

Field measurements of gaseous emissions in livestock buildings: A new approach using mass balance to improve accuracy

Anthony AUZERAIS¹ (anthony.auzerais@inrae.fr), Nicolas FISCHER², Mélynda HASSOUNA¹, Paul ROBIN¹

1: INRAE, UMR SAS, Institut Agro, 35000 Rennes, France

2: LNE, Data Science and Uncertainty Department, 75015 Paris, France

1- Context and objectives

Agriculture is a major contributor to global gaseous emissions:

- Greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)
- Ammonia (NH_3), which decreases air quality

95% of global emissions 10%

→ Assessing these major sources in livestock buildings is crucial in order for reliable emission reductions from these facilities, which are essential to drive effective mitigation strategies.

The present study involved calculating the following (see Approach below):

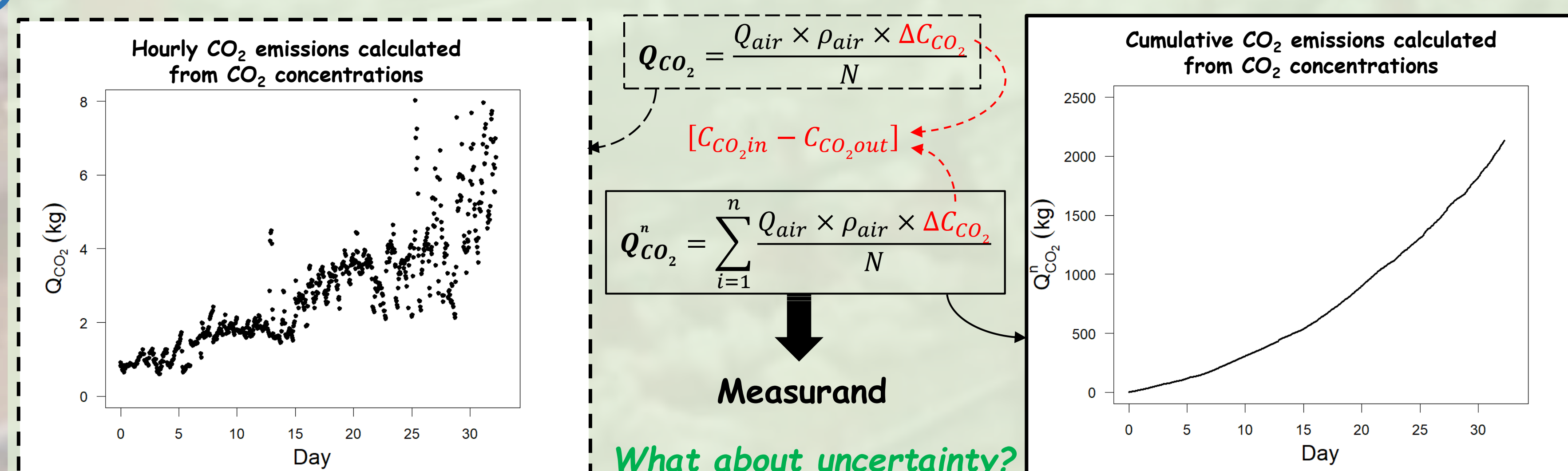
- Cumulative emissions and their uncertainties (to improve precision)
- Independent carbon mass balance, to improve measurement accuracy
- Adjusted gaseous emissions, which has improved measurement accuracy

2- Material and method

Analysis of the GestCO2 dataset: (Brittany, 2017; <https://doi.org/10.15454/FQ07VA>)

- Poultry house: mechanically ventilated
- Continuous and intermittent measurements performed by well-trained staff

Hourly measurements taken and cumulative emissions calculated for 32 days:



3- Calculate emission uncertainties

Measuring uncertainty (GUM method):

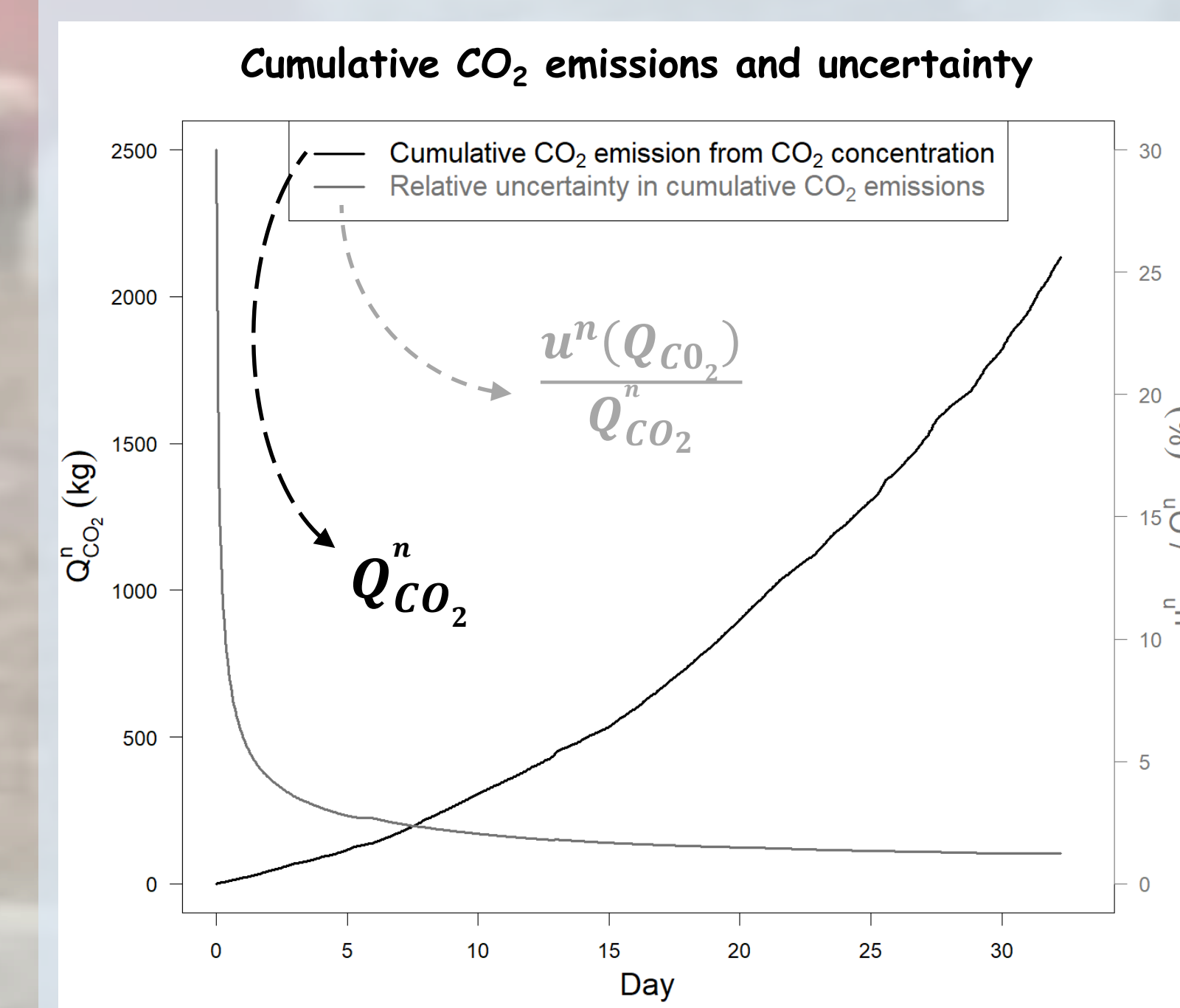
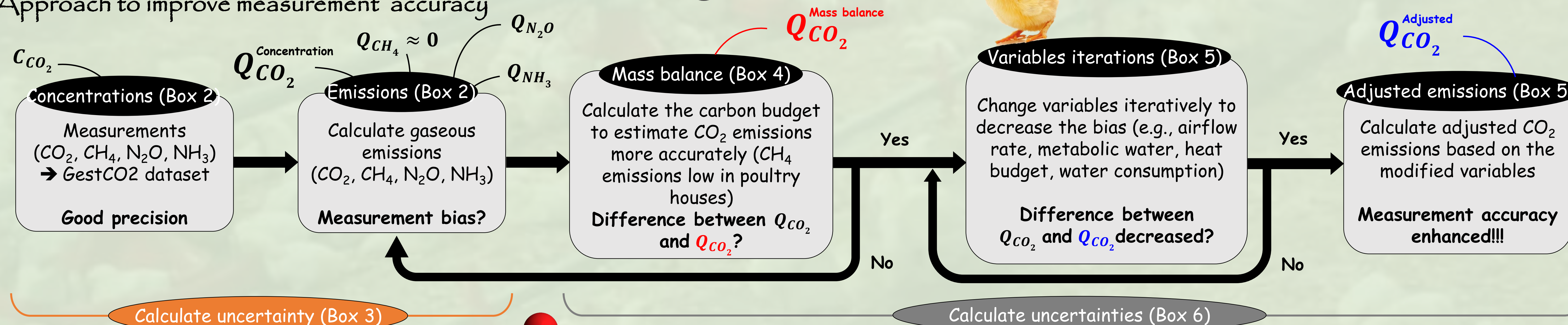
$$u^n(Q_{\text{CO}_2}) = \sqrt{\sum_{i=1}^n (u_{Q_{\text{air}}}^2 + u_{\rho_{\text{air}}}^2 + u_{C_{\text{CO}_2\text{in}}}^2 + u_{C_{\text{CO}_2\text{out}}}^2 + u_N^2)}$$

Uncertainty of each term:

$u_{Q_{\text{air}}}$	$u_{\rho_{\text{air}}}$	$u_{C_{\text{CO}_2\text{in}}}$	$u_{C_{\text{CO}_2\text{out}}}$	u_N
25%	3%	5%	5%	0%

Uncertainty was due mainly to Q_{air} and gas concentrations ($C_{\text{CO}_2\text{in}}$ and $C_{\text{CO}_2\text{out}}$)

Approach to improve measurement accuracy

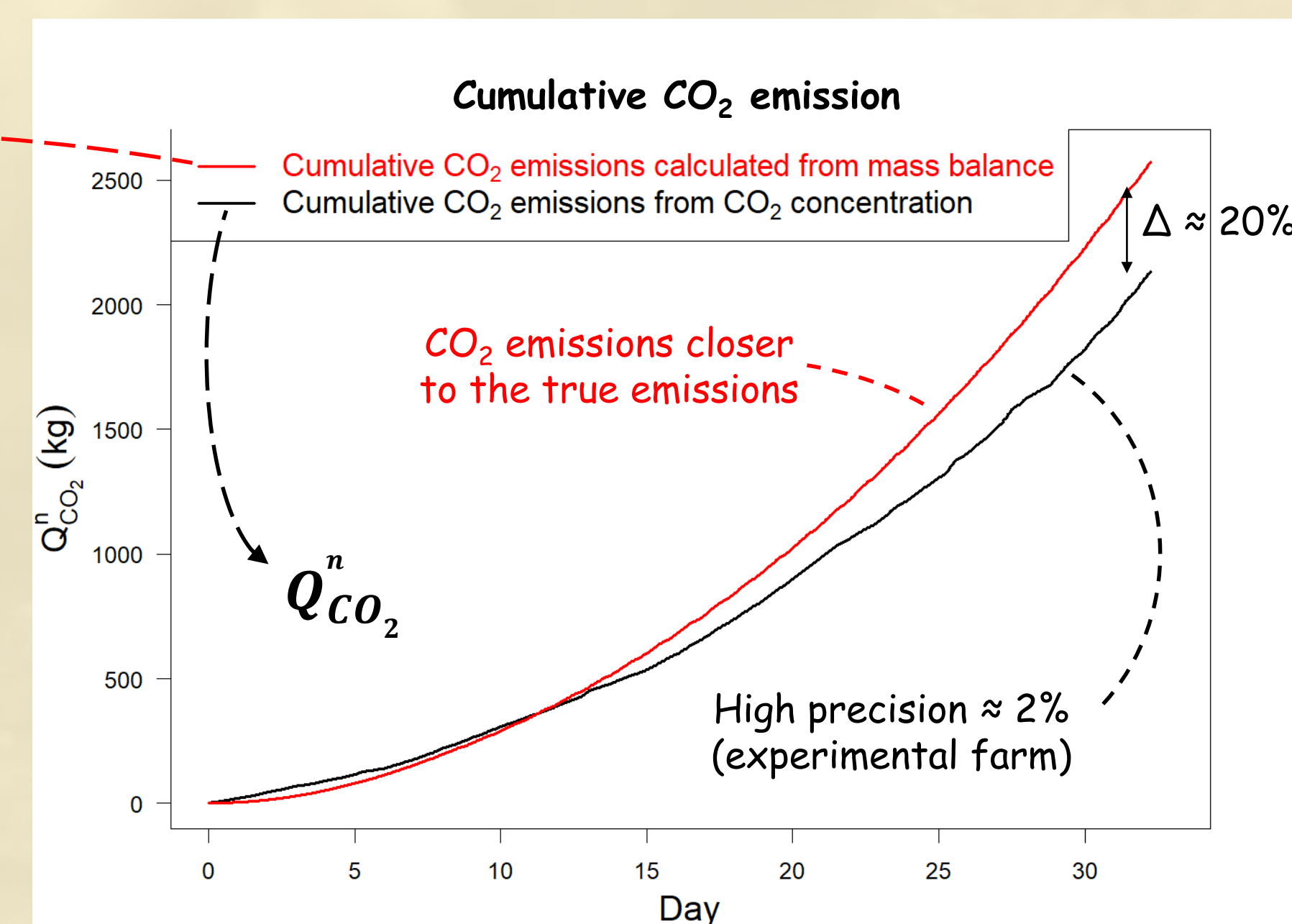


4- Calculate the carbon mass balance to improve measurement accuracy

$$C_{\text{Total_Input}} = C_{\text{LW_Initial}} + C_{\text{Feed}} + C_{\text{Bedding}} + C_{\text{Heating}}$$

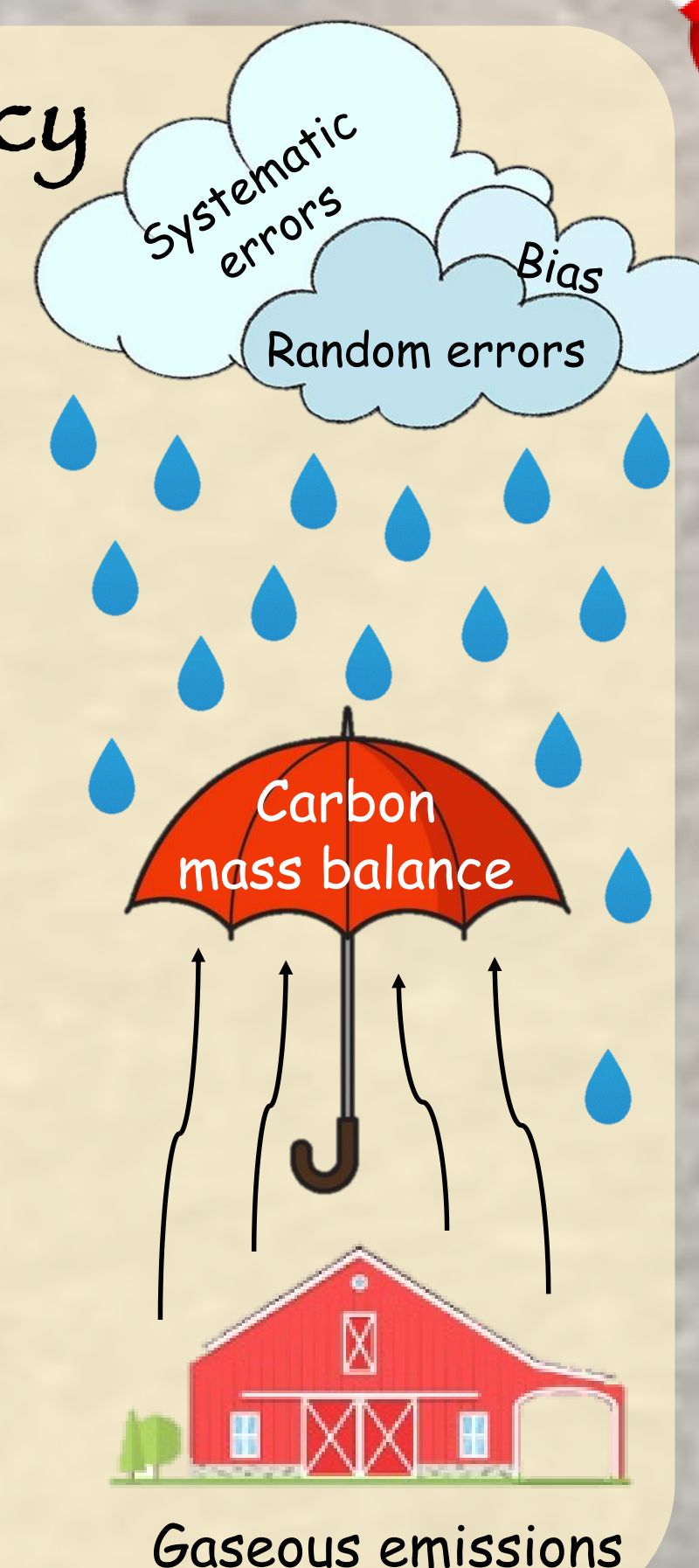
$$C_{\text{Total_Output}} = C_{\text{LW_Final}} + C_{\text{Death}} + C_{\text{Manure}} + C_{\text{CO}_2\text{Heating}} + C_{\text{CO}_2\text{E+M}}$$

E+M: Excretion + Manure
LW: Live Weight

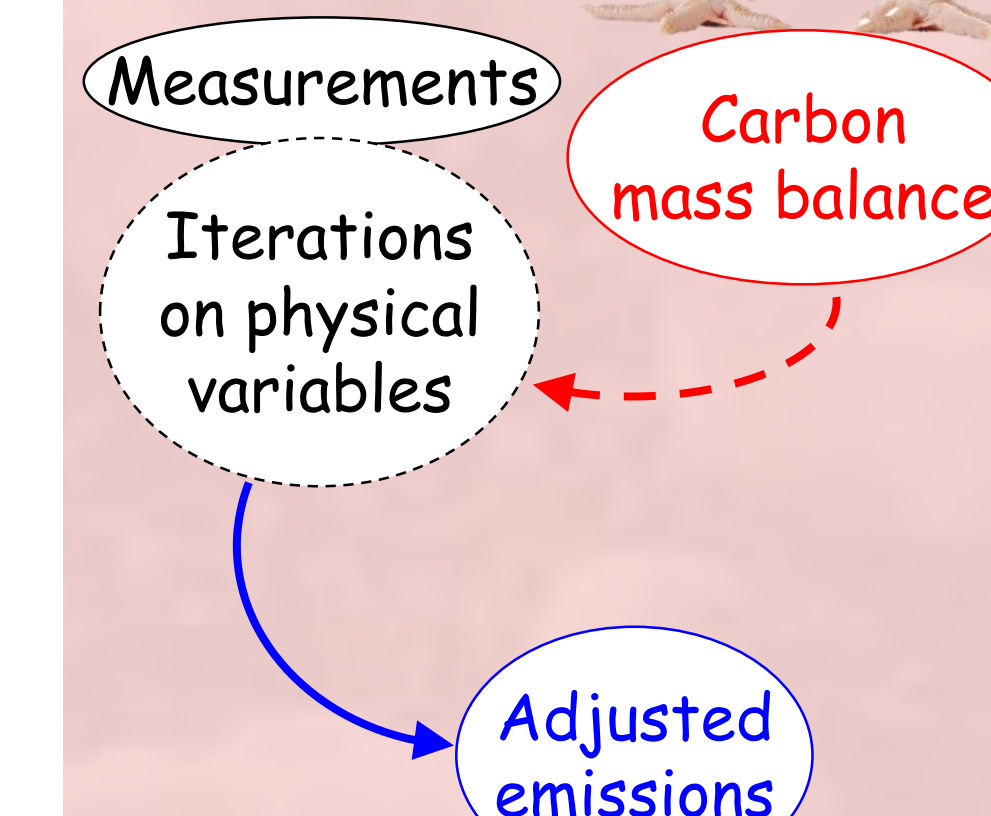
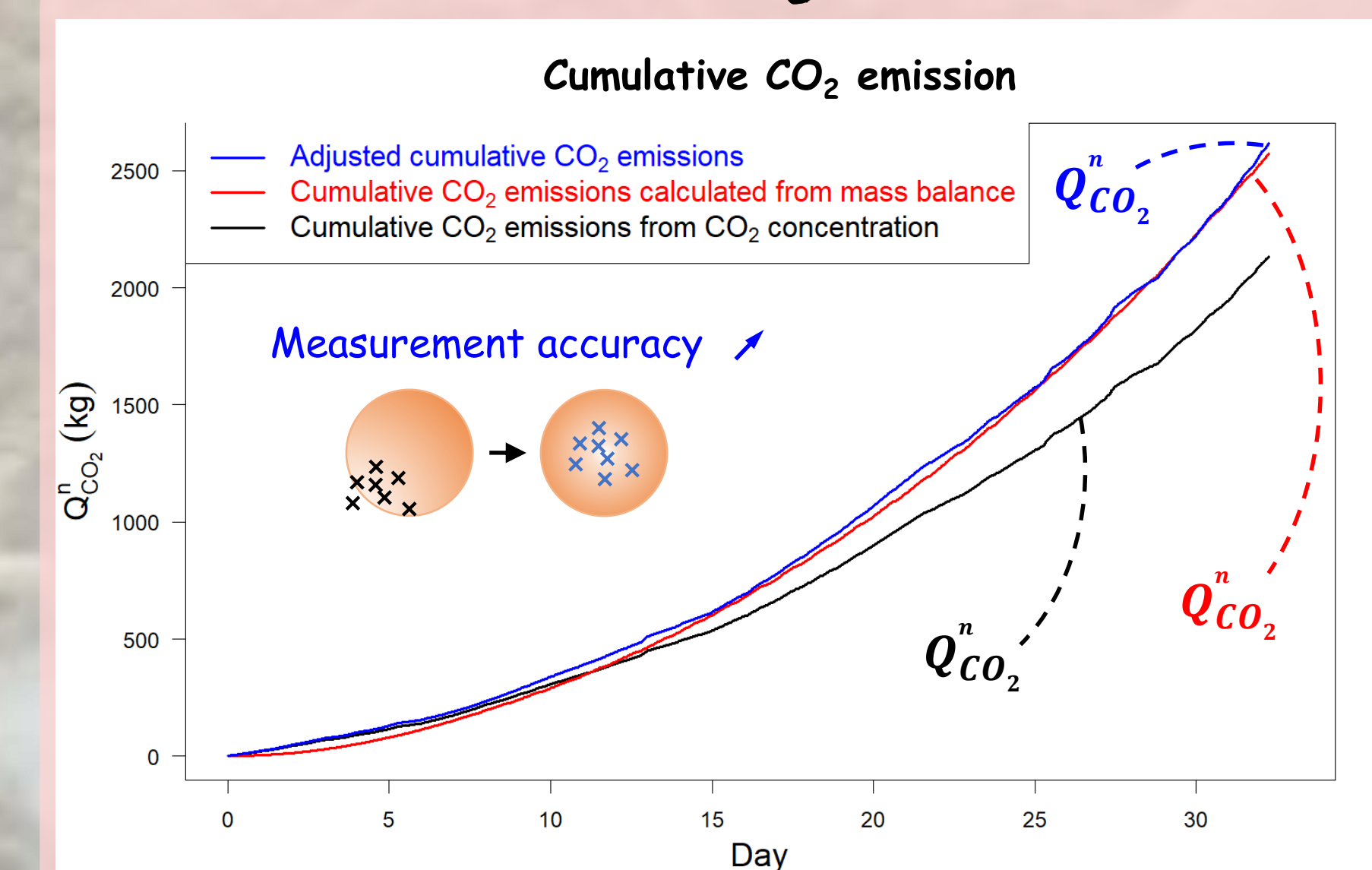


$$Q_{\text{CO}_2}^n = \frac{C_{\text{LW_Initial}} + C_{\text{Feed}} + C_{\text{Bedding}} + C_{\text{Heating}} - (C_{\text{LW_Final}} + C_{\text{Death}} + C_{\text{Manure}})}{\text{Carbon output}}$$

Why carbon? The total masses of carbon input and output provide independent and traceable measurements of carbon losses.



5- Calculate adjusted CO2 emissions



6- Perspectives

- Calculate adjusted NH_3 and N_2O emissions
- Calculate uncertainties in adjusted emissions and carbon mass balance

Acknowledgement of Metrology Partnership funding
The project 21GRD10 quantiAGREMI has received funding from the European Partnership on Metrology, co-financed from the European Union's Horizon Europe Research and Innovation Programme and by the Participating States.

