Dietary crude protein reduction in poultry diets allows to decarbonize poultry meat and egg production with different levels of expected benefits across segments

M. Durand, A. Mathiaud, C. Raybaud, P. Moquet, W. Lambert

Abstract n° 2213094

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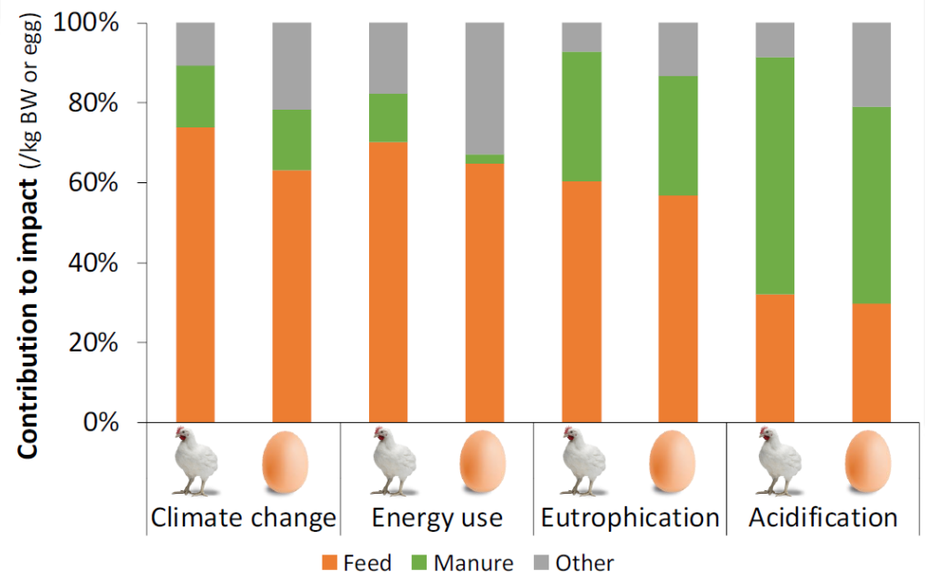
Context

Feed accounts for most of the environmental impacts of the poultry meat and egg production, regardless of the production method.



Acidification potential :

- majority explained by manure management
- only 20-40% explained by the feed

Importance of control excess in feed formulation

Carbon footprint:

70-80% explained by feed in poultry, and similar for eutrophication

link to imported soja content

Méda et al., 2019

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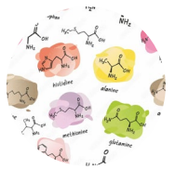
Objectives

Compile recently conducted poultry experiments with the same goal and methodology: studying **the impact of reduced dietary crude protein levels on meat poultry growth and laying performance,** as well as, **measuring the benefits in terms of carbon footprint and nitrogen efficiency**

REDUCTION OF CRUDE PROTEIN

CEREALS

PROTEIN-RICH FEEDSTUFFS



FREE AA

FORMULATION CONSTRAINTS

- Metabolizable energy: constant for all treatments within each experiment on a period.
- Dietary digestible Lysine supply: constant for all treatments within each experiment on a period.
- Dietary AA supply of other essential AA: controlled at least at the assumed requirement.

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Material and methods

	Broiler			Turkey	Duck	Laying hen
Genetics	**Ross308**	**JA787 (ECC)**	**S757N (Label)**	**Aviagen Premium**	**Mulard Hytop 85 A**	**Isabrown**
Sex	Male	Male	Male	Male	Male	Female
Trial period	0-42 days	0-56 days	0-56 days	0-42 days	0-43 days	15-30 weeks
Experimental period	0-42 days	21-56 days	21-56 days	0-42 days	8-43 days	18-30 weeks
Main feedstuffs	Wheat, SBM, Maize	Wheat, SBM, Maize	Wheat, SBM, Maize	Wheat, SBM, Maize	Wheat, SBM, Maize	Maize, Wheat, SBM
Level of CP's control (%)	Starter (0-10 d): 22.0 Grower (10-21 d): 20.5 Finisher (21-35 d): 18.5 Withdrawal (35-42 d): 17.5	Grower (21-35 d): 21.0 Finisher (35-56 d): 18.4	Grower (21-56 d): 17.1	Starter (0-21 d): 26.1 Transition (21-35 d): 24 Grower (35-42 d): 22.2	Starter (8-29 d): 18.5 Grower (29-43 d): 16.5	Laying1 (18-30 w): 17.0
Reduction of CP tested	-1 and -2 pts	-1.2, -2.3 and -3.2 pts	-1.1, -2 and -2.9 pts	- 2 pts	- 2 and -3 pts	-1.5 and -3 pts
Level tested (mg dLys /pt CP)	Starter: 55 to 61 Grower: 54 to 60 Finisher: 52 to 58 Withdrawal: 54 to 61	Grower: 49 to 58 Finisher: 49 to 58	Grower: 45 to 54	Starter: 57 to 62 Transition: 56 to 61 Grower: 56 to 62	Starter: 48 to 57 Grower: 47 to 53	41 to 50

What is the reduction level of CP achievable without compromising meat poultry growth or laying performance ?

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Material and methods

Broilers, ducks, turkeys:

- **Measurement on animal :** Body weight (BW), Average daily gain (ADG), Average Daily Feed Intake (ADFI) , Feed intake (FI), Feed conversion ratio (FCR), FCR corrected by BW
- **Calculation of N efficiency** (based on Belloir *et al.*, 2017)
  - N_{effi} *(%)* = 100 x N_{ret} *(g/j)* / N_{intake} *(g/j)*
    - N_{intake} *(g/j)* = FI *(g/j)* * CP_{diet} *(%)* / 6.25
    - N_{ret} *(g/j)* = N_{body} *(29 g/kg)* * (BWgain *(g/j) /1000)*
  - N_{exc} *(g/j)* = N_{intake} *(g/j)* - N_{ret} *(g/j)*
- **Linear Mixed-Effects models:**
  - Var. : treatment (protein level)
  - Covar. : BW at start
  - Random effect : pen

Layers:

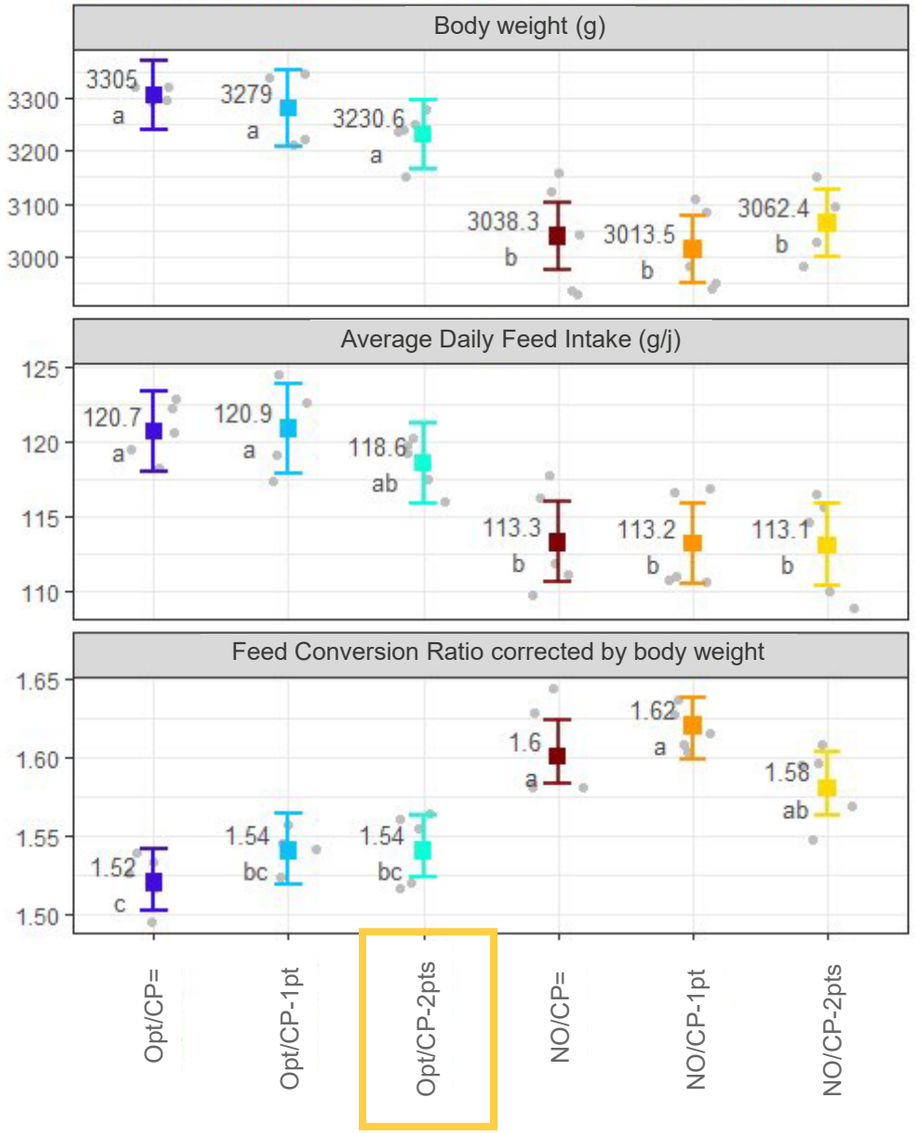
- **Measurement on animal :** Egg weight and quality, Laying Rate, Average Daily Feed Intake (ADFI) , Feed intake, Feed conversion ratio (FCR), FCR corrected by BW
- **Calculation of N efficiency** (based on Barzegar *et al.*, 2019)
  - N_{effi} *(%)* = 100 x N_{ret} *(g/j)* / N_{intake} *(g/j)*
    - N_{intake} *(g/j)* = FI *(g/j)* * CP_{diet} *(%)* / 6.25
    - N_{ret} *(g/j)* = N_{body} *(g/kg)* * (BWgain *(g/j) /1000)* + N_{egg} *(%)* * Egg mass *(g/j)*
  - N_{exc} *(g/j)* = N_{intake} *(g/j)* - N_{ret} *(g/j)*
- **Linear Mixed-Effects models:**
  - Var. : treatment (protein level)
  - Covar. : quadratic effect of week
  - Random effect : cage, week of age (repeated measures).

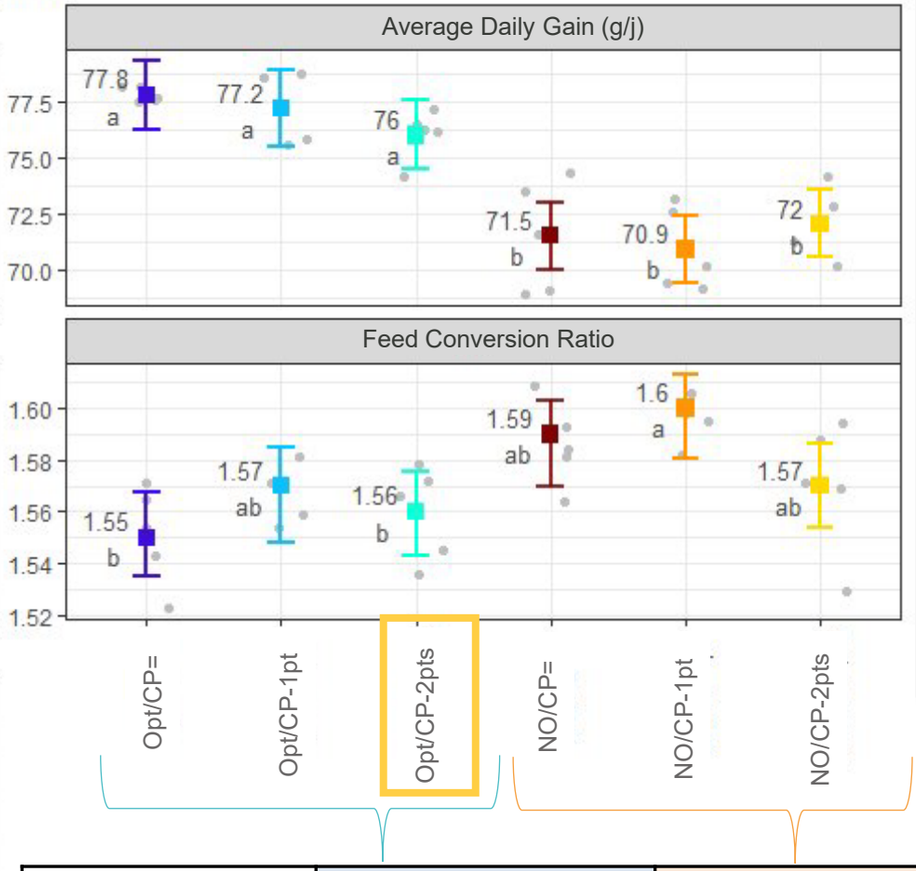
If there are **not significant difference (p > 0.05)** between control and treatment, that means that the **reduction level is achievable without compromising performance.**

Raybaud *et al.*, 2022

Exemple in broiler Ross 308

Effects of reducing dietary crude protein under two different sanitary conditions on performance & environmental impacts of Ross 308 broiler chickens, at 0-42 days





	Broiler
Genetics	Ross308
Sex	Male
Trial period	0-42 days
Experimental period	0-42 days
Age	0-42 days
Level of CP in control diet (%)	Starter (0-10 d): 21.8 Grower (10-21 d): 20.3 Finisher (21-35 d): 18.3 Withdrawal (35-42 d): 17.3
Reduction of CP tested	-1 and -2 pts
Level tested (mg dLys / pt CP)	Starter: 55 to 61 Grower: 54 to 60 Finisher: 52 to 58 Withdrawal: 54 to 61

	Optimal	Suboptimal
Paracox vaccination	No	At d0 and d9 on farm
Coccidiostat use	Diclazuril in feed	No
Litter	Wood shavings	Long straw
Density	15.3kg/m^2 (40 birds/pen)	18.1kg/m^2 (47 birds/pen)

Synthesis

	Ross 308	ECC	Label	Turkey	Duck	Layer
Experimental period	0-42 days	21-56 days	21-56 days	0-42 days	8-43 days	18-30 weeks
Level achievable (mg dLys / pt CP)	58-61*	52-55**	48-51**	61-62*	53-57*	45
Evolution of CP diet (pts)	**-2**	**-1.2 to -2.3****	**-1.1 to -2****	**-2**	**-2**	**-1.5**

*Depending on the period evaluated
** Depending of the criteria to optimised

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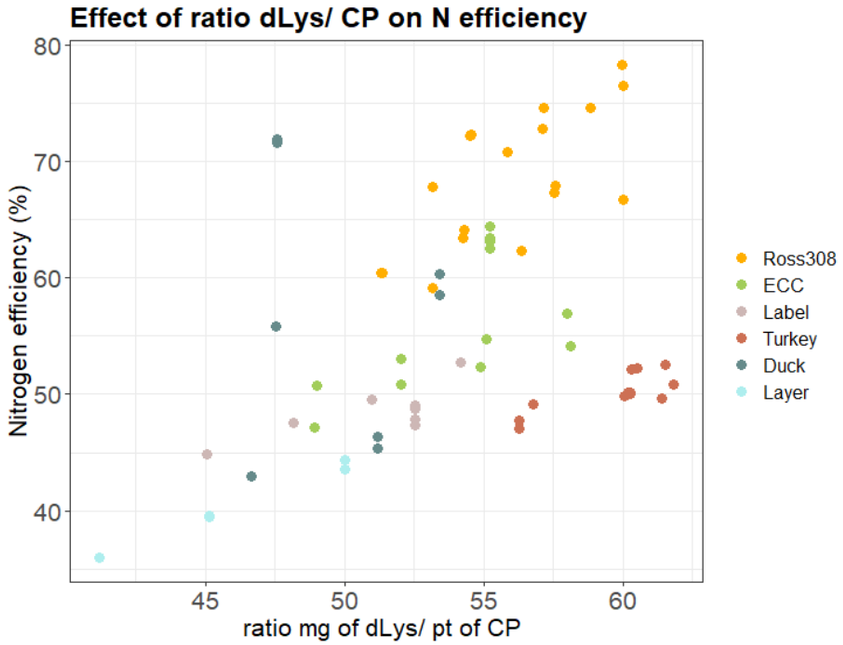
Evolution of CP diet (pts)	**-2**	**-1.2 to -2.3****	**-1.1 to -2****	**-2**	**-2**	**-1.5**
N efficiency of control diet (%)	62.38	51.20	45.66	47.82	50.79	35.99
Evolution of N efficiency (pts)	**+7.6**	**+2.6 to +3.9 ****	**+2.2 to +3.5****	**+2.7**	**+3.8**	**+3.4**



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Key points :

- Reduction of CP by 1 to 2 pts link to differences in lys/CP content
- Increase of N efficiency by to 2 to 7 pts with a reduction of N losses

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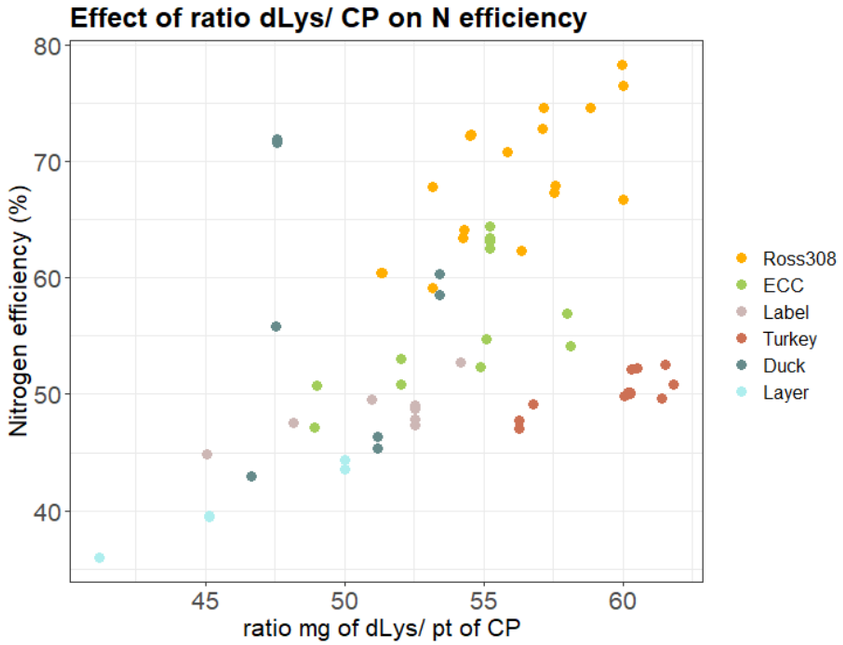
N excreted of control diet (g/d)	1.24	1.75	1.02	1.75	1.91	1.87
Evolution of N excreted (%)	**-29.0**	**-10.3 to -16.0****	**-13.7 to -32.4****	**-6.9**	**-16.2**	**-14.6**



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How the reduction level of CP achievable impact carbon footprint ?

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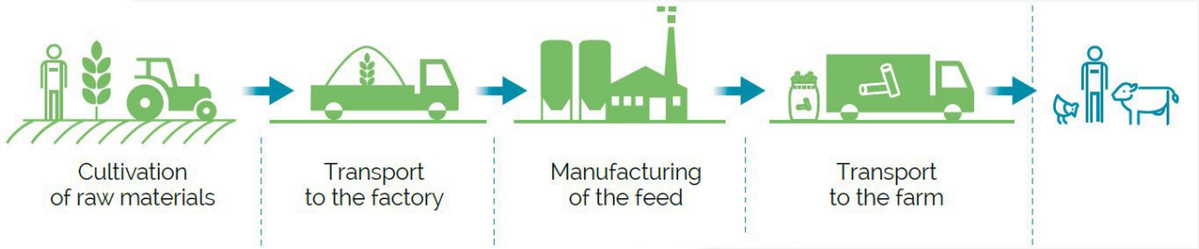
Material and methods

- maTREEx® was used to calculate **carbon footprint** of diets based on GFLI 2022 for imported raw materials and EcoAlim 2023 for French raw materials and additives (e.g. amino acids in two origin context: EU. *vs.* CN.)



maTREEx Matrix and Environmental Footprint Calculation

gfli

carbone4

ECOALIM database

Broilers, ducks, turkeys:

Carbon footprint *(kg de CO2 eq / T of live weight)* =

Carbon footprint of diet *(kg de CO2 eq / T of diet)* / FCR

Layers:

Carbon footprint *(kg de CO2 eq / kg of eggs)* =

Carbon footprint of diet *(kg de CO2 eq / T of diet)* * FCR

- FCR = Feed intake *(g/week)* / egg mass *(g/week)*
- Egg mass = mean egg weight *(g/egg)* * laying rate *(%)* / 100 * 7

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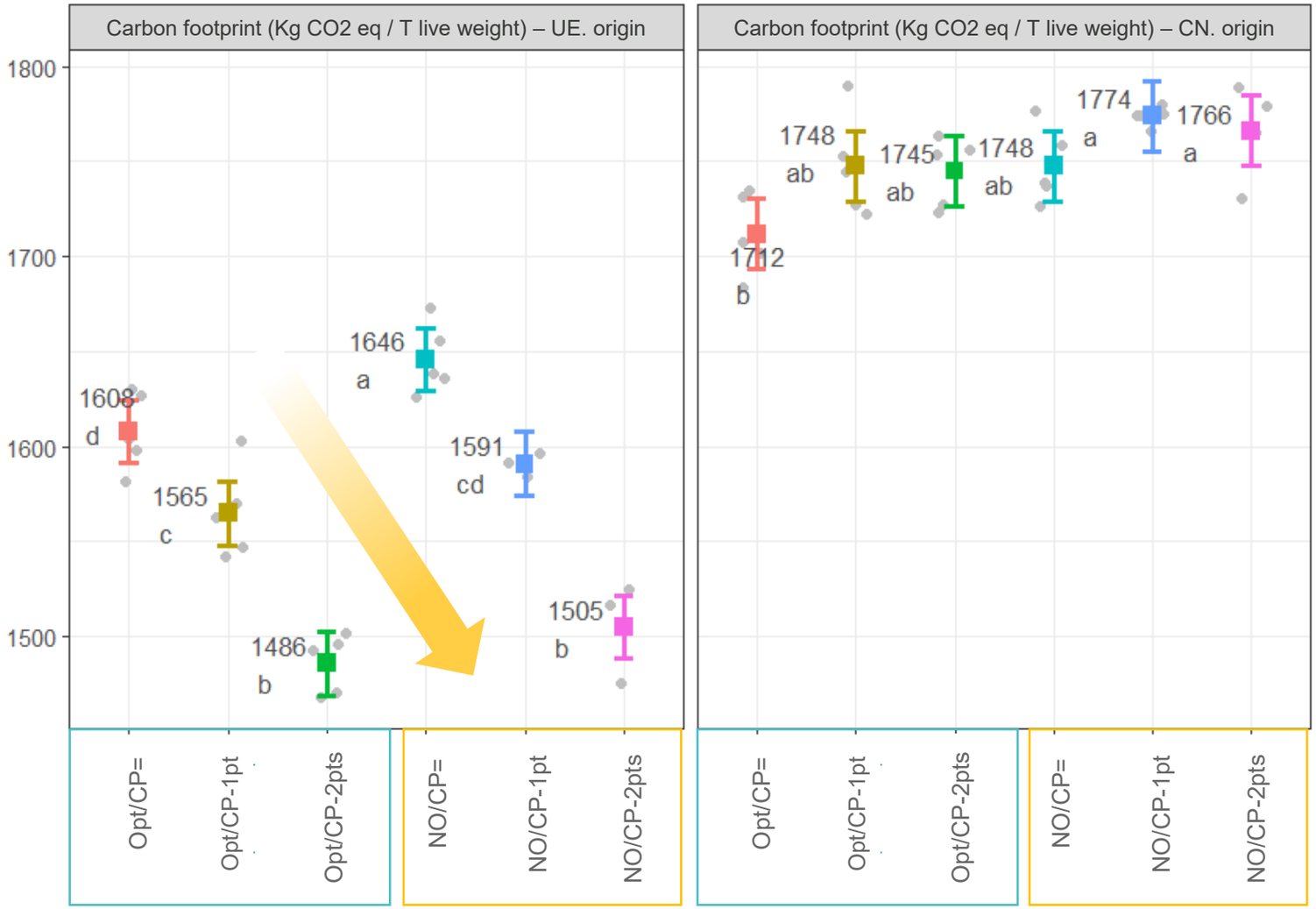

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Synthesis

In bold if p < 0.05
*Depending on the period evaluated
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	Ross 308		ECC		Label		Turkey		Duck		Layer	
AA origin	**EU**	**CN**	**EU**	**CN**	**EU**	**CN**	**EU**	**CN**	**EU**	**CN**	**EU**	**CN**
Experimental period	0-42 days		21-56 days		21-56 days		0-42 days		8-43 days		18-30 weeks	
Level achievable (mg dLys / pt CP)	58-61*		52-55**		48-51**		61-62*		53-57*		45	
kg CO2eq / t of live weight (or eggs) of control diet	1608	1712	1640	1685	1708	1754	1820	1863	1486	1514	1790	1790
Reduction, as a % of control	**-8.4 %**	+1.9 %	-1.8 to -**2.5 %**	+0.1 to +2.0%	+0.1 to +0.6 %	+0.6 to +1.3 %	-1.2 %	**+5.7 %**	**-8.2 %**	+0.1%	**-7.3 %**	-1.2 %

Synthesis

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AA origin	**EU**	**CN**	**EU**	**CN**	**EU**	**CN**	**EU**	**CN**	**EU**	**CN**	**EU**	**CN**
Experimental period	0-42 days		21-56 days		21-56 days		0-42 days		8-43 days		18-30 weeks	
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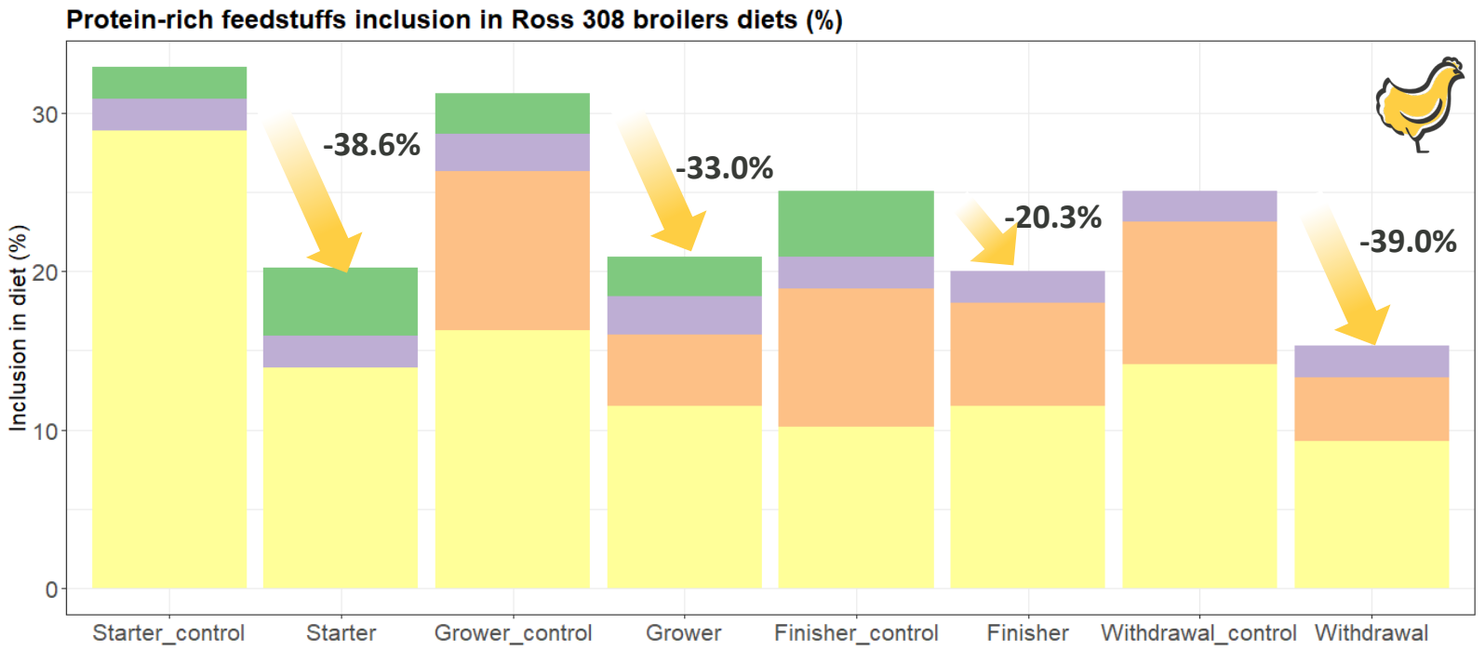
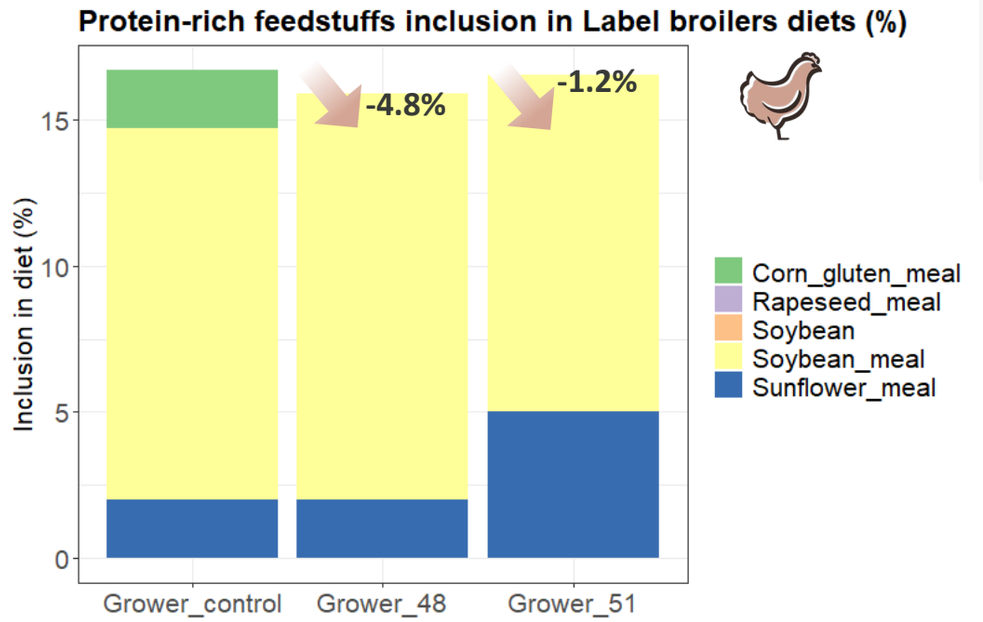
Reduction, as a % of control diet	**-8.4 %**	+1.9 %	-1.8 to -**2.5 %**	+0.1 to +2.0%	+0.1 to +0.6 %	+0.6 to +1.3 %	-1.2 %	**+5.7 %**	**-8.2 %**	+0.1%	**-7.3 %**	-1.2 %
% of protein-rich feedstuffs	-20.3 to -39.0 %*		- 8.6 to -20.4 %**		-1.2 to -4.8 %**		-11.8 to -44.7 %*		-18.0 to -36.3 %*		-18.0 %	





Conclusion

Dietary crude protein reduction in poultry diets allows to decarbonize poultry meat and egg production with different levels of expected benefits across segments

- Reduction of CP by 1 to 2 pts without compromising performance, with differences in lys/CP content : lowest in layer and highest in turkey.
- Clear environmental benefits: Increase of N efficiency by to 2 to 7 pts, with a reduction of N excretion between -7 to -32 %.
- Benefit on carbon footprint on the majority of segment (Ross broiler (-8%), ECC broiler (-2%), duck (-8%) and layer (-6%)) in a context of european amino acid, linked to the reduction of imported soja content.

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Thank you for your attention

Special thanks to MRC, Eurolysine and Mixscience teams

MiXscience Research Center

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