Environmental Impacts of genetic improvement in Growth Rate and Feed Conversion Ratio in Fish Farming

Mathieu Besson

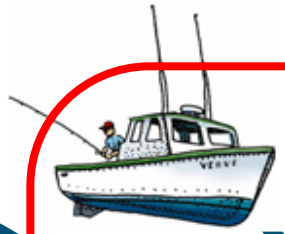
Joel Aubin, Hans Komen, Marc Vandeputte, Edwige Quillet, Johan van Arendonk and Imke de Boer

WAGENINGEN UR
For quality of life

EGS
ABG

INRA
SCIENCE & IMPACT

Introduction



Climate change

Energy use

Acidification

Fish production system

Europhication

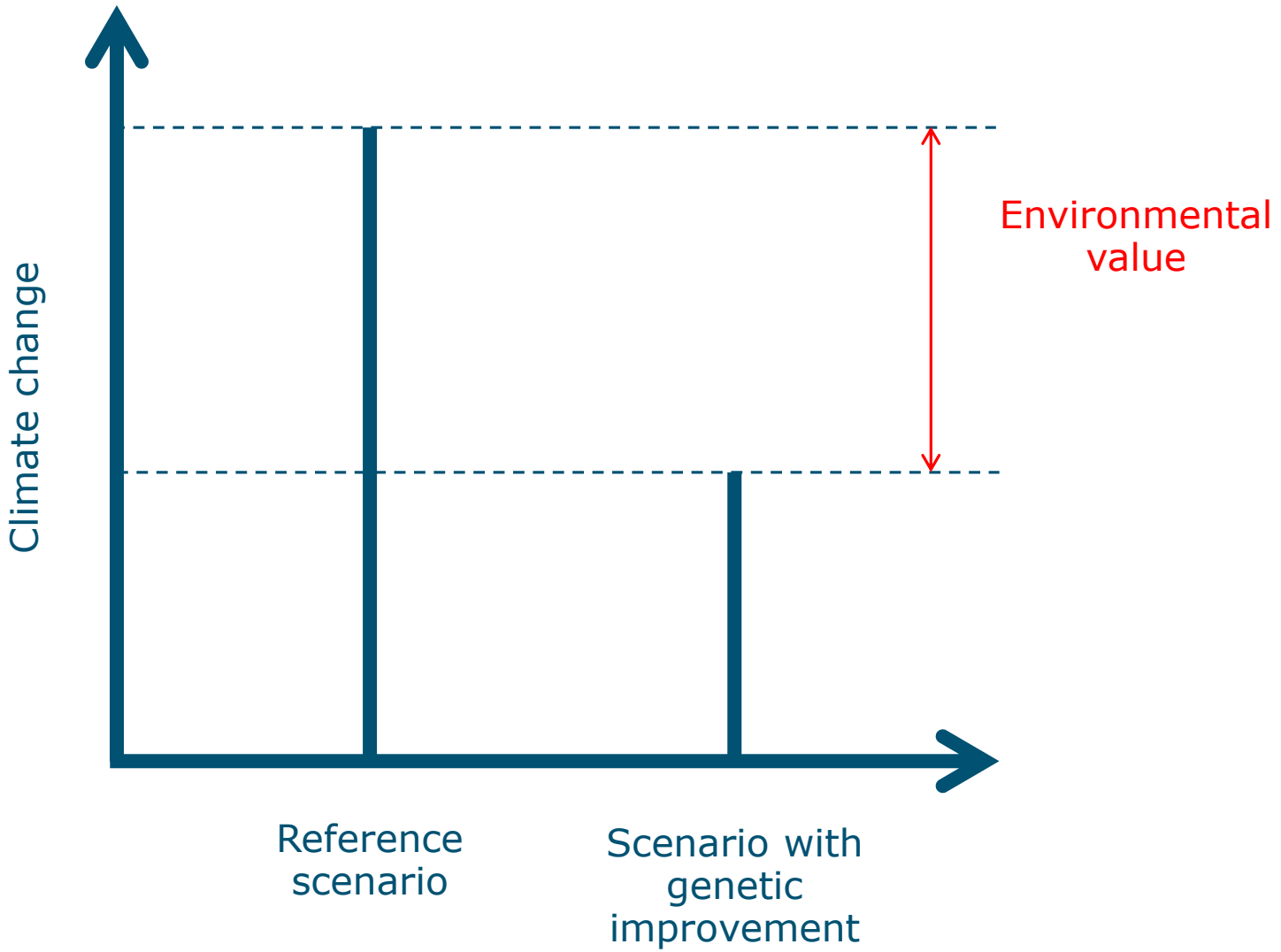
- Genetic improvement

=> cumulative change in animal performances

- What is the environmental response to genetic improvement?

In fish farming context

- Environmental values = ENV



Material and method

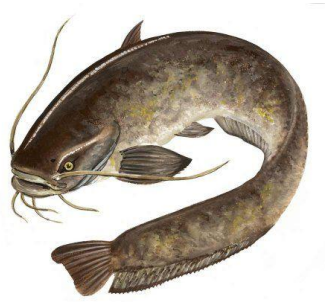
1 step

Bioeconomic model

+ Life Cycle Assessment analysis

Bioeconomic model

- African catfish in Recirculating Aquaculture System (RAS)



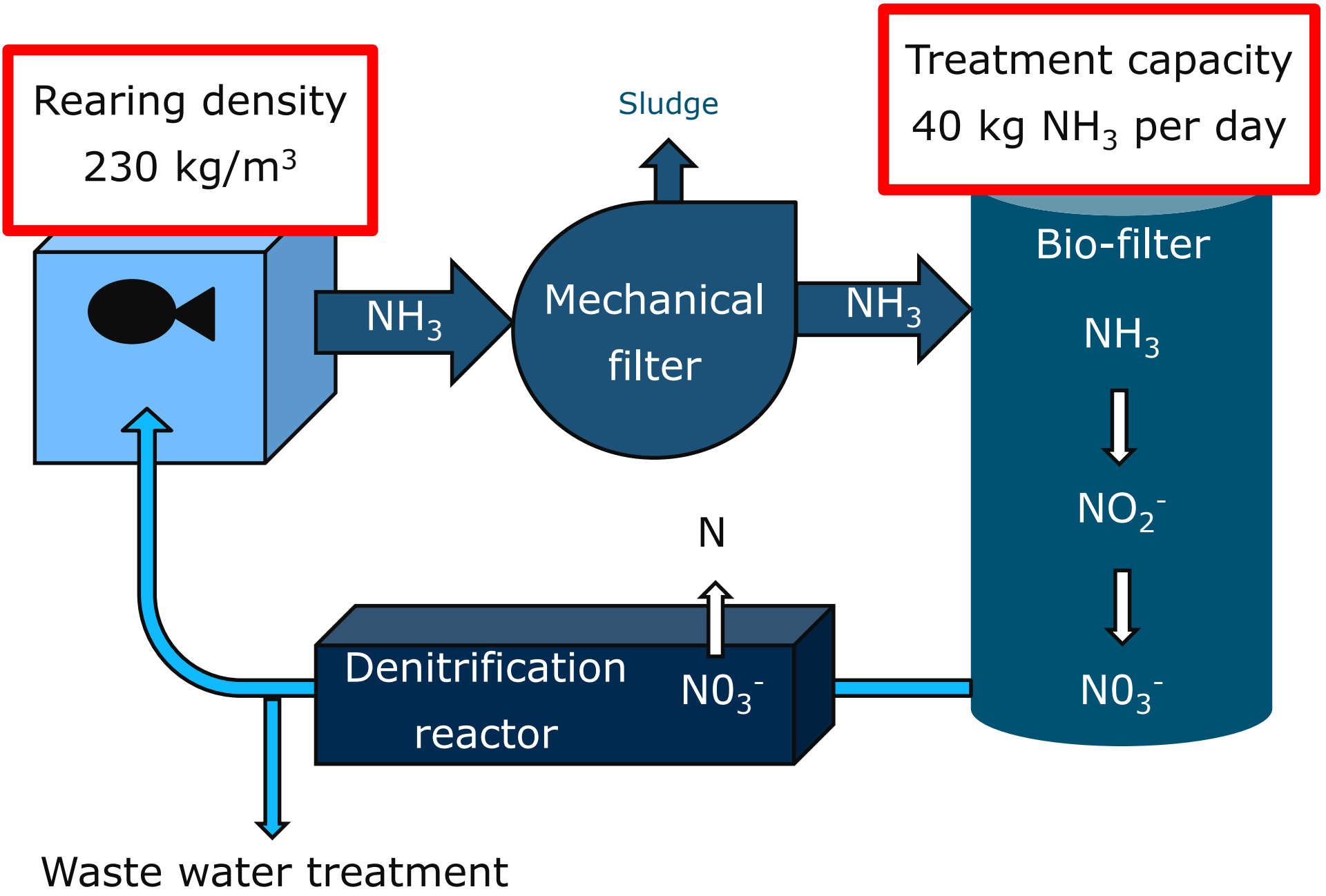
Estimates : Annual fish production

Annual feed consumption

According to genetic improvement in : Growth rate (TGC)

Feed conversion ratio

RAS

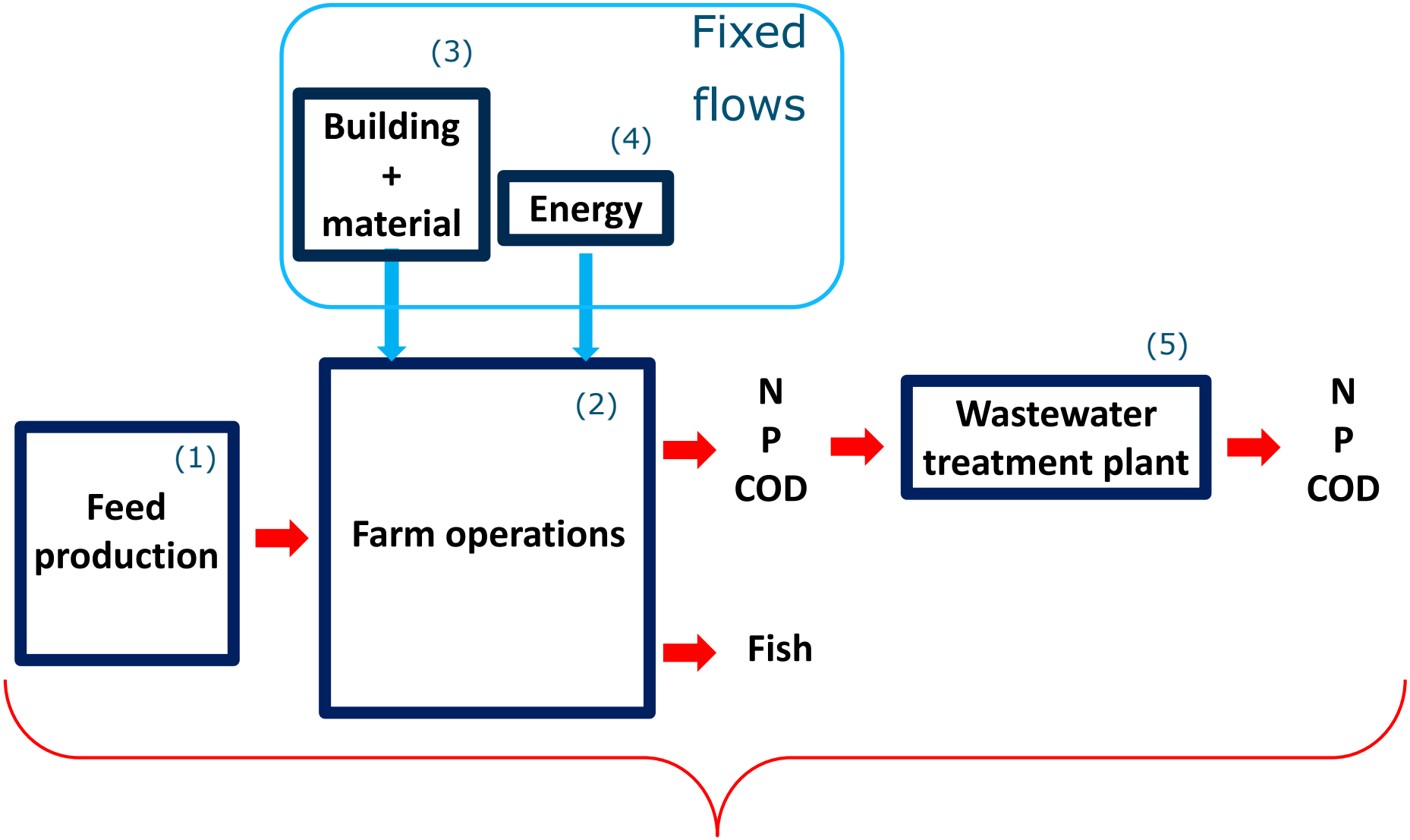

Rearing density
230 kg/m3
Sludge
Treatment capacity
40 kg NH3 per day
NH3
Mechanical filter
NH3
Bio-filter
NH3
NO2-
NO3-
N
Denitrification reactor
NO3-
Waste water treatment

Life Cycle Assessment

- Goal and scope

Cradle-to-farm-gate analysis

Functional unit = 1 t of catfish



Variable flows :

growth rate and feed conversion ratio

Life Cycle Impact Assessment

- Climate change (CML2 Baseline 2000)
- Eutrophication (CML2 Baseline 2000)
- Acidification (CML2 Baseline 2000)
- Cumulative energy demand (Frischknecht et al. 2004)

1st step

Bioeconomic model

+ Life Cycle Assessment analysis

2nd step

Environmental impacts in reference scenario:

- Growth rate = 8.33
- Feed conversion ratio = 0.81

3rd step

Environmental impacts after genetic improvement :

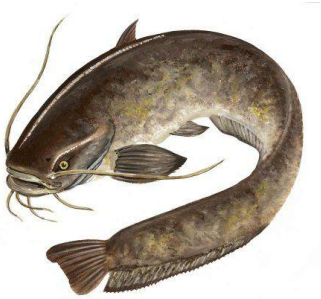
- 6.8% per generation for growth rate
- 7.6% per generation for feed conversion ratio

Environmental values

Results

- What influence environmental values?

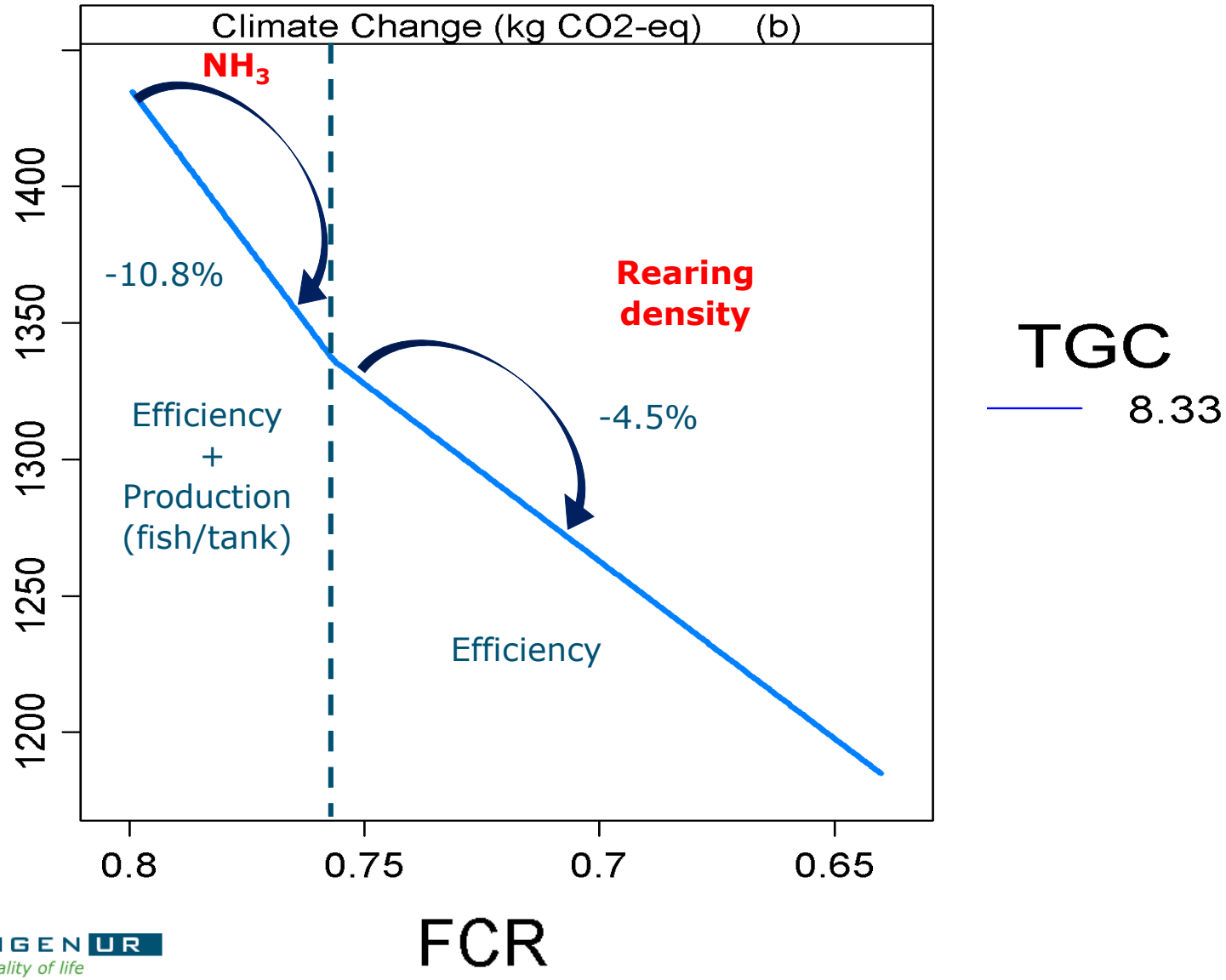
Increase annual <u>production</u> | Nb of batch | ×



Increase <u>production efficiency</u>

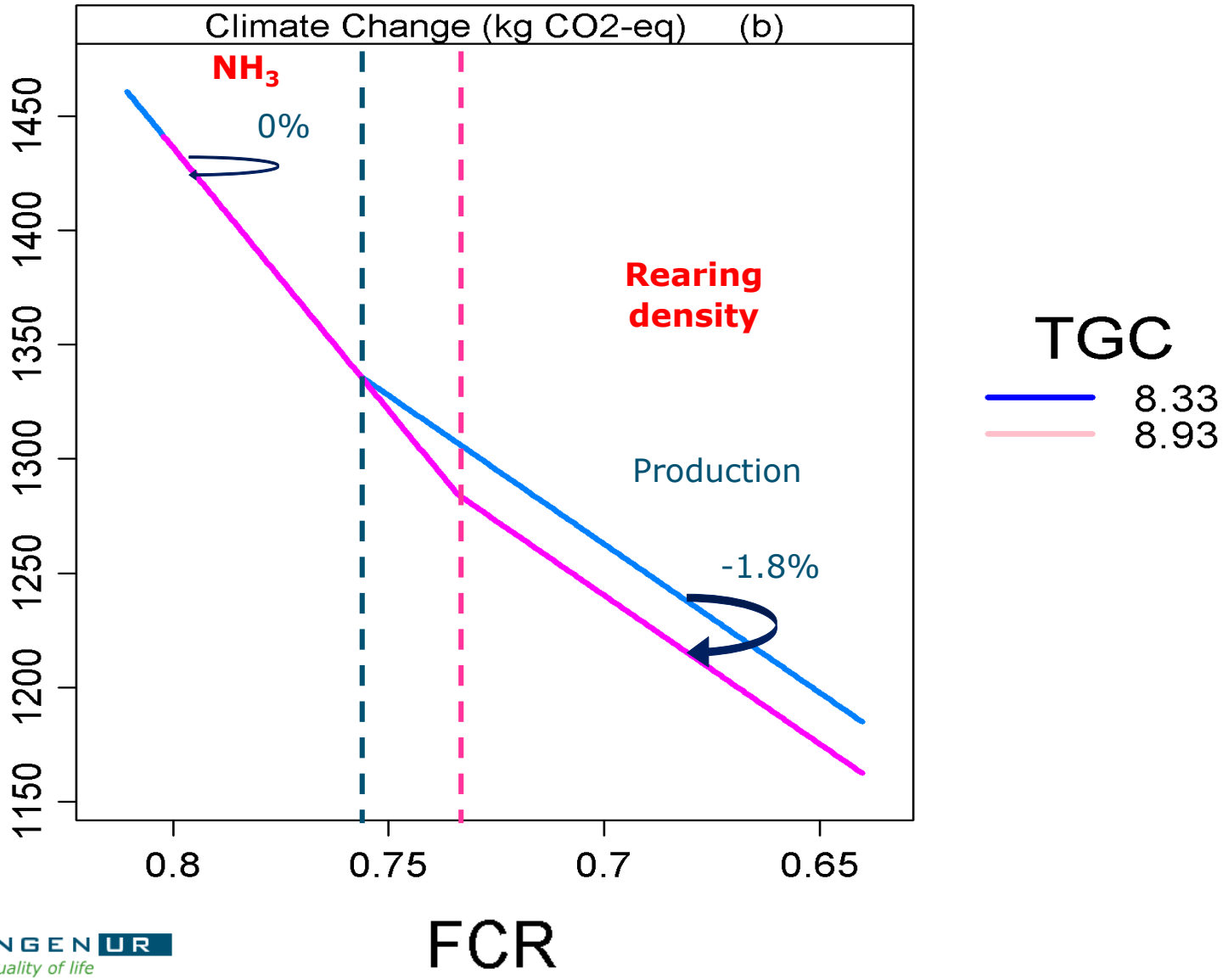
(kg of feed/ kg of fish)

Environmental impacts of FCR

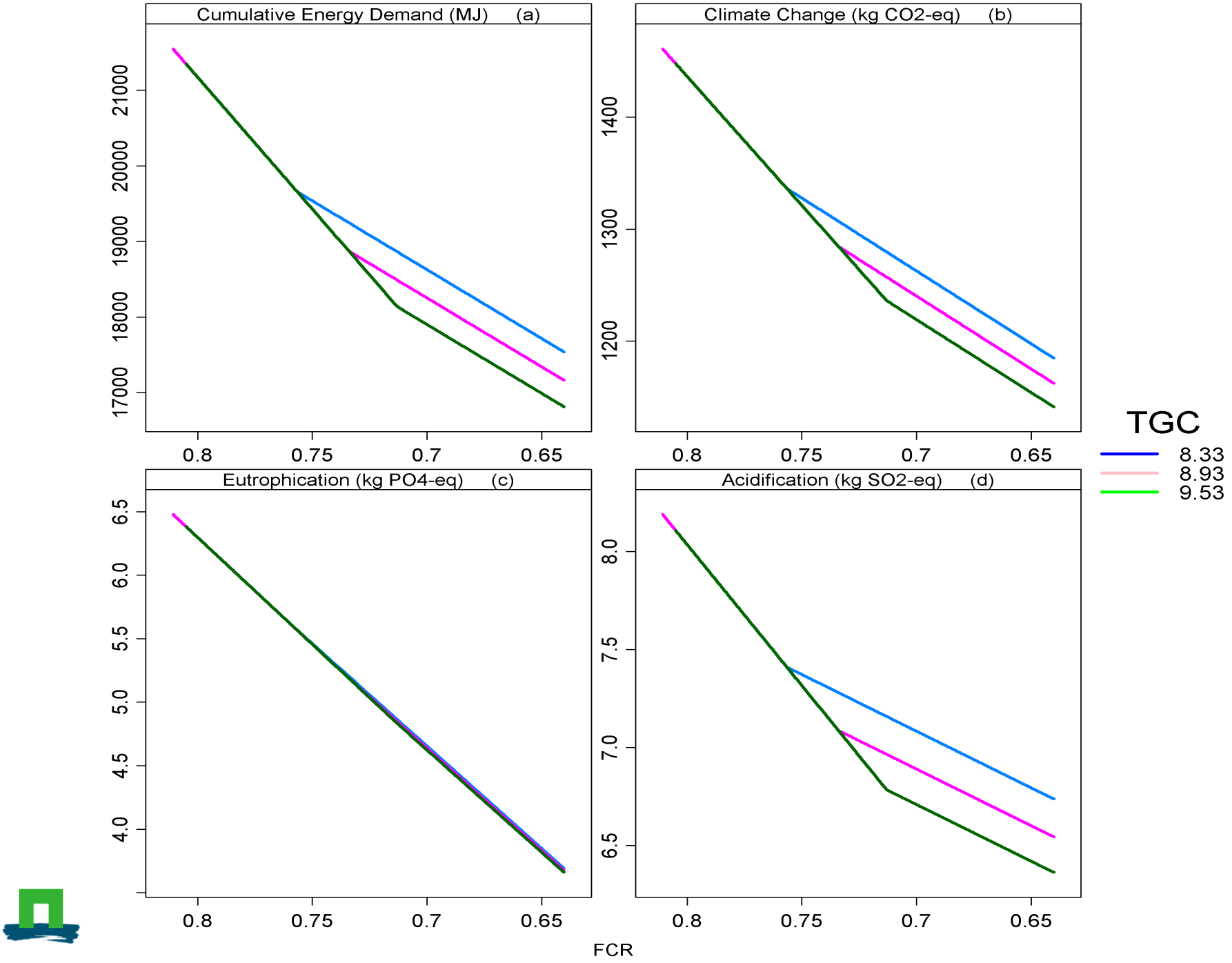


WAGENINGEN UR
For quality of life

Environmental impacts of growth rate



WAGENINGEN UR
For quality of life


Cumulative Energy Demand (MJ) (a)
Climate Change (kg CO2-eq) (b)
Eutrophication (kg PO4-eq) (c)
Acidification (kg SO2-eq) (d)
17000
18000
19000
20000
21000
1200
1300
1400
4.0
4.5
5.0
5.5
6.0
6.5
6.5
7.0
7.5
8.0
0.8
0.75
0.7
0.65
FCR
TGC
8.33
8.93
9.53

Summary

Limiting factor	ENV_{TGC}	ENV_{FCR}
NH_3	0	++ (10%)
Rearing density	+ (2%)	+ (4%)

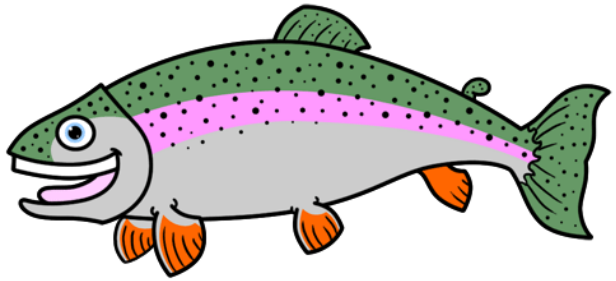
Limiting factor	EV_{TGC}	EV_{FCR}
NH_3	0 €/kg	0.14 €/kg
Rearing density	0.03 €/kg	0.06 €/kg

Conclusion

- Farming system modelling = very important
- FCR always decreases environmental impacts
- TGC does not (depends on limiting factor)
- Synergies between environmental and economic values

- Take home message:

Genetic improvement can decrease environmental impacts



Thanks for your attention