19	25	19	23	26
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ENV	EUTR KGC	5. Eutrophication	kg P eq/10^4 kgc	17	12	11	14	10	10	20
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AW		7. Grazing time	% of year	47	50	46	56	46	54	56

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HA : hectare, KGC : kg carcass, CLIM : climate impact, EUTR : eutrophication

Confliting objectives: RATIO vs € indicators

OPTIMISATION MODELS

				ECO		ENV				BEA
				€	RATIO	CLIM		EUTR		
						KGC	HA	KGC	HA	
		INDICATORS	**UNITS**	1	2	3	4	5	6	7
ECO	€	**1. Feed margin**	1 000 €	36	33	32	23	32	29	22
	RATIO	**2. Feed margin**	%	36	52	34	45	34	47	29
ENV	CLIM KGC	**3. Climate impact**	kg CO2 eq/kgc	21	22	19	25	19	23	26
	CLIM HA	**4. Climate impact**	100 kg CO2 eq/ha	43	34	42	31	41	33	43
	EUTR KGC	**5. Eutrophication**	kg P eq/10^4 kgc	17	12	11	14	10	10	20
	EUTR HA	**6. Eutrophication**	kg P eq/100 ha	34	18	23	17	22	15	34
AW		**7. Grazing time**	% of year	47	50	46	56	46	54	56

The feed margin in € in the model optimising for feed margin ratio is rather high

But there is a shortfall in € compared to the optimisation based on the margin in €

HA : hectare, KGC : kg carcass, CLIM : climate impact, EUTR : eutrophication

Confliting objectives: functional units

OPTIMISATION MODELS

				ECO		ENV				BEA
				€	RATIO	CLIM		EUTR		
						KGC	HA	KGC	HA	
		INDICATORS	UNITS	1	2	3	4	5	6	7
ECO	€	1. Feed margin	1 000 €	36	33	32	23	32	29	22
	RATIO	2. Feed margin	%	36	52	34	45	34	47	29
ENV	CLIM KGC	3. Climate impact	kg CO2 eq/kgc	21	22	19	25	19	23	26
	CLIM HA	4. Climate impact	100 kg CO2 eq/ha	43	34	42	31	41	33	43
	EUTR KGC	5. Eutrophication	kg P eq/10^4 kgc	17	12	11	14	10	10	20
	EUTR HA	6. Eutrophication	kg P eq/100 ha	34	18	23	17	22	15	34
AW		7. Grazing time	% of year	47	50	46	56	46	54	56

For the climate impact indicators:

Optimising CLIM or EUTR per KGC lead to similar results

HA : hectare, KGC : kg carcass, CLIM : climate impact, EUTR : eutrophication

Confliting objectives: functional units

OPTIMISATION MODELS

					1	2	3	4	5	6	7
					ECO		ENV				BEA
					€	RATIO	CLIM		EUTR		
							KGC	HA	KGC	HA	
			INDICATORS	UNITS	1	2	3	4	5	6	7
ECO	€		1. Feed margin	1 000 €	36	33	32	23	32	29	22
	RATIO		2. Feed margin	%	36	52	34	45	34	47	29
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		HA	6. Eutrophication	kg P eq/100 ha	34	18	23	17	22	15	34
AW			7. Grazing time	% of year	47	50	46	56	46	54	56

For the climate impact indicators:

Optimising CLIM or EUTR per KGC lead to similar results

Whereas

Optimising CLIM per KGC or per HA lead to divergent results

HA : hectare, KGC : kg carcass, CLIM : climate impact, EUTR : eutrophication

Conflicting objectives

❑ Hypothesis: RATIO versus €

- ✓ Optimising an economic ratio (e.g. feed margin ratioed to sales) leads to a shortfall in €, but improves environmental and animal welfare performances
- ✓ Optimising an economic ratio encourages a shift towards extensification in terms of feeding (more grass in the ration) and stocking density (fewer animals sold and/or fattened for the same UAA)

❑ Hypothesis: ha versus kgc

- ✓ Optimising with different functional units (e.g. ha versus kgc) for an environmental indicator may lead to more conflicts than optimising with different environmental indicators (e.g. climate impact versus eutrophication)
- ✓ Optimising per ha encourages a shift towards extensification in terms of feeding (more grass in the ration) and stocking density (fewer animals sold and/or fattened for the same UAA)

Compromise solutions

OPTIMISATION MODELS

			ECO		ENV				BEA	COMP	COMPINF
			€	RATIO	CLIM		EUTR			p=1	p=inf
					KGC	HA	KGC	HA			
	INDICATORS	UNITS	1	2	3	4	5	6	7		
ECO €	1. Feed margin	1 000 €	36	33	32	23	32	29	22	29	31
ECO RATIO	2. Feed margin	%	36	52	34	45	34	47	29	47	45
ENV CLIM KGC	3. Climate impact	kg CO_2 eq/kgc	21	22	19	25	19	23	26	23	21
ENV CLIM HA	4. Climate impact	100 kg CO_2 eq/ha	43	34	42	31	41	33	43	33	35
ENV EUTR KGC	5. Eutrophication	kg P eq/10^4 kgc	17	12	11	14	10	10	20	12	13
ENV EUTR HA	6. Eutrophication	kg P eq/100 ha	34	18	23	17	22	15	34	17	21
AW	7. Grazing time	% of year	47	50	46	56	46	54	56	55	53

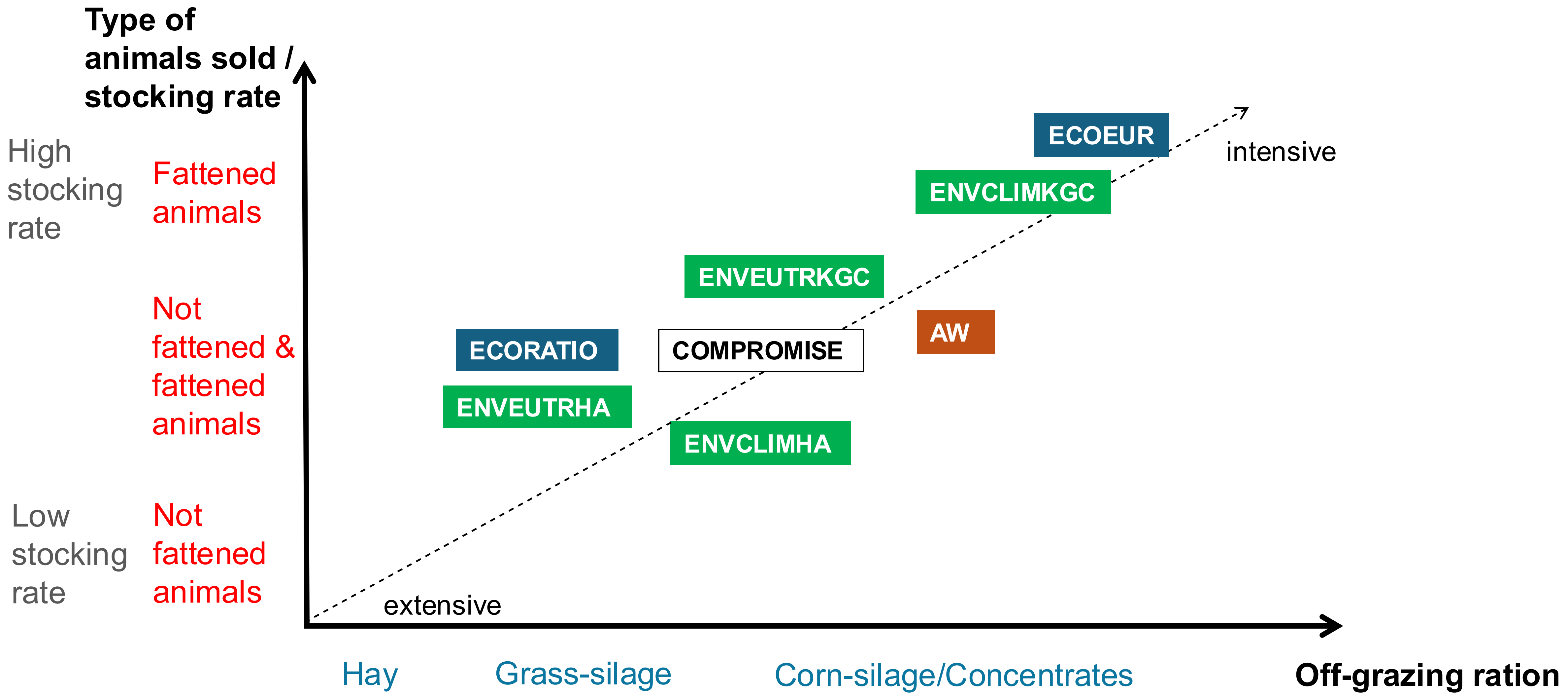
HA : hectare, KGC : kg carcass, CLIM : climate impact, EUTR : eutrophication

Compromise solutions

- **The two metrics do not yield the same result, but they have the following in common:**
  - ✓ For sales: a mix of not fattened and fattened animals
  - ✓ For the ration: more silage maize and concentrates than for the ECO RATIO and EUTR/HA optimisations, but less than for the ECO € optimisation

→ In both cases, it is the production of not fattened animals that improves AW and ENV

Approximate positioning of the different optimisation models



Conclusion

- **The choice of indicators and functional units has a crucial impact on the results**
  - ✓ The various models highlight the potential pitfalls in interpretation that arise from these choices
  - ➢ The choice depends on the objectives

- **Compromise solutions can significantly improve animal welfare and reduce environmental impacts**
  - ✓ But they lead to a loss of revenue of around 15%
  - ➢ The question is who bears this cost … which comes down to political will
  - ✓ The compromise is achieved by producing less fattened animal and by reducing the use of concentrates
  - ➢ We need to explore other options to improve animal welfare and environmental performance during the fattening phase: grass-fed fattening? beef from dairy cattle? …