Mitigation Strategies versus Adaptation Strategies

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Mitigation Strategies versus Adaptation Strategies

(OR dairy cows and climate is more than only about methane)

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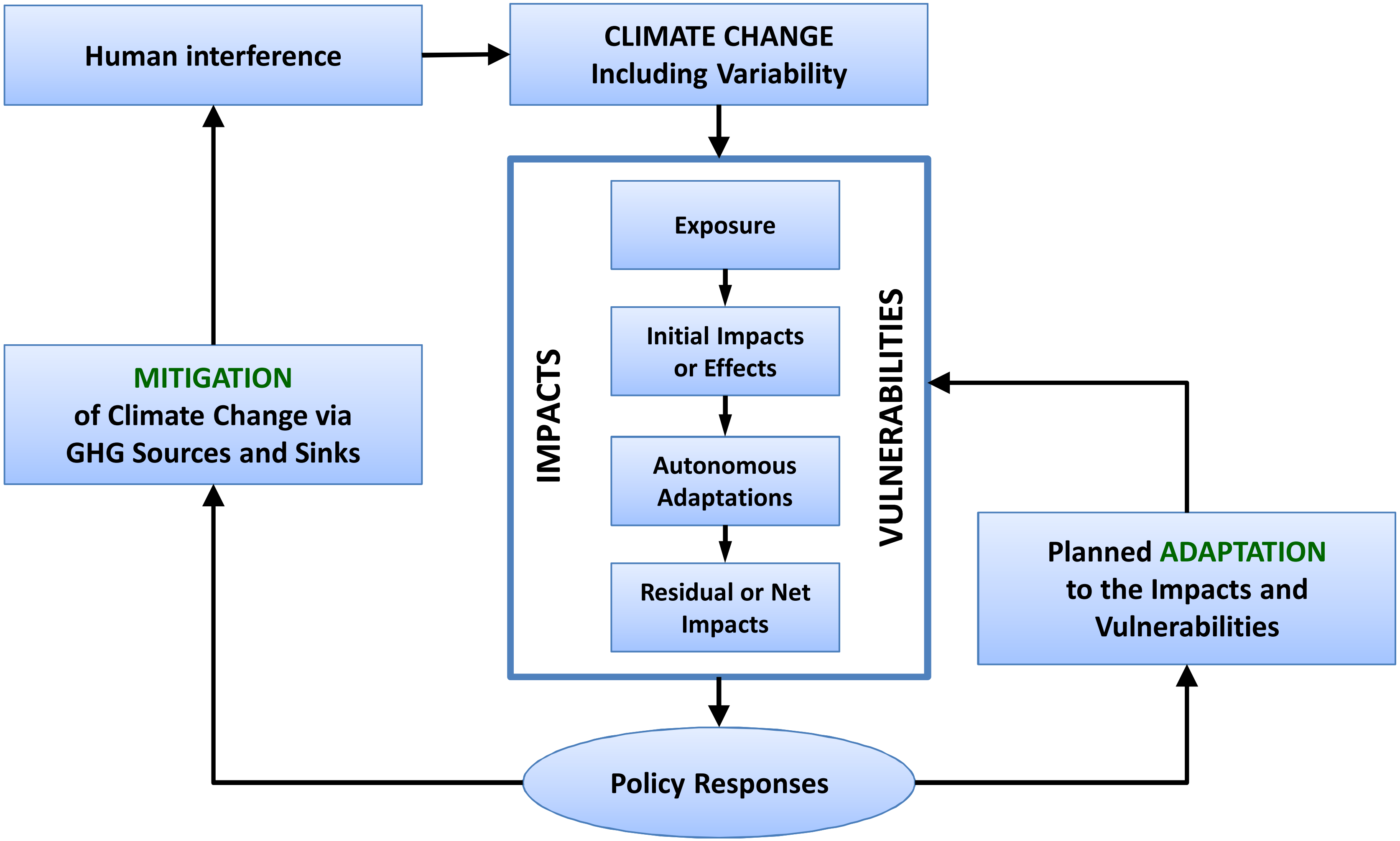
Mitigation and Adaptation



IPCC TAR 2001 WG2 after Smit *et al.*, 1999 (Mitigation and Adaptation Strategies for Global Change 4: 199-213)

Context

e.g., methane emissions

Dairy cows

Climate change

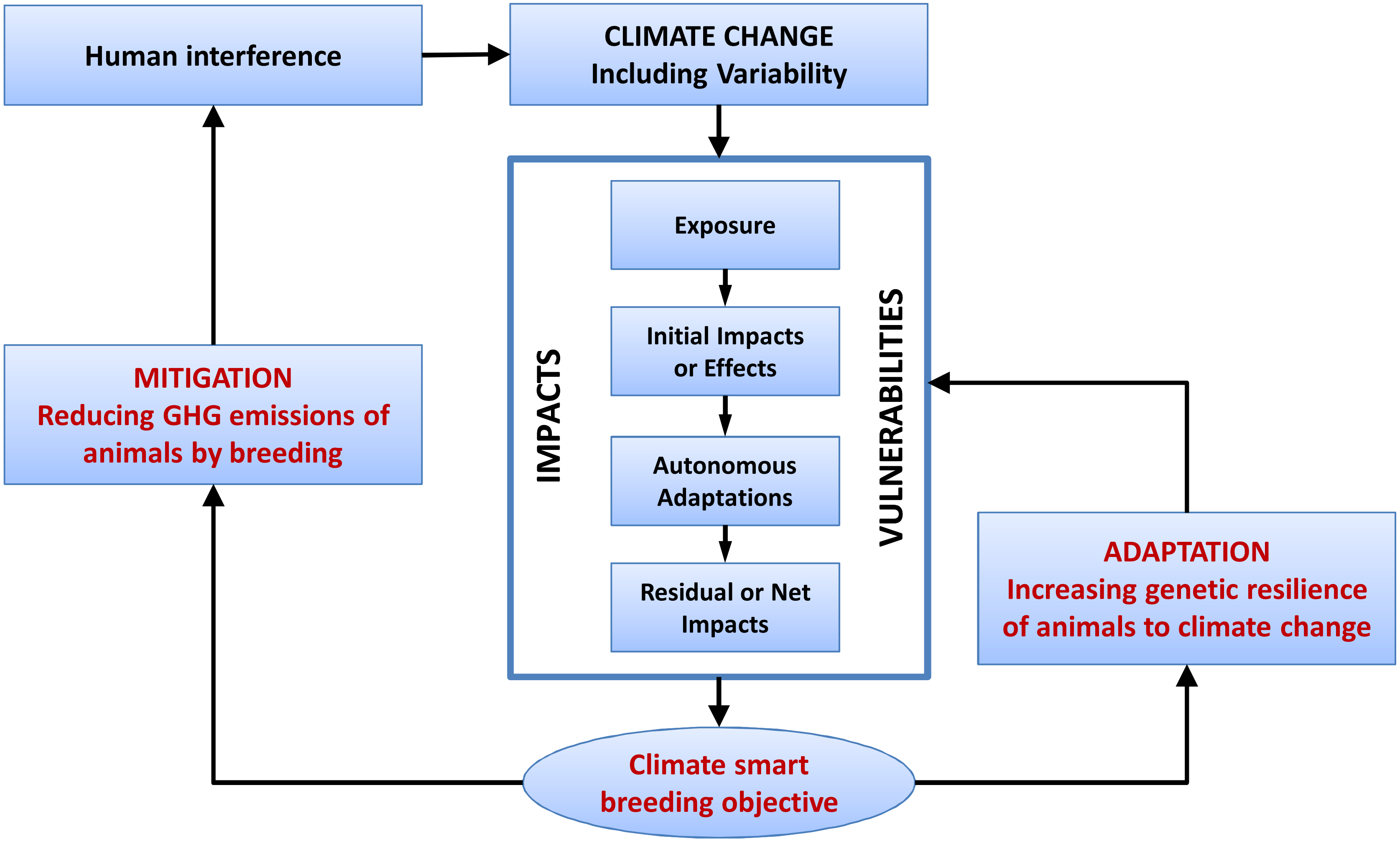
e.g., heat stress

Å **Mitigation and Adaptation**

ï **Doing management choices**

ï **But also breeding: permanent and cumulative !**

Breeding for Mitigation and Adaptation



Modified from IPCC TAR 2001 WG2 after Smit *et al.*, 1999 (Mitigation and Adaptation Strategies for Global Change 4: 199-213)

MITIGATION

Reducing GHG emissions of animals by breeding

Context

- Selecting for reduced GHG emission
- Two conditions
  - Available data
  - Exploitable genetic variation

Both conditions remain even using Genomics

Focus on CH_4

- Currently many efforts to develop and use large-scale methane measurement tools
  - Major objective in METHAGENE COST Action
- Needed steps:
  1. harmonize large-scale methane measurements using different techniques
  2. develop easy and inexpensive proxies for methane emissions
  3. develop approaches for incorporating methane emissions into national breeding strategies

Easy and Inexpensive Proxies for CH_4

- Several possibilities here
- Will focus in this presentation on
  - Use of milk composition described by mid-infrared (MIR) spectral data

Current research effort in Gembloux (CRA-W and ULg-GxABT) and several external collaborations

Ongoing Collaborations for CH_4

Amélie Vanlierde
Fréderic Dehareng
Eric Froidmont
Pierre Dardenne

cra-w

Eva Lewis
Frank Buckley
Mathew H. Deighton
Sinead McParland
Donagh Berry

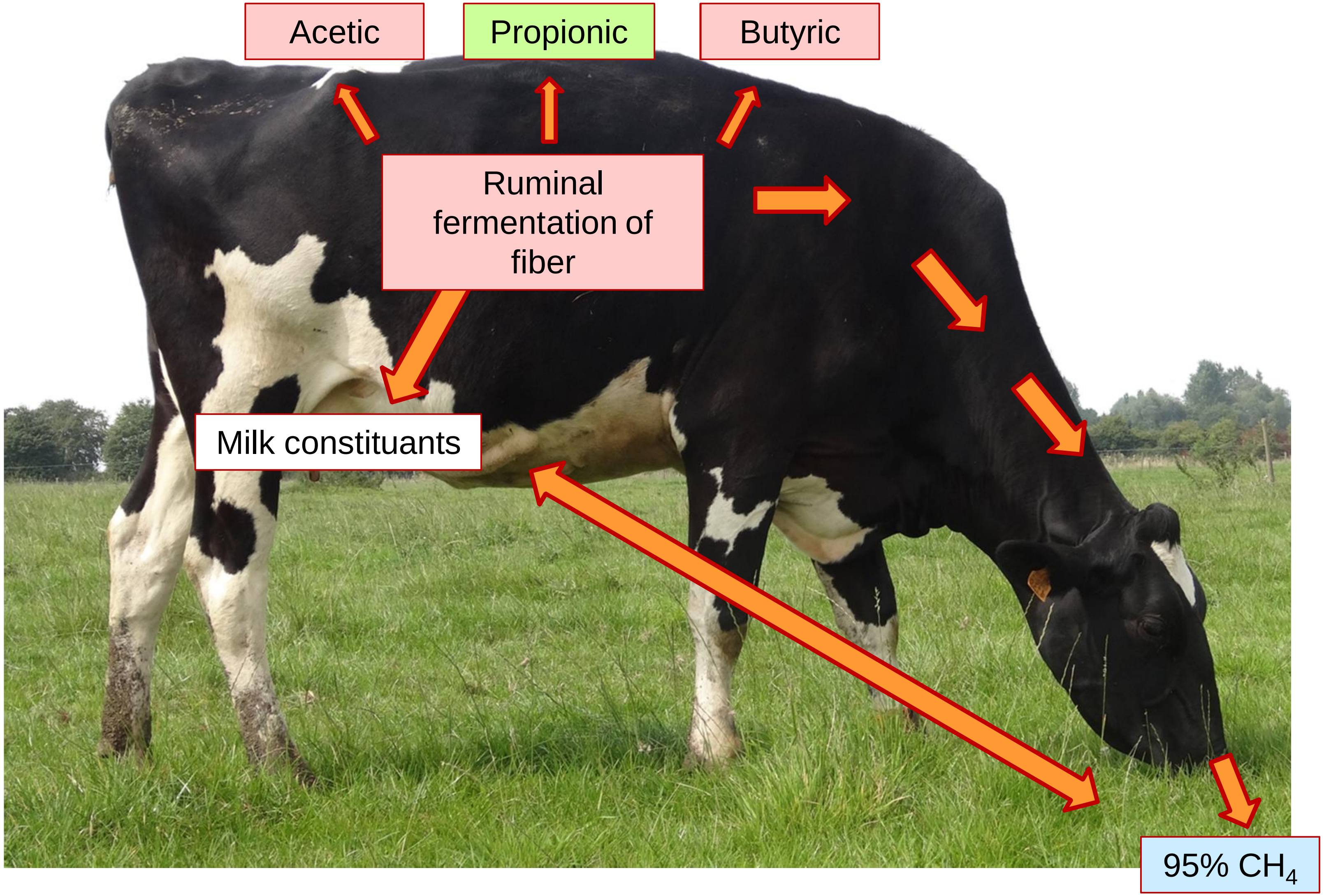
Teagasc
Agriculture and Food Development Authority

Hélène Soyeurt
Purna Kandel
Marie-Laure Vanrobays
Sylvie Vanderick

gembloux agro bio tech

Université de Liège

Context



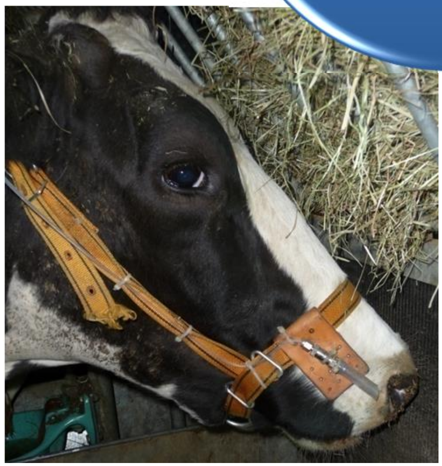
Acetic
Propionic
Butyric
Ruminal fermentation of fiber
Milk constituants
95% CH_4

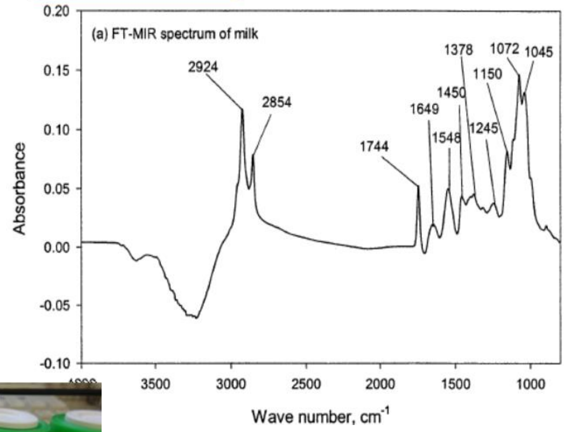
Basic Concept

Enteric CH_4

MIR milk spectra

Equation



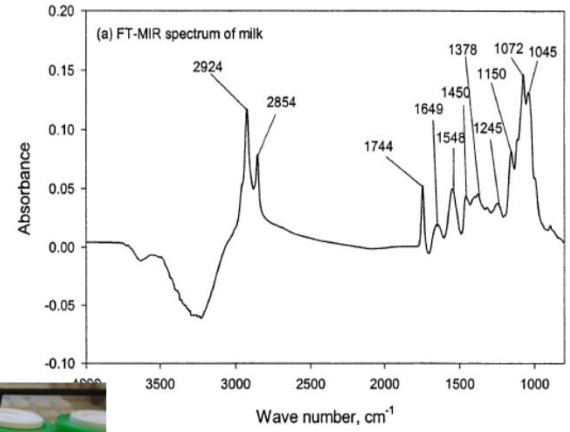


Basic Concept

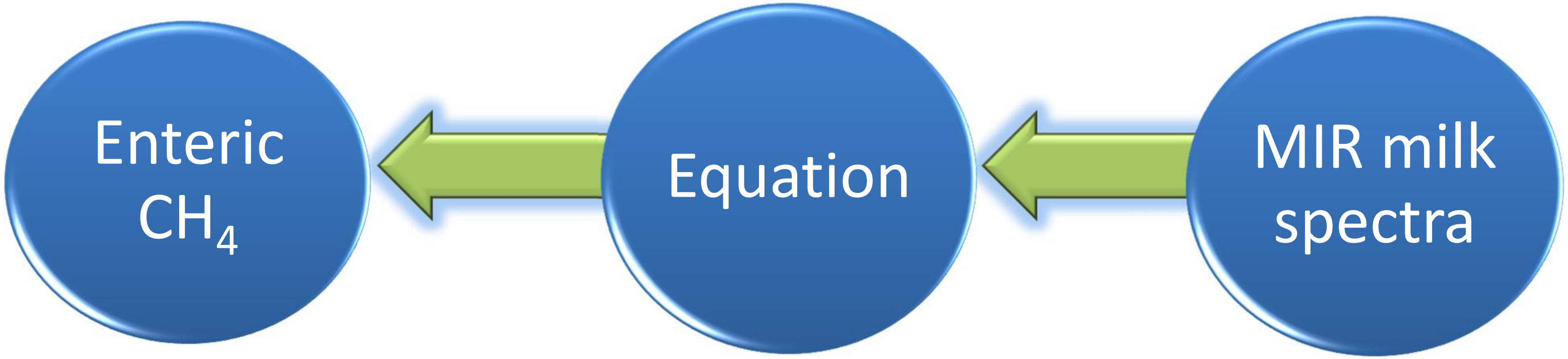
Enteric CH_4

MIR milk spectra

Equation



Previous Work



Animal (2012), **6:10**, pp 1694–1701 © The Animal Consortium 2012
doi:10.1017/S1751731112000456

Potential use of milk mid-infrared spectra to predict individual methane emission of dairy cows

F. Dehareng[1*†], C. Delfosse[1*], E. Froidmont[2], H. Soyeurt[3,4], C. Martin[5], N. Gengler[3,4], A. Vanlierde[1] and P. Dardenne[1]

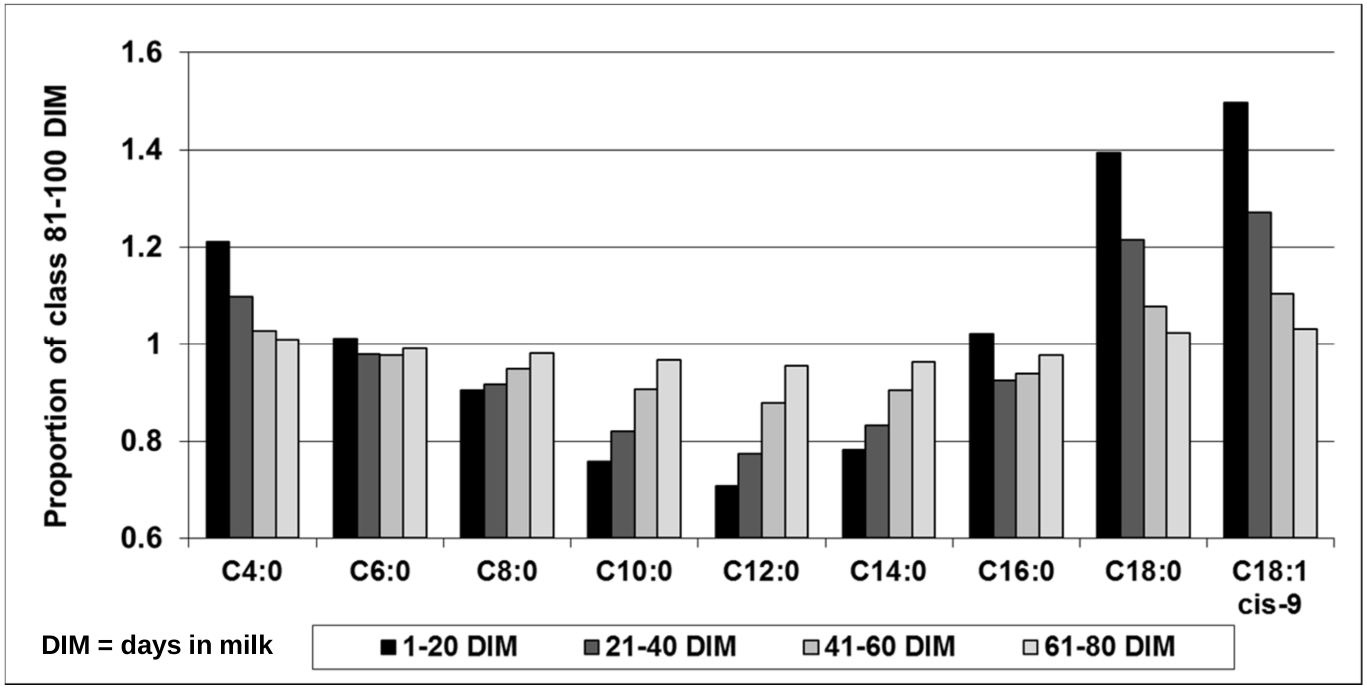
[1]Valorisation of Agricultural Products Department, Walloon Agricultural Research Centre, B-5030 Gembloux, Belgium; [2]Department of Production and Sectors, Walloon Agricultural Research Centre, B-5030 Gembloux, Belgium; [3]Animal Science Unit, Gembloux Agro Bio-Tech, University of Liège, B-5030 Gembloux, Belgium; [4]National Fund for Scientific Research, B-1000 Brussels, Belgium; [5]UR1213 Herbivores, INRAClermont-Theix Research Centre, F-63122 Saint Genès Champanelle, France

Milk Fatty Acids Change With Lactation Stage

J. Dairy Sci. 94:4152–4163
doi:10.3168/jds.2010-4108

Phenotypic and genetic variability of production traits and milk fatty acid contents across days in milk for Walloon Holstein first-parity cows

C. Bastin,*[1] N. Gengler,*† and H. Soyeurt*†
*University of Liège, Gembloux Agro-Bio Tech, Animal Science Unit, B-5030 Gembloux, Belgium
†National Fund for Scientific Research (F.R.S.-FNRS), B-1000 Brussels, Belgium



- Changes due to the equilibrium: mobilization ⇔ intake

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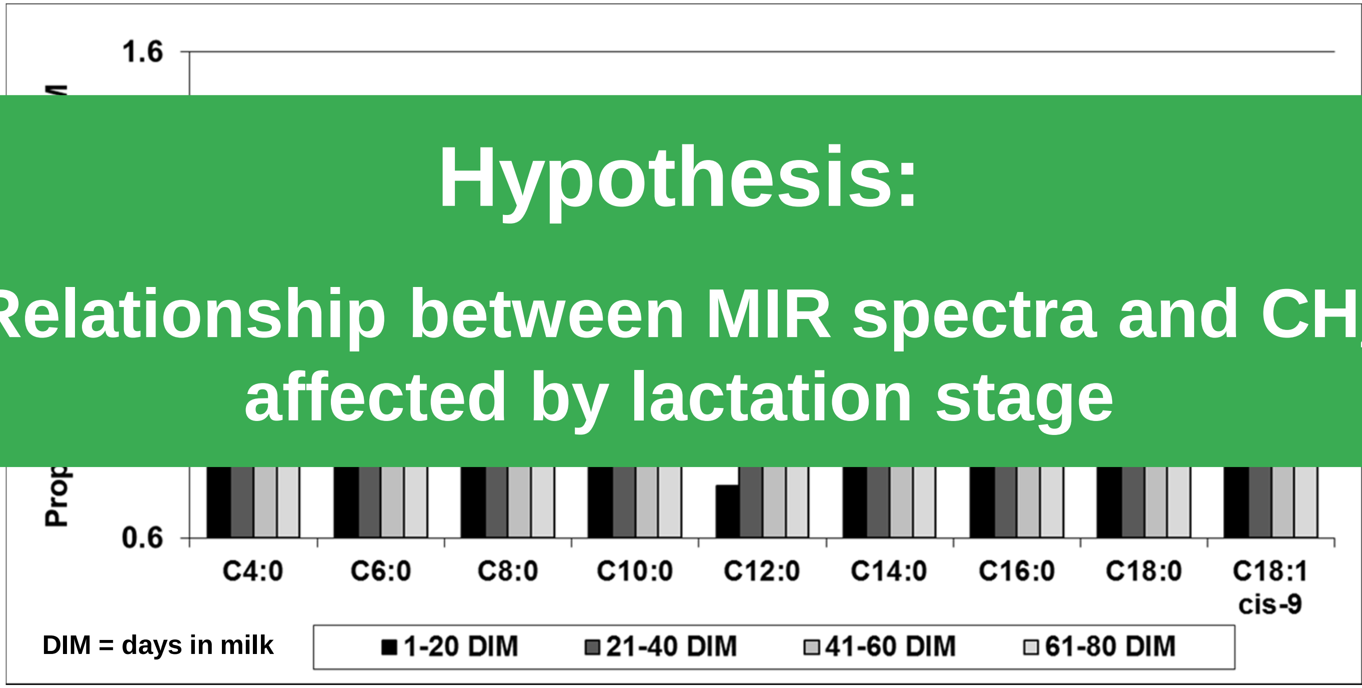
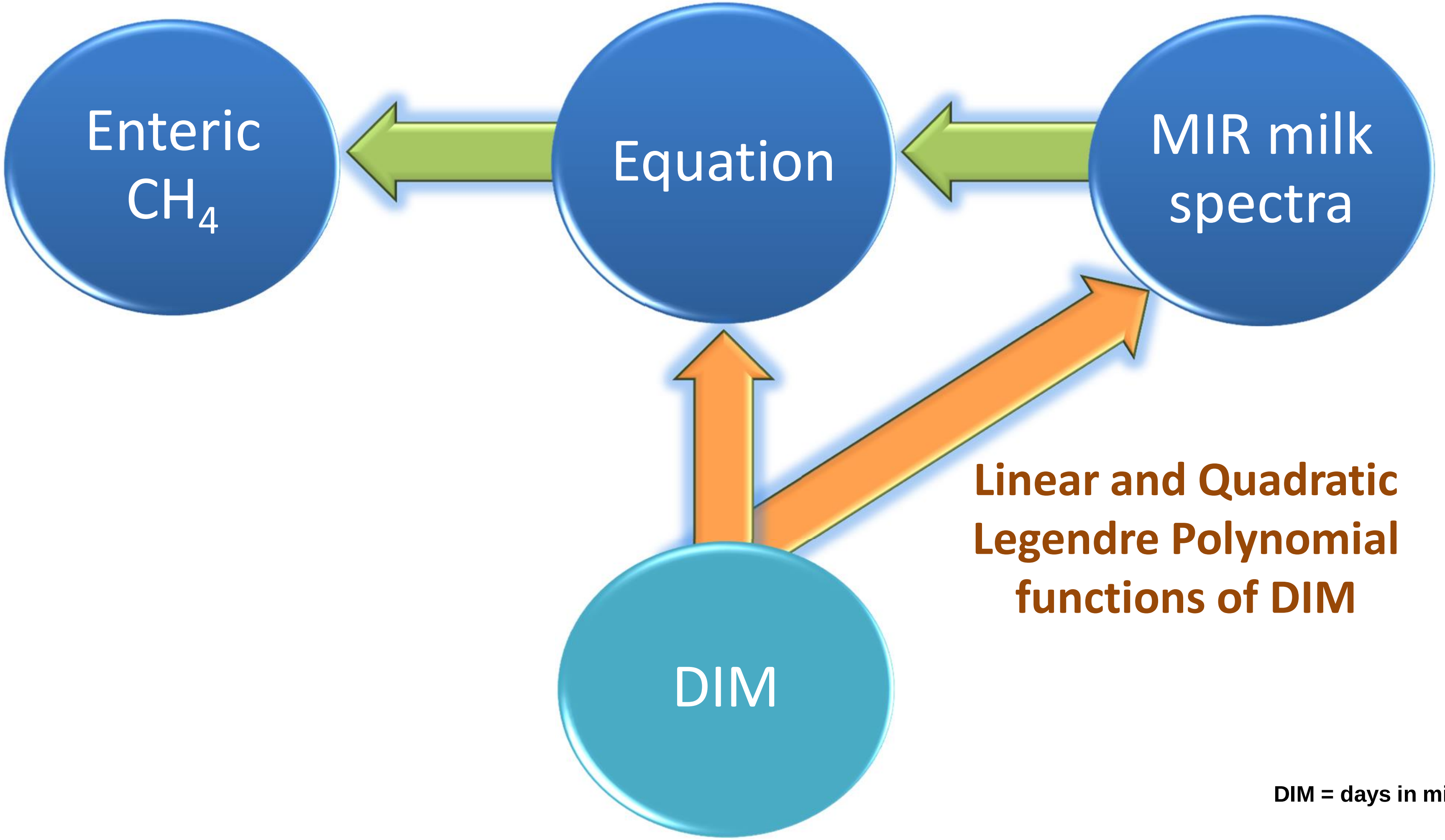


Hypothesis:

Relationship between MIR spectra and CH_4 affected by lactation stage

- ❑ Changes due to the equilibrium: mobilization ⇔ intake

Inclusion of Lactation Stage (DIM) in Methane Equation



Linear and Quadratic Legendre Polynomial functions of DIM

DIM = days in milk

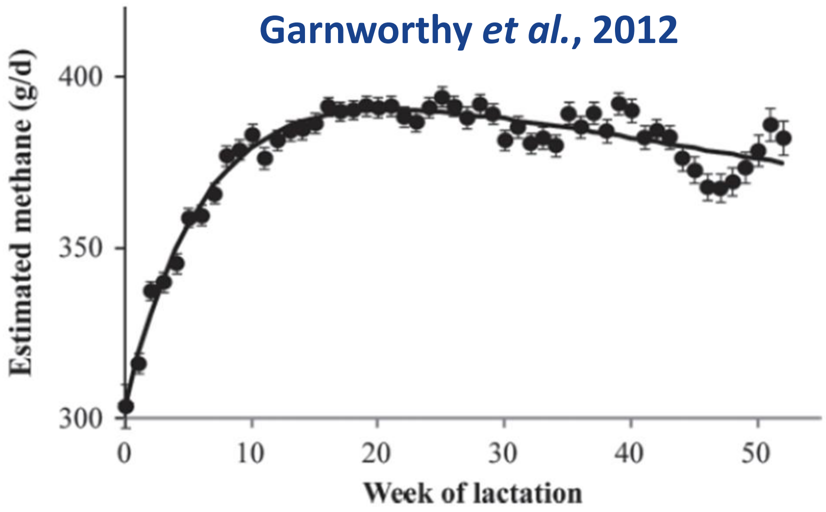
Calibration

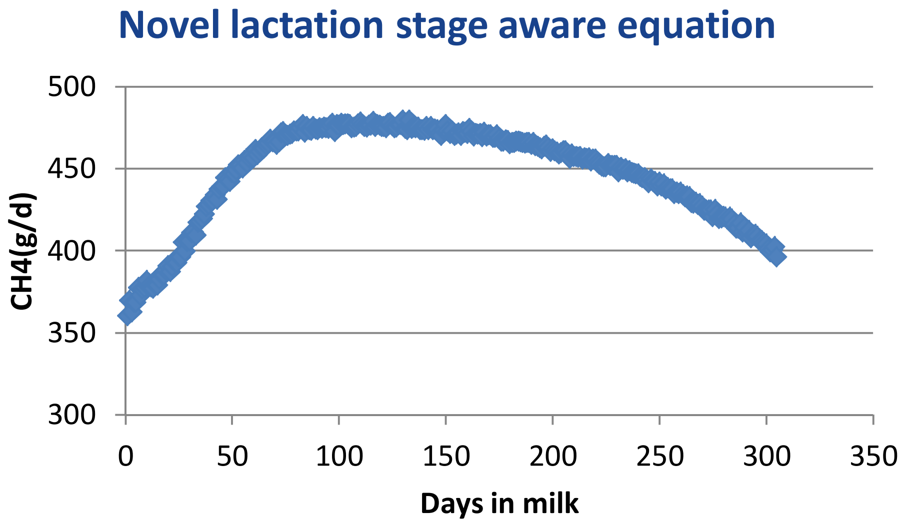
- SF_6 data from BEL and IRL
  - Breeds: HOL, JER, HOL x JER
  - 446 records
  - Feeding systems: TMR or grass-based

- Cross-validation R^2: 0.67
  - Value slightly lower then previous studies

But two findings show (next slides)
→potentially appropriate strategy

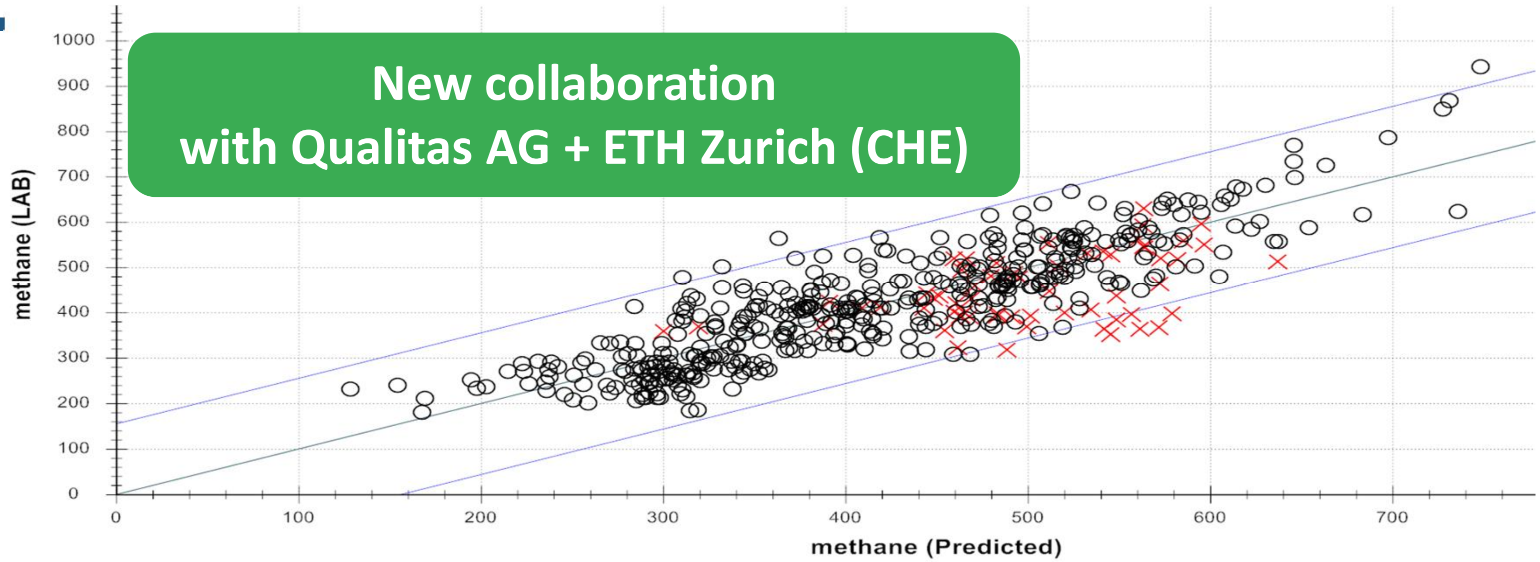
Application on Walloon Spectral Database





MIR proxy for CH_4 follows expected evolution (similar to DMI) throughout the lactation

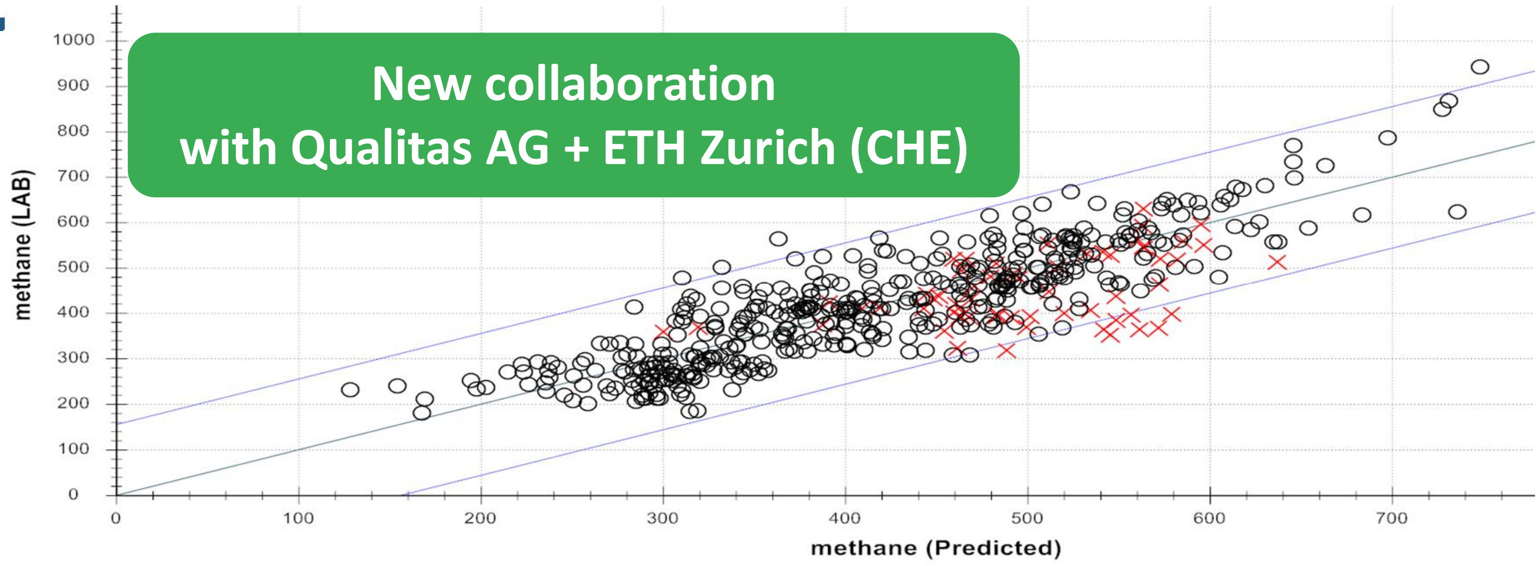
First Completely External Validation



- Validation data (X) of completely different origin, different:
  - Measurement method (chambers)
  - Feeding system (hay based)
  - Breed (Brown-Swiss)
- With novel lactation stage aware equation correlation of 0.48
  - When adding this new data to calibration correlation up to 0.70

Shows potential for other future collaborations

First Completely External Validation



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  - Breed (Brown-Swiss)
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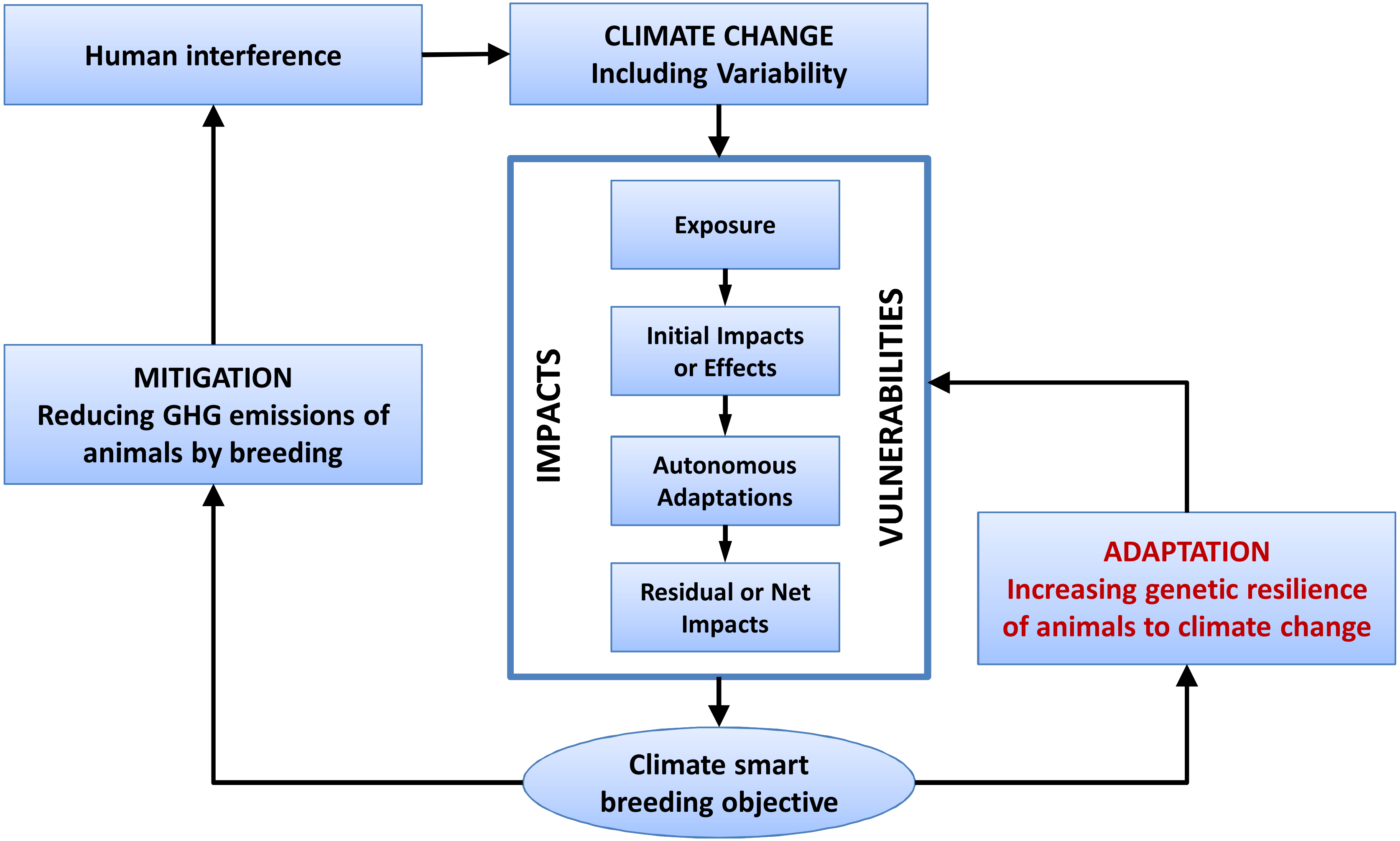
  - When adding this new data to calibration correlation up to 0.70

Useful for harmonization of measurements?

Breeding for Mitigation and Adaptation



Modified from IPCC TAR 2001 WG2 after Smit *et al.*, 1999 (Mitigation and Adaptation Strategies for Global Change 4: 199-213)

ADAPTATION

Increasing genetic resilience of animals to climate change

Context

- Selecting for increased resilience of animals (here focus dairy cows) to climate change
- However important question:
  - How to assess before climate change happens!
- Traditional solution:
  - Use of historical weather data and extreme weather events as proxies of climate change

Extension of heat tolerance research

Contributions

- This part reports research done in the context of FACCE-JPI and supported by different people

Hedi Hammami
Marie-Laure Vanrobays
Catherine Bastin
Sylvie Vanderick
Bernard Tychon
Julien Minet

gembloux agro bio tech

Université de Liège

- In collaboration with CRA-W, AWE in Belgium
- Collaboration was initiated with different other groups
  - DLO (NLD), INIA (ESP), SRUC (SCO), UGA (USA), UNI-KS (GER), KIS (SLO), …

Heat Tolerance Research

- Assessing variability of studied phenotypes following gradient of “heat stressors” (HS)
  - Mostly done using reaction norm approach
  - In practice random regression models
- Heat stress assessed using:
  - Temperature – Humidity – Index (THI)

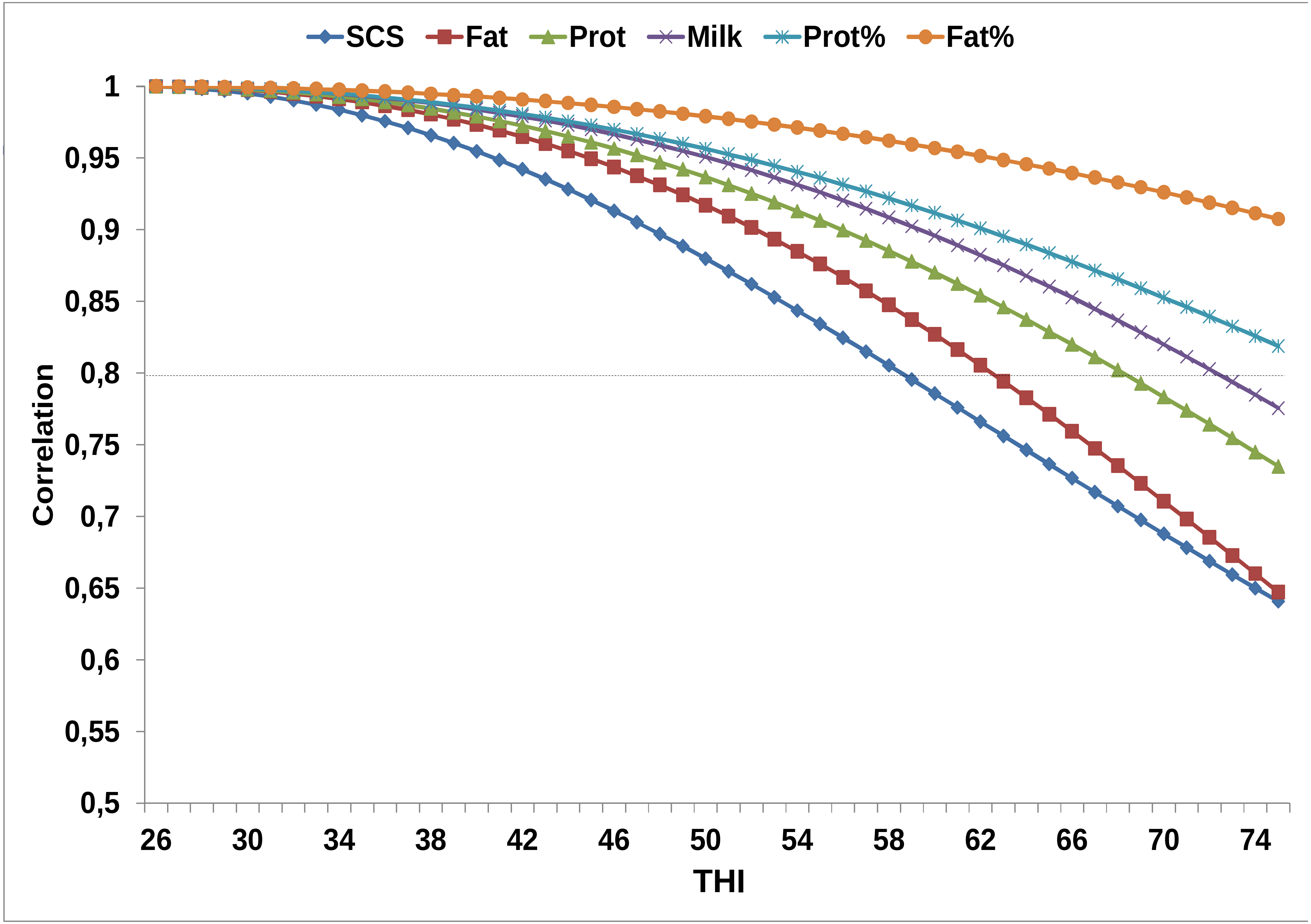
$$THI = (1.8 \times T_{db} + 32\ ) - [(0.55 - 0.0055 \times RH) \times (1.8 \times T_{db} - 26)]$$

where T_{bd} = Dry Bulb Temperature (°C) & RH = Relative Humidity (%)

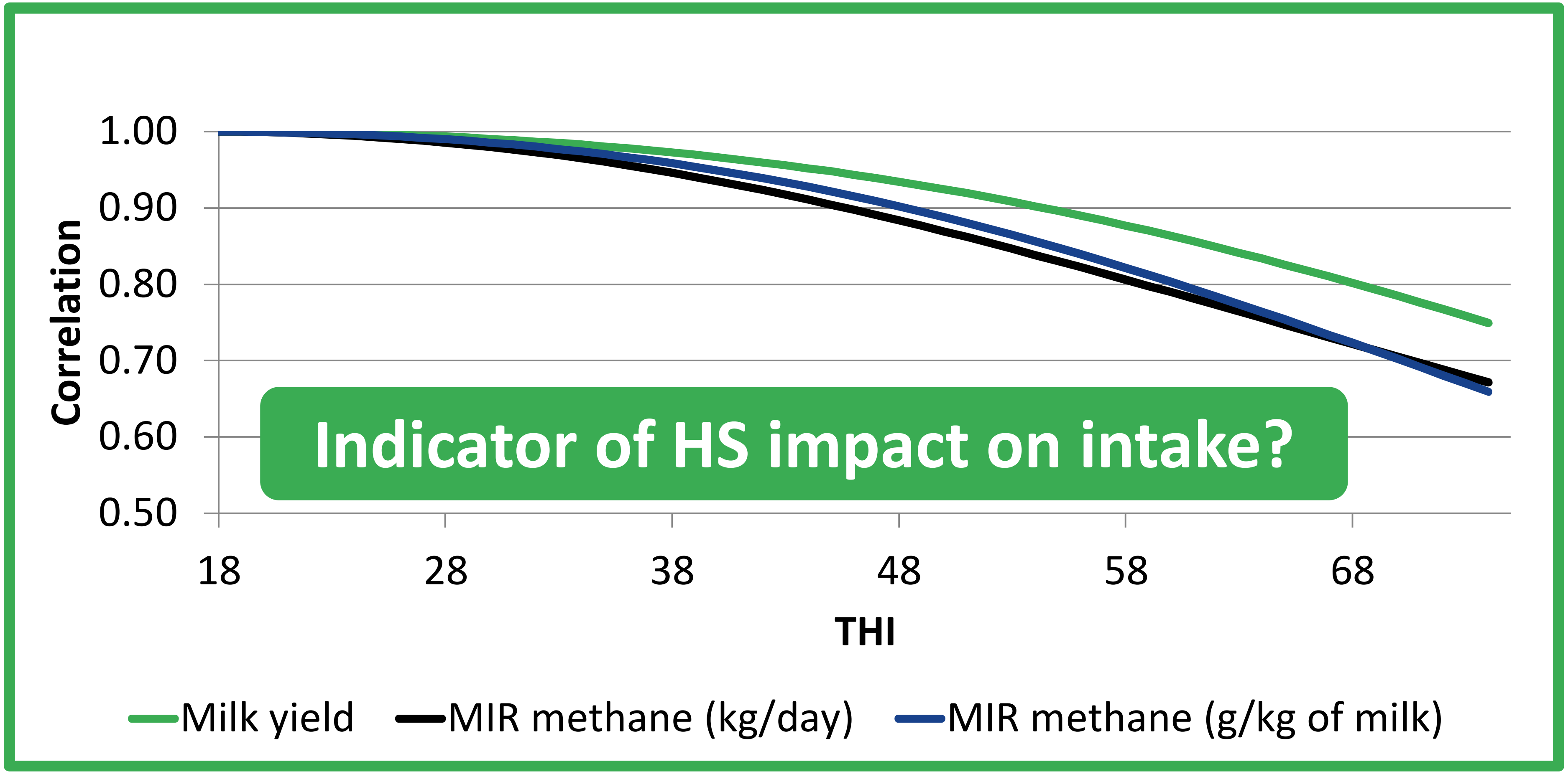
(NRC, 1981)

Genetic Differences across THI Ranges

- ❑ Genetic differences when traits affected by head stress?
- ❑ Random regression → genetic correlations
  - ➢ High correlations → traits less affected
  - ➢ Low correlations → traits more affected
- ❑ Following slides some results
  - ➢ Results from different studies by my coworkers Hedi Hammami (Post-Doc) and Marie-Laure Vanrobays (PhD student)

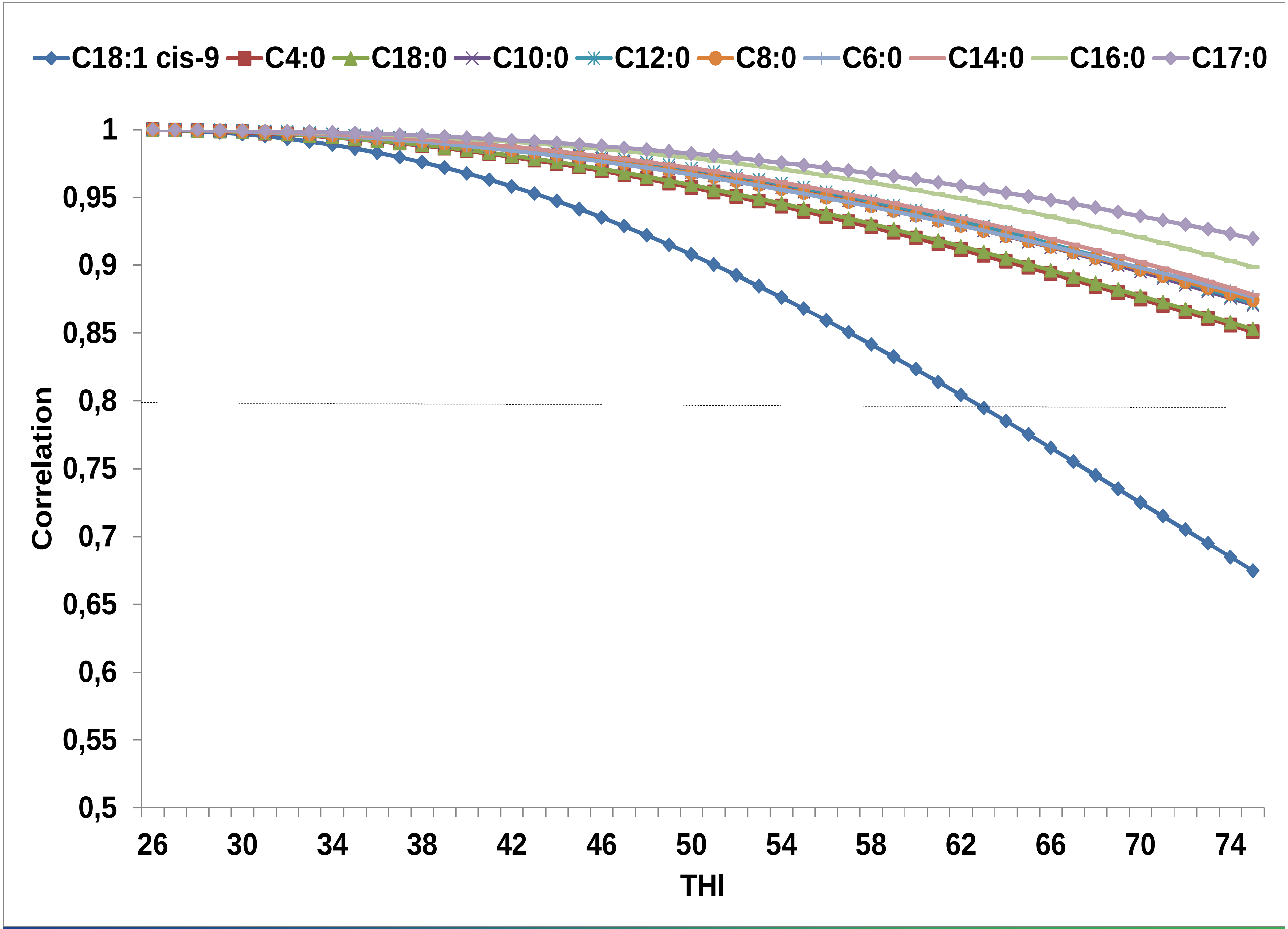

SCS
Fat
Prot
Milk
Prot%
Fat%
Correlation
1
0,95
0,9
0,85
0,8
0,75
0,7
0,65
0,6
0,55
0,5
26
30
34
38
42
46
50
54
58
62
66
70
74
THI

And for CH_4? (results based on MIR proxy)



Indicator of More Mobilization Under HS?

- Is it possible to catch milk indicators of more mobilization (to cover intake reduction)?
- Nowadays possible to study!
  - Because large scale studies of MIR predicted fatty acids content in milk feasible
- Following slide give some first results, please notice C18:1 cis-9 (oleic acid)
  - Indicator of body fat mobilization

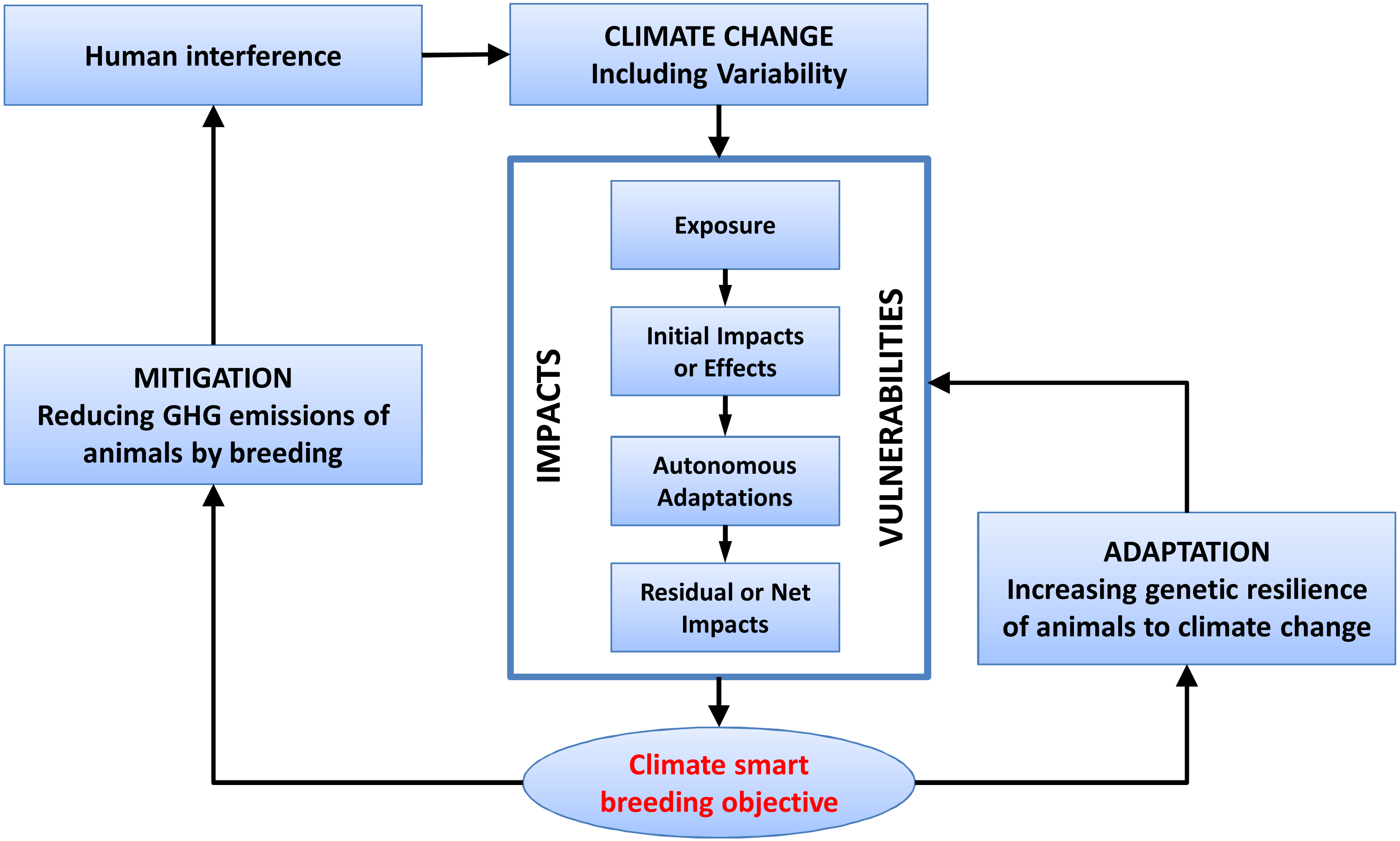

C18:1 cis-9
C4:0
C18:0
C10:0
C12:0
C8:0
C6:0
C14:0
C16:0
C17:0
Correlation
1
0,95
0,9
0,85
0,8
0,75
0,7
0,65
0,6
0,55
0,5
26
30
34
38
42
46
50
54
58
62
66
70
74
THI

Detection of Heat Stress in Milk?

- Results obtained until now showed:
  - Milk components affected by heat stress
  - BUT differences in reaction of some key components
  - Some directly linked to the status of the cows
- Therefore:
  - Potential early detection of heat stress in milk
- Next steps:
  - Linking MIR spectral data to heat tolerance
  - First indicators promising
  - More work needed

Hope to find indirect indicators of heat stress

Climate Smart Breeding Objective



Modified from IPCC TAR 2001 WG2 after Smit *et al.*, 1999 (Mitigation and Adaptation Strategies for Global Change 4: 199-213)

Climate Smart Breeding Objective (Index)

- Clear idea about breeding objective traits
  - + economic weights
- Ability to measure the required index traits
  - Cf. first parts of this talk
- Good knowledge of correlations
  - Among involved new traits
  - With existing and currently selected traits

Consequences of Selection

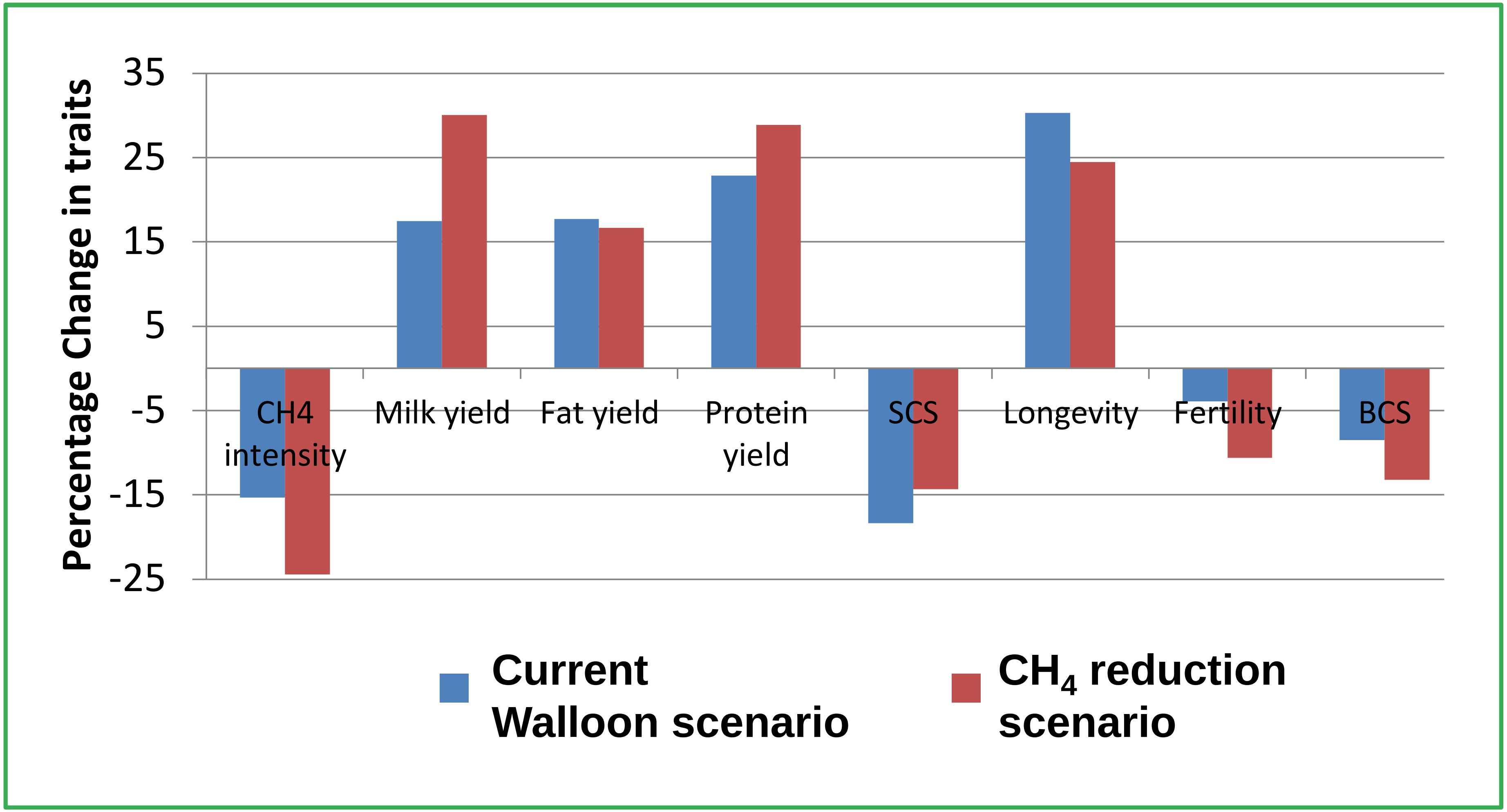
- Following slides some results from Purna B. Kandel (PhD Student)
  - Used CH4 intensity (g/kg milk)
  - Normally not optimal trait (ratio trait)
  - But here OK for testing → close to breeding goal (less methane / unit produced)
  - Estimated correlations between EBV of sires as proxy to genetic correlations
- If you want to know more details
  - Please go to his talk on Tuesday 2:30 PM

Consequences of Selection for Environmental Impact Traits in Dairy Cows.
P. B. Kandel[*1], *S. Vanderick*[1], *M. L. Vanrobays*[1], *A. Vanlierde*[2], *F. Dehareng*[2], *E. Froidmont*[2], *H. Soyeurt*[1], *and N. Gengler*[1], [1]*University of Liege, Gembloux Agro-Bio Tech, Gembloux, Belgium,* [2]*Walloon Agricultural Research Center, Gembloux, Belgium.*

Selection Scenarios (relative weights in index)

	Production			Functionality		Type	Environment
	Milk	Fat yield	Protein yield	SCS	Longevity	Total type	CH_4 intensity
Current Walloon scenario	-10	9	29	-5	23	24	0
CH_4 reduction scenario	-7.50	6.75	21.75	-3.75	17.25	18	-25

Expected Genetic Changes



Conclusions

- Complex relationships between mitigation and adaptation traits
  - Clearly more research necessary
- Clear indications functional traits more affected by heat stress
  - Presented research + some results by others in particular I. Misztal's group
- Recent presented research indicate
  - Selecting for less CH_4 → reduces "robustness"
  - Affecting resilience to climate change?

Conclusions

- Here presented research showed
  - Importance of equilibrium: mobilization ⇔ intake and its link to Mitigation and Adaptation
- If you want to know more details about the link between fertility and milk composition
  - Please go to the talk of Catherine Bastin on Thursday 11:00 AM

Improving Dairy Cow Fertility using Milk-Based Indicator Traits.
C. Bastin[*1], *J. Vandenplas*[1,2], *and N. Gengler*[1], [1]*University of Liege, Gembloux Agro-Bio Tech, Gembloux, Belgium,* [2]*National Fund for Scientific Research, Brussels, Belgium.*

Conclusions

- Results show again need to consider getting intake (affected by HS)
  - Context of relation RFI ⇔ methane
  - Trait definition methane yield (g / kg DMI)
- Also indication link intake ⇔ MIR spectra
  - More on this topic in the talk by Sinead McParland on Tuesday 11:30 AM

Mid-Infrared Spectroscopy to Predict Feed Intake and Efficiency in Lactating Dairy Cows.
S. McParland[1], E. Kennedy[1], S. Butler[2], M. O'Donovan[1], B. McCarthy[2], J. E. Pryce[3], and D. P. Berry[2], [1]Teagasc, Moorepark, Fermoy, Co. Cork, Ireland, [2]Animal & Grassland Research and Innovation Centre, Teagasc, Moorepark, Fermoy, Co. Cork, Ireland, [3]Biosciences Research Division, Department of Environment and Primary Industries, Victoria, Australia.*

Held in conjunction with the IDF/ISO Analytical Week 2015

From Milk analysis to advisory tools

Investing in Oppo

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

Wallonie

SPW Service public de Wallonie

Acknowledgments

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  FACCE WB

  the Walloon "Agriculture – Climate Change" Network inside the European Joint Programming Initiative FACCE-JPI
- Finally again thanks to
  - Many, internal and external, collaborators and
  - Many involved funding bodies, in particular

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SEVENTH FRAMEWORK PROGRAMME

Thank you!