

# Reducing environmental impact of broiler production: The role of crude protein and soybean meal

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# Low crude protein diet has the potential to reduce nitrogen volatilisation & soybean meal use

LCP diet are used to :

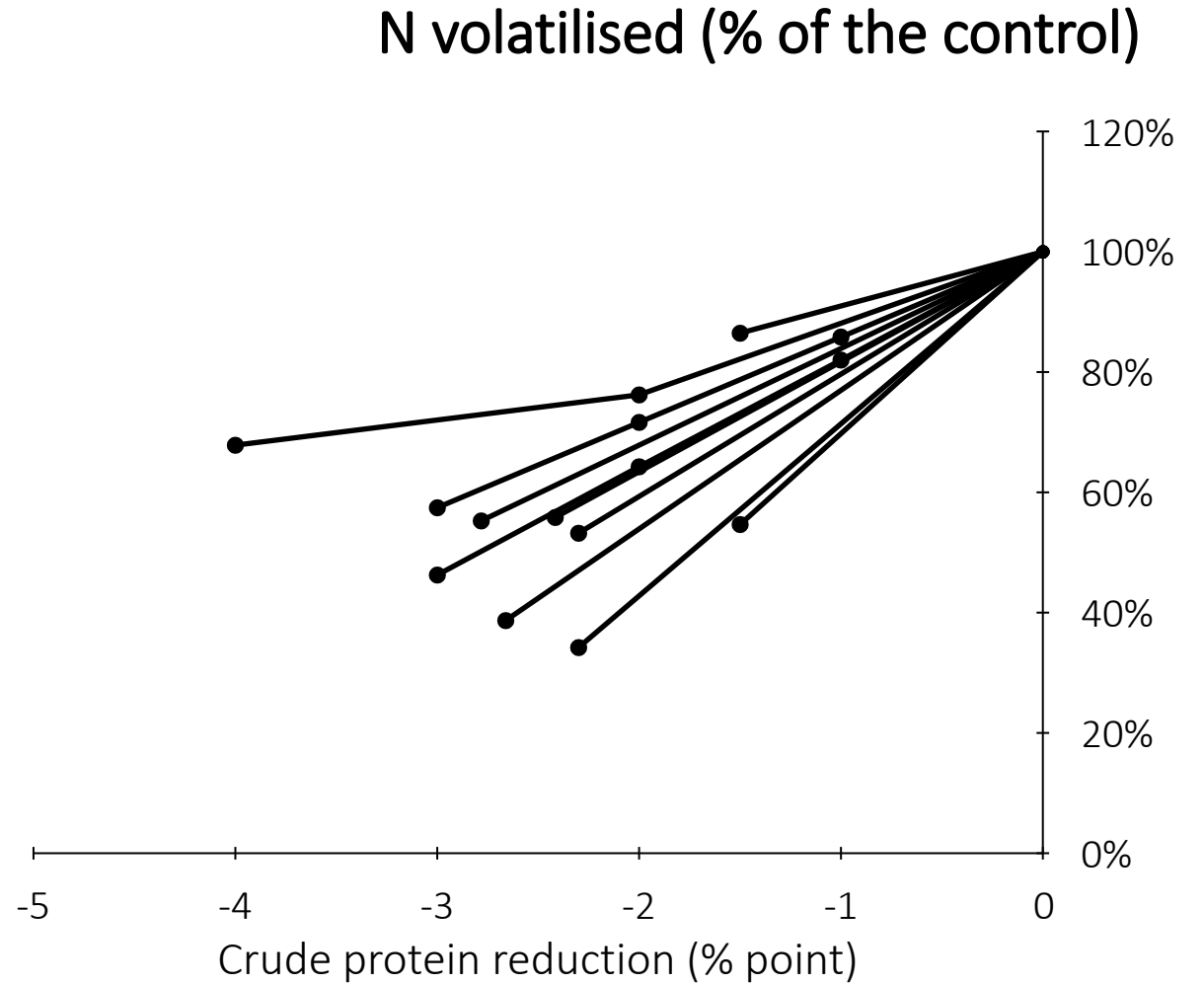
↓ N volatilisation

↓ Acidification  
Eutrophication

↑ Closing the N cycle



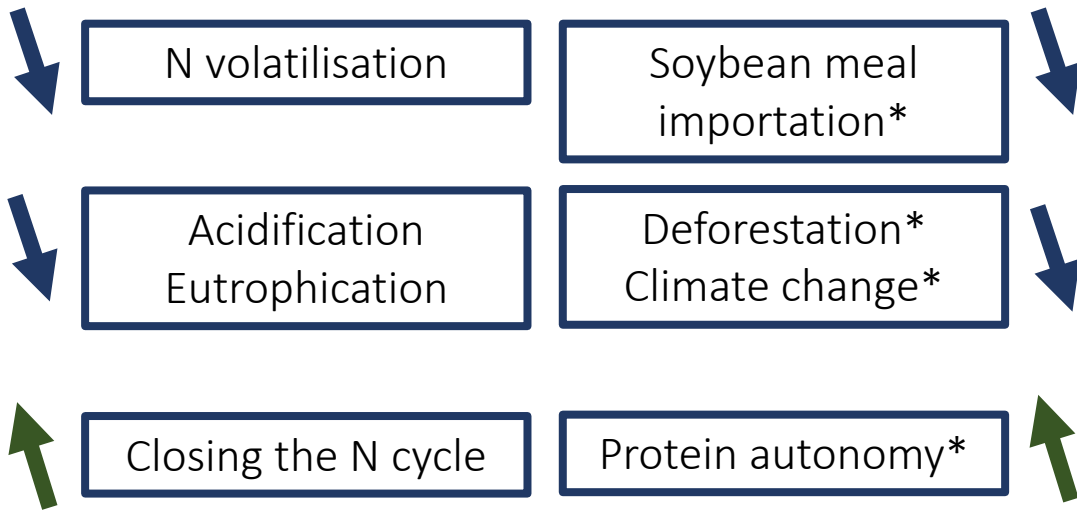
**Increase sustainability**



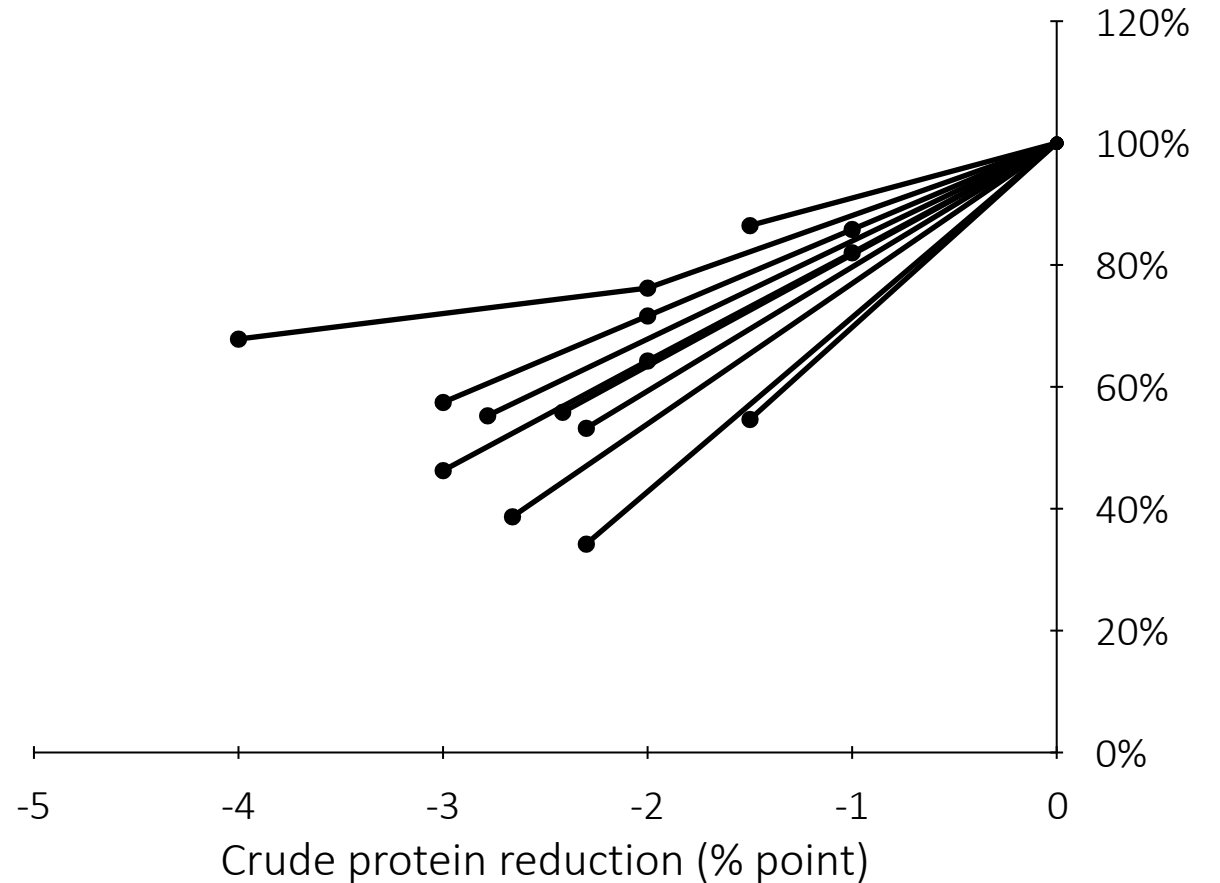
Belloir et al., 2017; Van Emous et al., 2019; Elwinger et al., 1990; Wiedeman et al., 2016; Méda et al., 2019; de Rauglaudre et al., unpublished data

# Low crude protein diet has the potential to reduce nitrogen volatilisation & soybean meal use

LCP diets are used to :



N volatilised (% of the control)

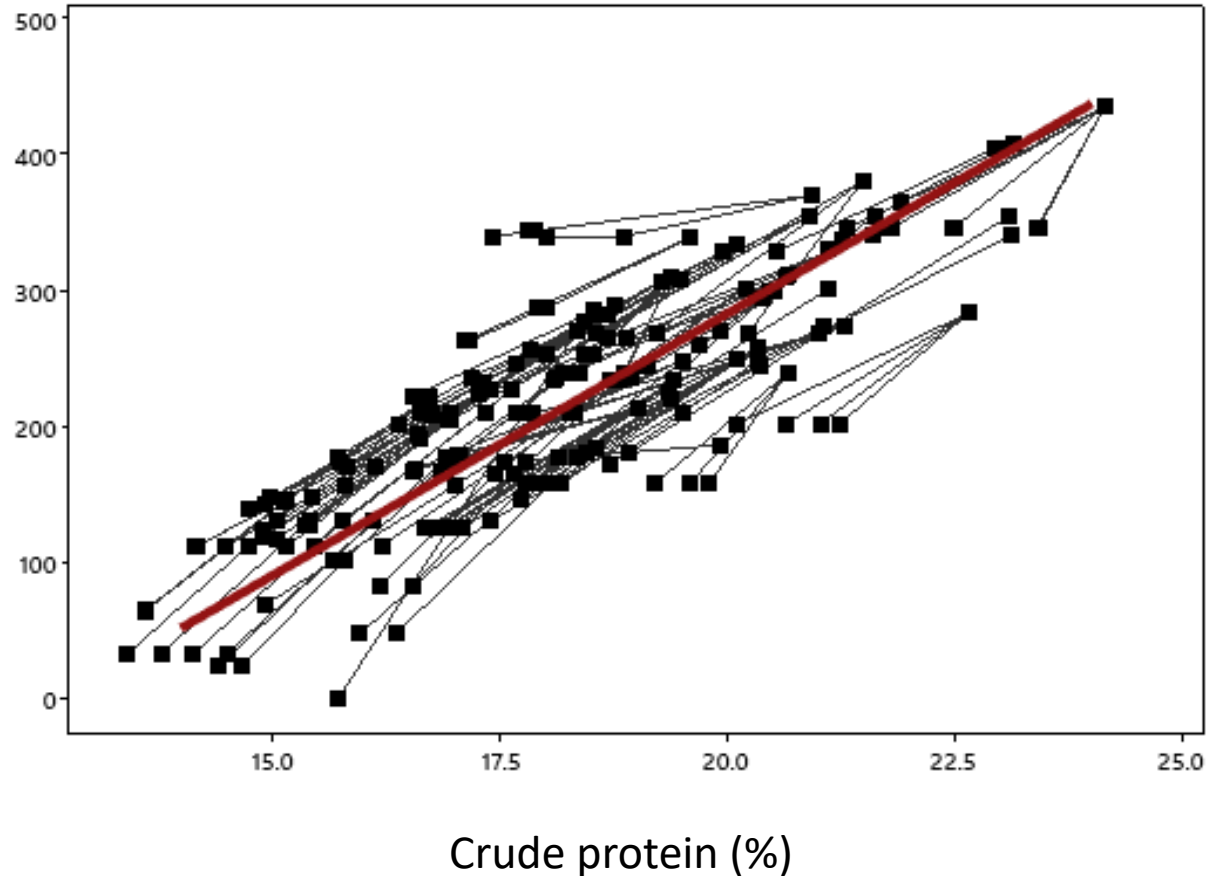


\* Belloir et al., 2017; Van Emous et al., 2019; Elwinger et al., 1990; Wiedeman et al., 2016; Méda et al., 2019; de Rauglaudre et al., unpublished data

## Introduction

In most low crude protein trials, the effects of crude protein & soybean meal are confounded

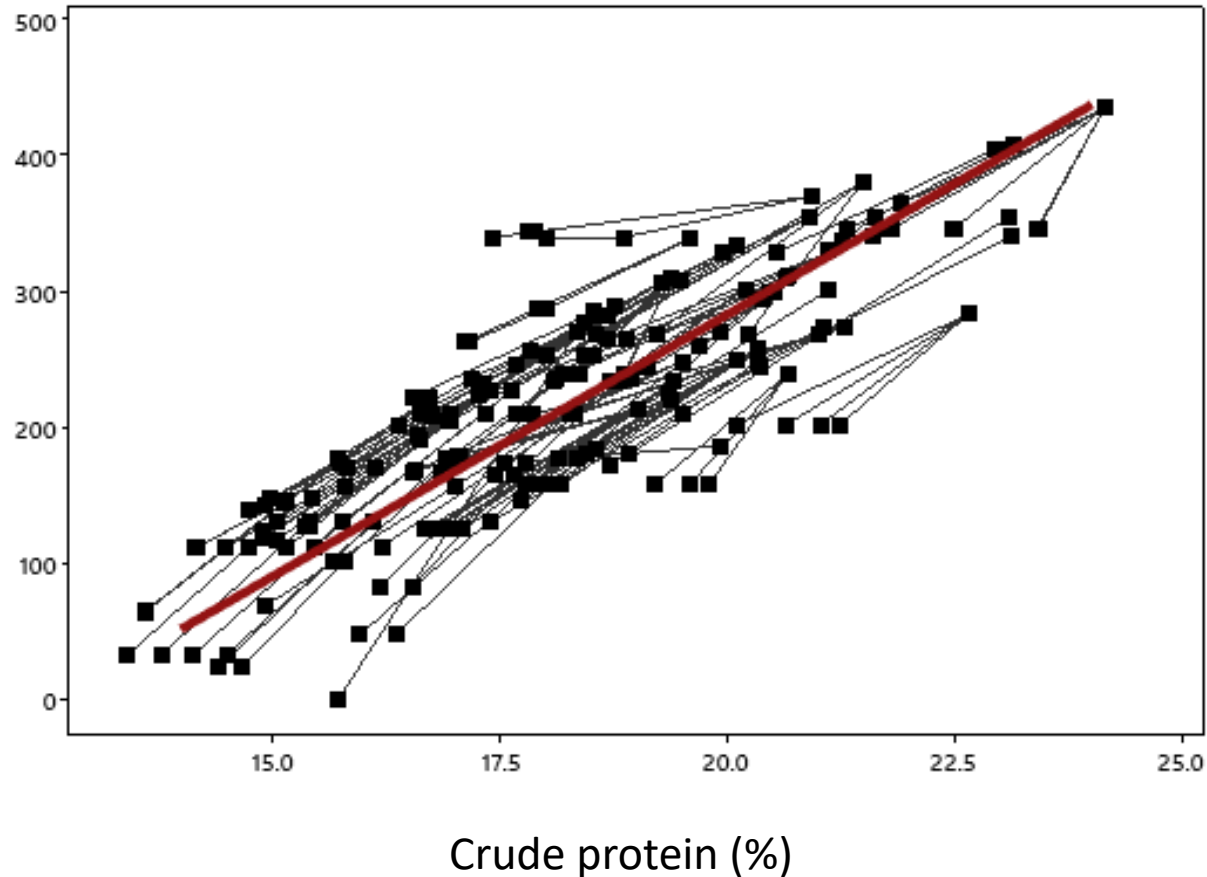
Soybean Meal (g/kg)



## Introduction

In most low crude protein trials, the effects of crude protein & soybean meal are confounded

Soybean Meal (g/kg)

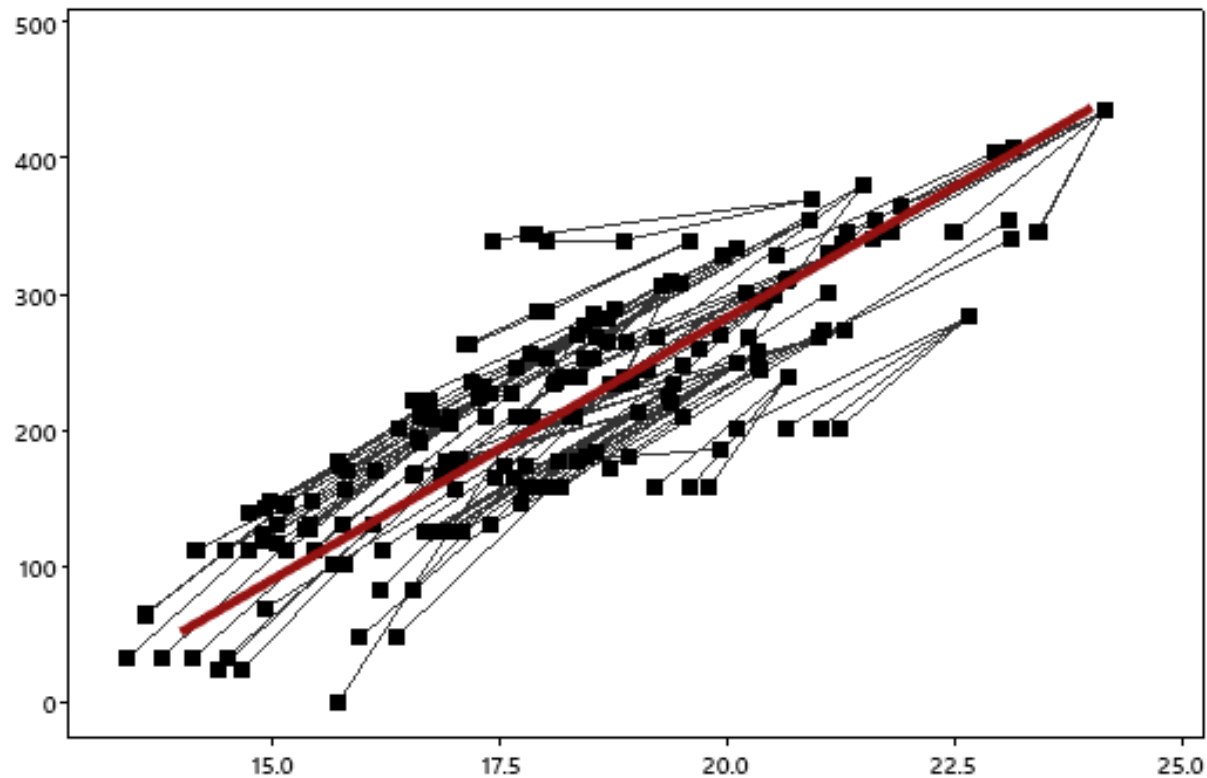


- ↓ K
- ↓ DEB
- ↑ Starch
- ↓ Sugar
- ↓ Fat
- ...

## Introduction

In most low crude protein trials, the effects of crude protein & soybean meal are confounded

Soybean Meal (g/kg)



Crude protein (%)



K



DEB



Starch



Sugar



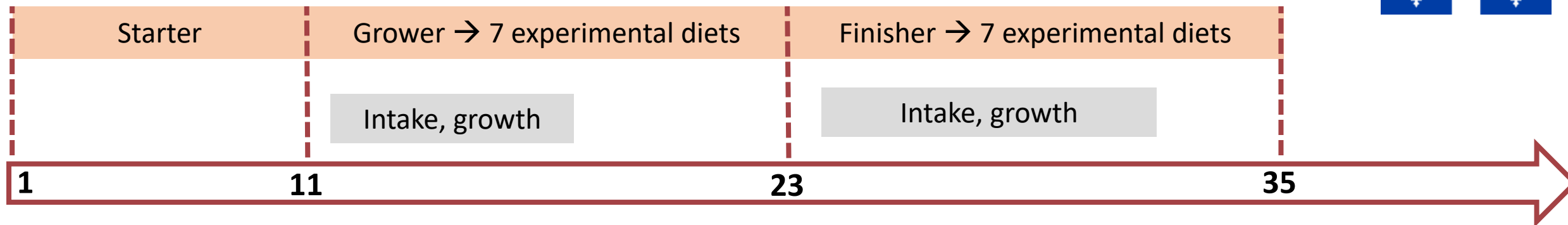
Fat

...

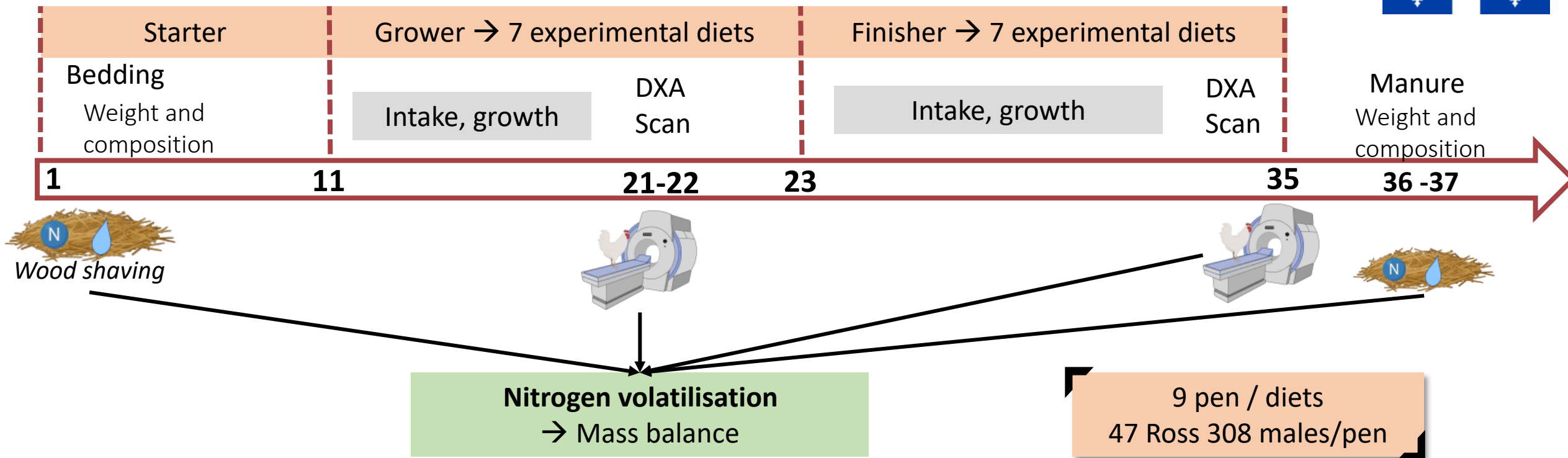
How low can we reduce protein and soybean meal contents?

Which effects on N flows?

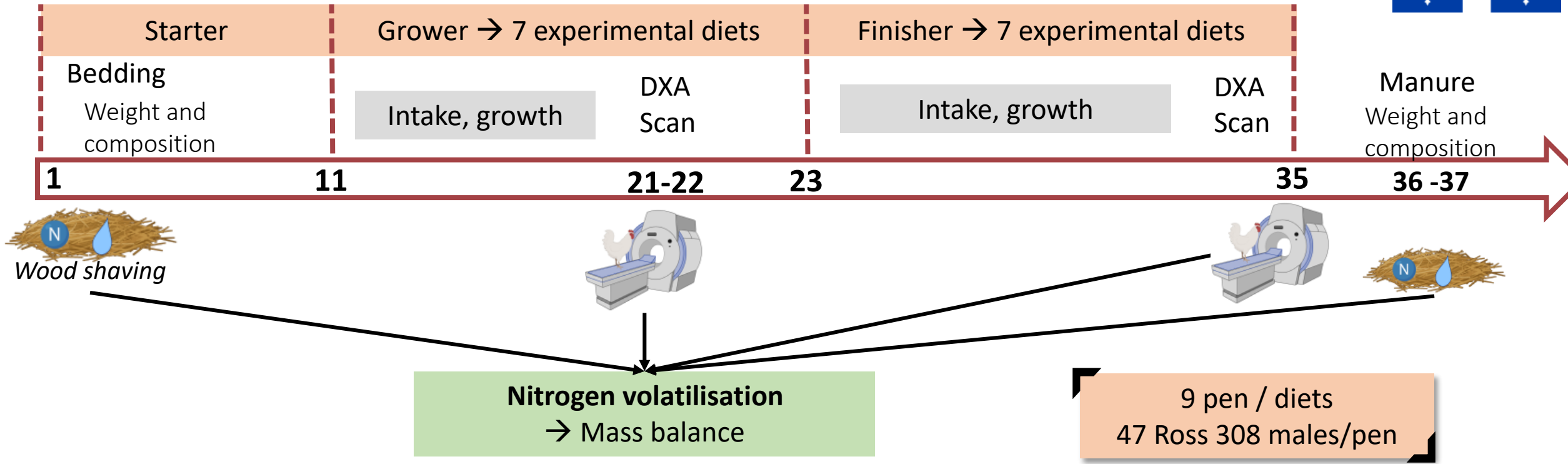
# Experimental design



# Experimental design



# Experimental design



	A	B	C	D	E	F	G
	Control	-1.5 Soya	-1.5 Mixed	-1.5 Soya free	-3 Soya	-3 Mixed	-1.5 Soya free
11-22 day, CP (%)		-1,5 % CP			-3 % CP		
23-35 day, CP (%)		-1,5 % CP			-3 % CP		





















## Experimental Feeds

	10-23 days							23-35 days							
kg/Tonne	A	B	C	F	E	F	G		A	B	C	F	E	F	G
<b>Corn</b>	524	555	533	512	590	584	578		551	588	565	542	624	617	611
<b>Wheat</b>	100	100	100	100	100	100	100		100	100	100	100	100	100	100
<b>Soybean meal</b>	230	190	95	-	167	83.5	-		211	183	91.6	-	150	75	-
<b>Canola meal</b>	22	42	125	208	47	96.5	146		17	20	99.5	179	35	75.5	116
<b>DDGS</b>	50	50	75	100	50	75	100		50	50	75	100	50	75	100
<b>Corn Gluten</b>	40	25	25	25	-	10.5	21		40	25	25	25	-	10.5	21
<b>Soya oil</b>	-	-	5.5	11	-	-	-		1	-	6	12	-	-	-
<b>Other</b>	28	29	28	26	30	29	29		25	25	25	24	26	26	26
<b>Free AA</b>	<i>5.46</i>	<i>8.93</i>	<i>13.58</i>	<i>18.23</i>	<i>15.48</i>	<i>20.86</i>	<i>26.22</i>		<i>5.44</i>	<i>8.90</i>	<i>13.37</i>	<i>17.93</i>	<i>15.78</i>	<i>20.88</i>	<i>25.95</i>
<b>CP, %</b>	20.4		19.0			17.5			19.5		18.0			16.5	
<b>SID Lys, %</b>				1.00								0.95			
<b>AMEn, kcal/kg</b>				3010								3050			
<b>Starch, %</b>	41.9	43.4	41.9	40.4	45.2	44.9	44.6		43.4	45.4	43.9	42.4	47.2	46.9	46.6
<b>DEB, mEq/kg</b>	212	210	195	180	210	189	169		202	190	185	179	181	173	166
<b>Fat, %</b>	2.7	2.8	3.5	4.1	2.9	3.0	3.1		2.9	2.9	3.5	4.2	2.9	3.0	3.1
<b>ADL, %</b>	0.9	1.1	2.2	3.3	1.2	1.8	2.5		0.8	0.9	1.9	2.9	1.1	1.6	2.1
























## Experimental Feeds

kg/Tonne	10-23 days			23-35 days		
	A	B	E	A	B	E
Corn	524	555	590	551	588	624
Wheat	100	100	100	100	100	100
Soybean meal	230	190	167	211	183	150
Canola meal	22	42	47	17	20	35
DDGS	50	50	50	50	50	50
Corn Gluten	40	25	-	40	25	-
Soya oil	-	-	-	1	-	-
Other	28	29	30	25	25	26
Free AA	5.46	8.93	15.48	5.44	8.90	15.78
CP, %	20.4	19.0	17.5	19.5	18.0	16.5
SID Lys, %	1.00			0.95		
AMEn, kcal/kg	3010			3050		
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## Experimental Feeds

kg/Tonne	10-23 days				23-35 days				
	B	C	F		B	C	F		
Corn	555	533	512		Corn		588	565	542
Wheat	100	100	100		SBM		100	100	100
Soybean meal	190	95	-		Canola		183	91.6	-
Canola meal	42	125	208		DDGS		20	99.5	179
DDGS	50	75	100		Oil		50	75	100
Corn Gluten	25	25	25		Free AA		25	25	25
Soya oil	-	5.5	11				-	6	12
Other	29	28	26				25	25	24
Free AA	8.93	13.58	18.23				8.90	13.37	17.93
CP, %	19.0						18.0		
SID Lys, %		1.00						0.95	
AMEn, kcal/kg		3010						3050	
Starch, %	43.4	41.9	40.4		Starch		45.4	43.9	42.4
DEB, mEq/kg	210	195	180		DEB		190	185	179
Fat, %	2.8	3.5	4.1		Fat		2.9	3.5	4.2
ADL, %	1.1	2.2	3.3		Lignin		0.9	1.9	2.9

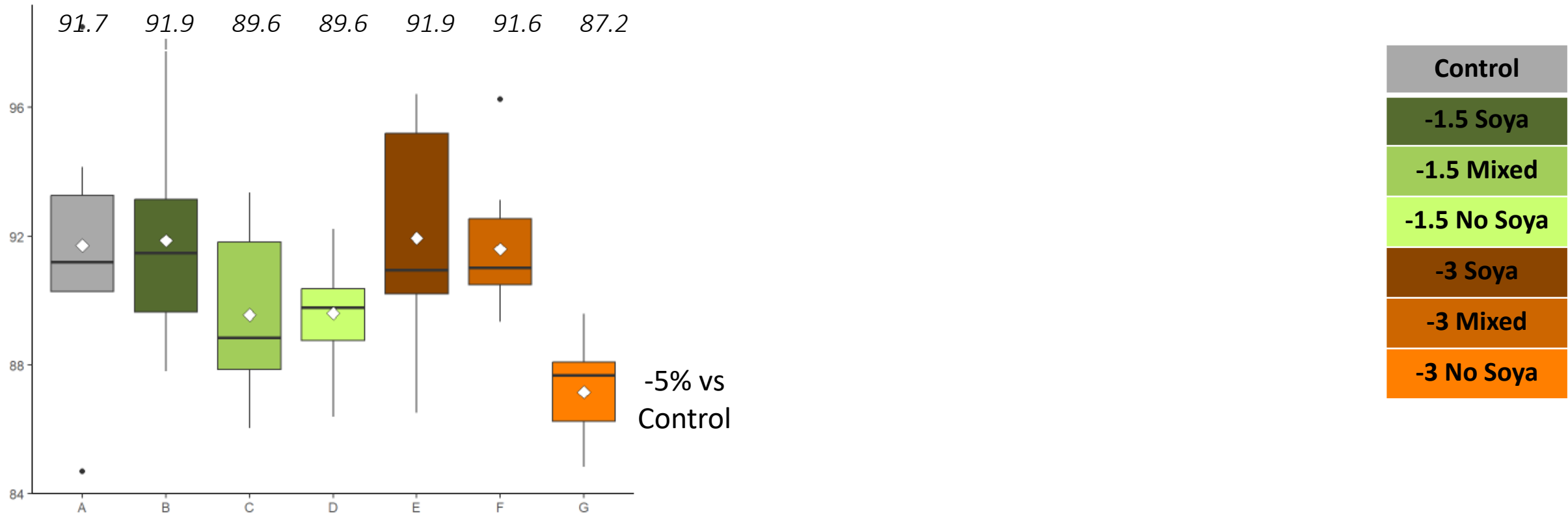
## Experimental Feeds

kg/Tonne	10-23 days				23-35 days				
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Free AA	8.93	13.58	18.23		Free AA	15.78	20.88	25.95	
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ADL, %	1.1	2.2	3.3		Lignin	1.1	1.6	2.1	

# Results

**10-35 days :** The gain was decreased by the canola inclusion in interaction with the CP reduction

**Average daily gain (g/j)**



**Crude protein**

**Feedstuff**

**Interaction**

Linear

Quadratic

Linear

Quadratic

Contrast test

A vs [E, F, G]

A vs [B,C,D] vs[E, F, G]

[B,E] vs [D,G]

[B,E] vs [C,F] vs [D,G]

B vs D

E vs G

ADG

NS

NS

P<0.001

NS

NS

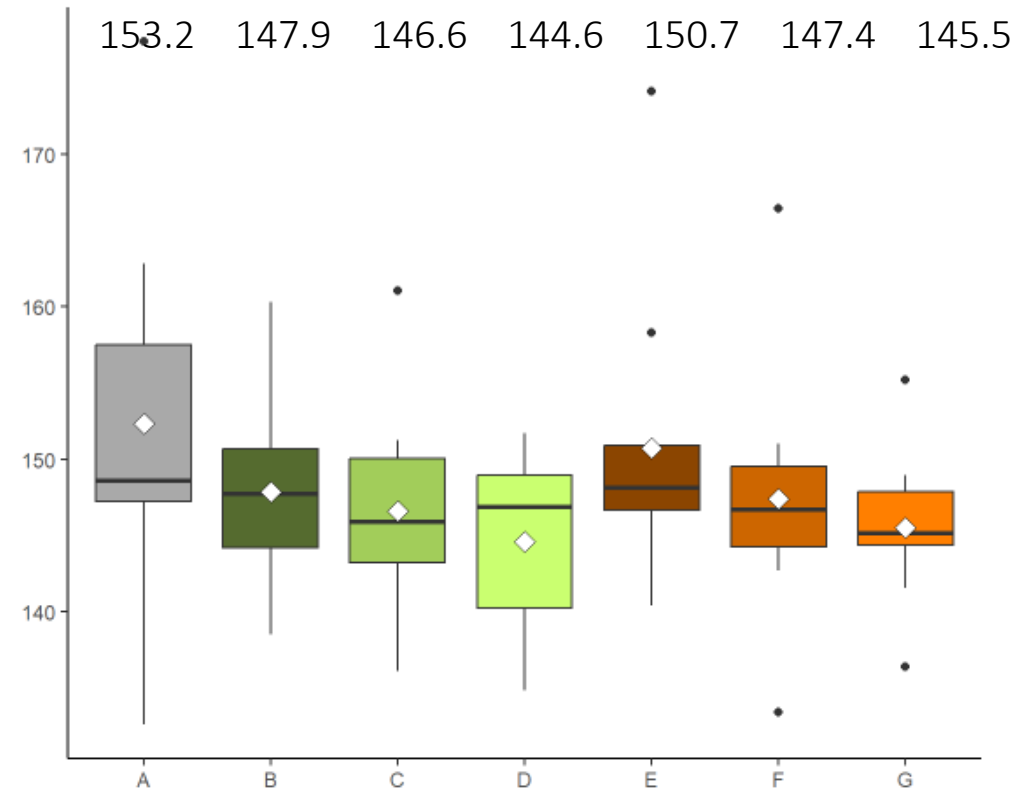
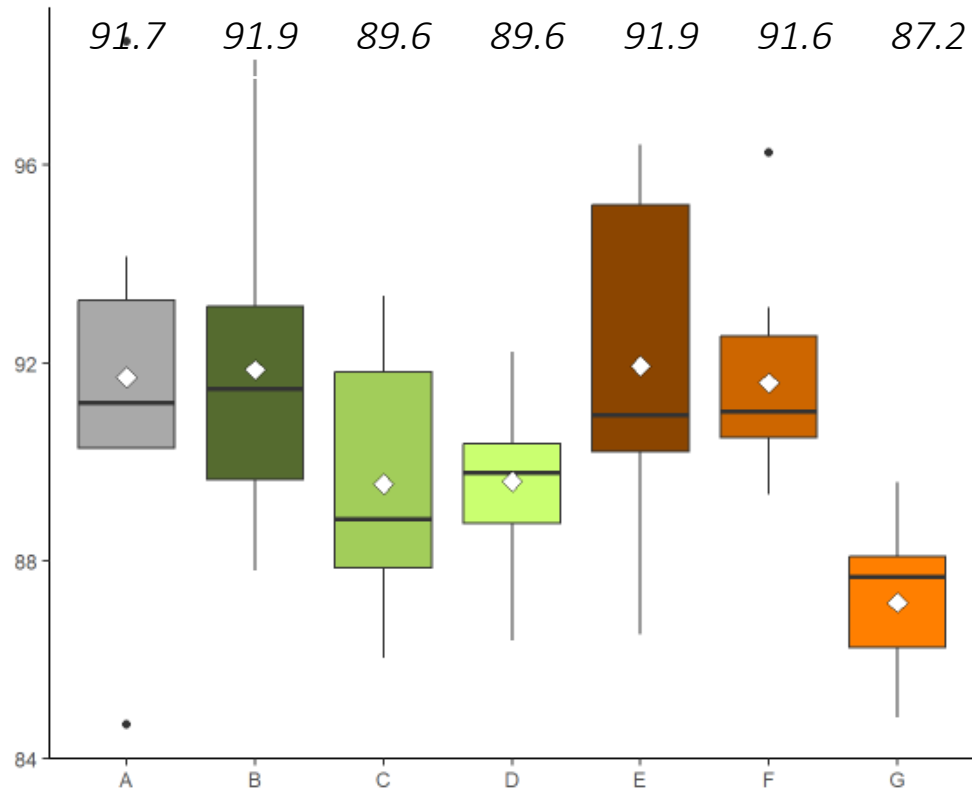
P<0.001

# Results

**10-35 days :** The gain was decreased by the canola inclusion in interaction with the CP reduction

**Average daily gain (g/j)**

**Average daily feed intake (g/j)**



**Crude protein**

**Feedstuff**

**Interaction**

Contrast test

Linear

Quadratic

Linear

Quadratic

B vs D

E vs G

ADG

NS

NS

**P<0.001**

NS

NS

**P<0.001**

ADFI

NS

NS

NS

NS

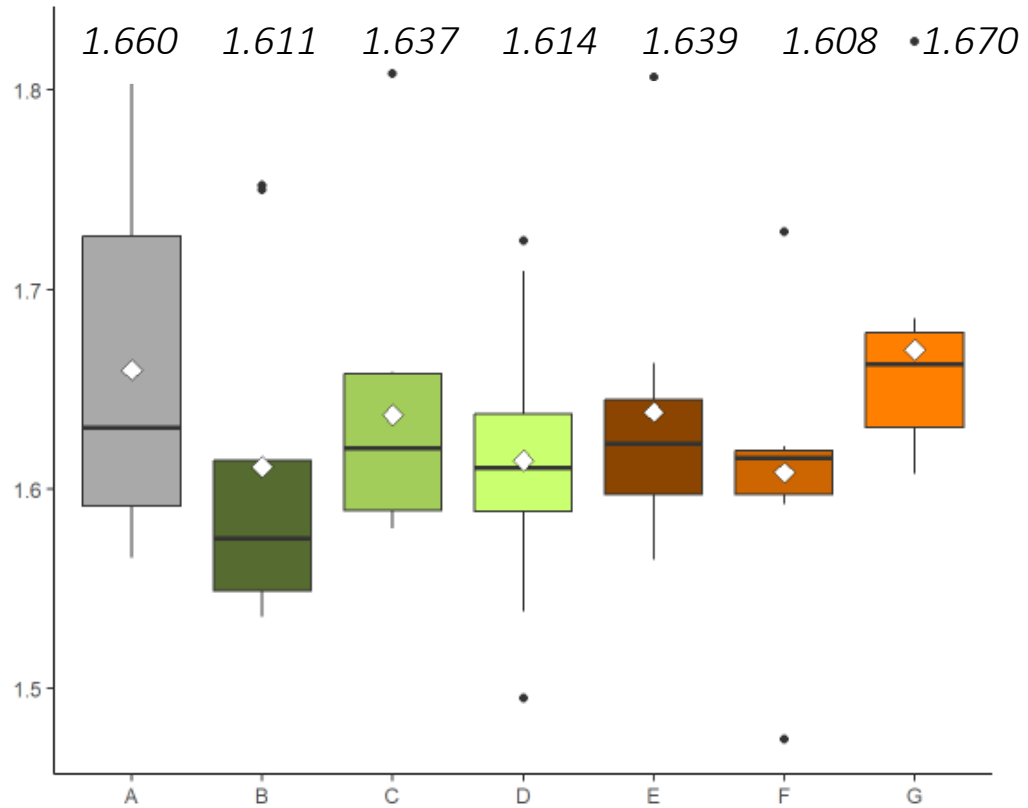
NS

NS

# Results

10-35 days : FCR and N efficiency were positively impacted by the CP reduction

## Feed conversion ratio (g/g)

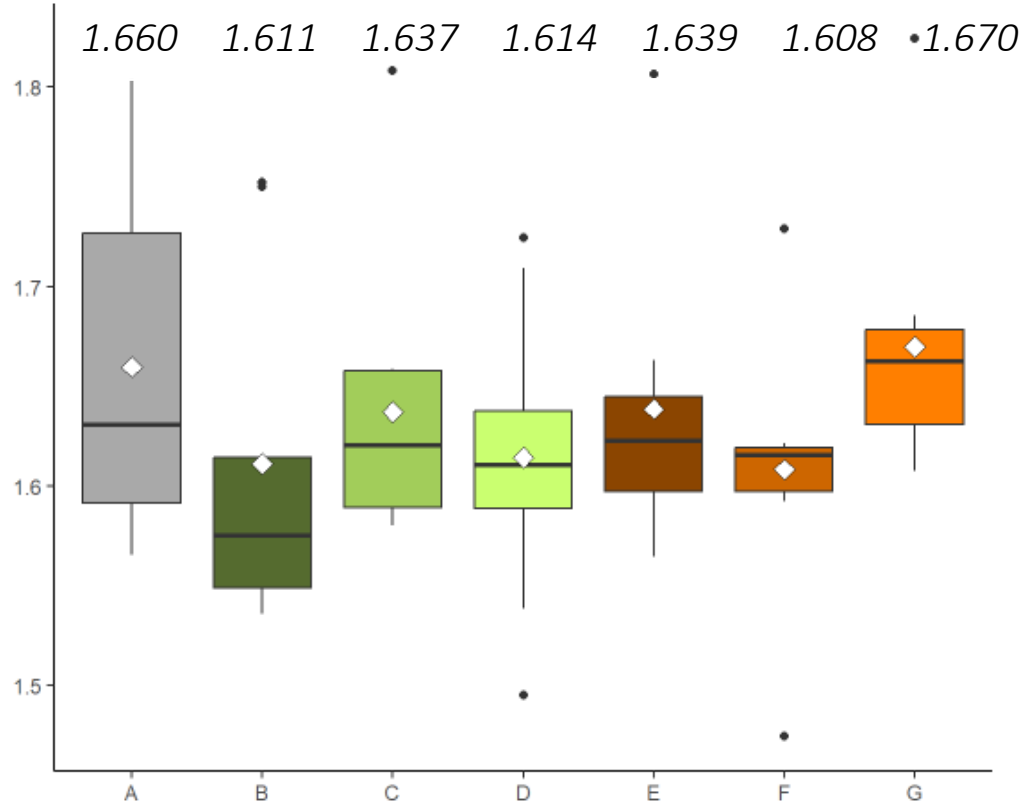


Contrast test	Crude protein		Feedstuff		Interaction	
	Linear	Quadratic	Linear	Quadratic	B vs D	E vs G
FCR	NS	NS	NS	NS	NS	NS
N effi	P<0.001	NS	NS	NS	NS	NS

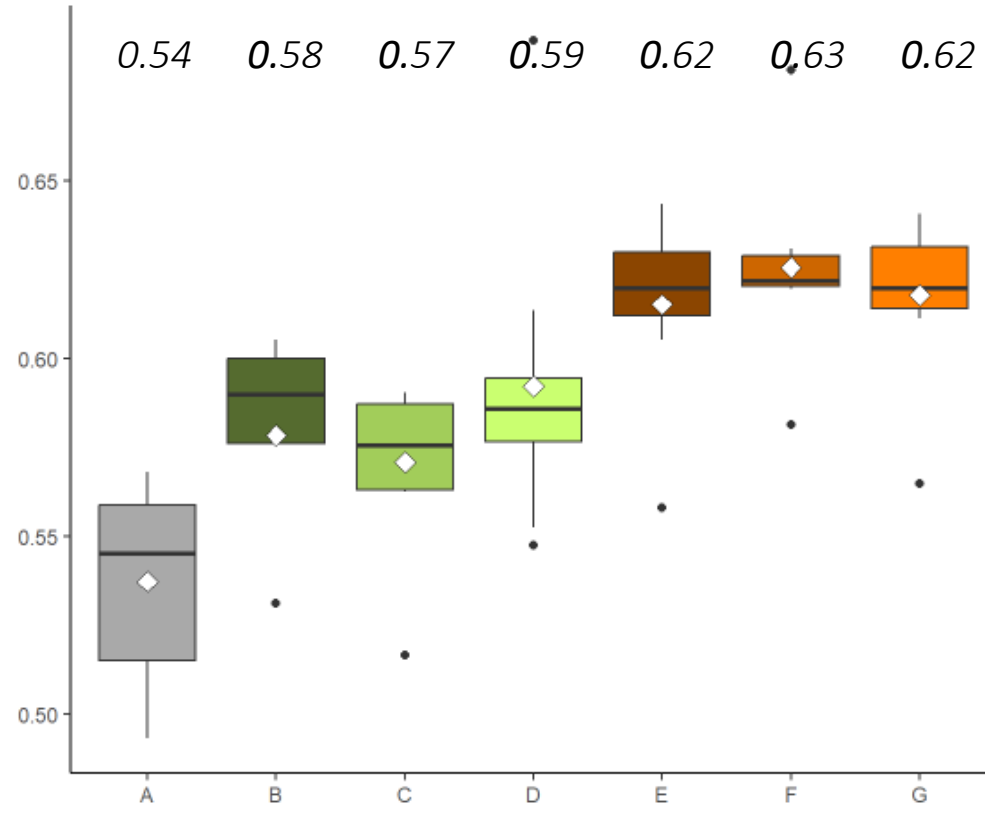
# Results

10-35 days : FCR and N efficiency were positively impacted by the CP reduction

**Feed conversion ratio (g/g)**



**N efficiency (g/g)**



Crude protein

Feedstuff

Interaction

Contrast test

Linear

Quadratic

Linear

Quadratic

B vs D

E vs G

FCR

NS

NS

NS

NS

NS

NS

N effi

**P<0.001**

NS

NS

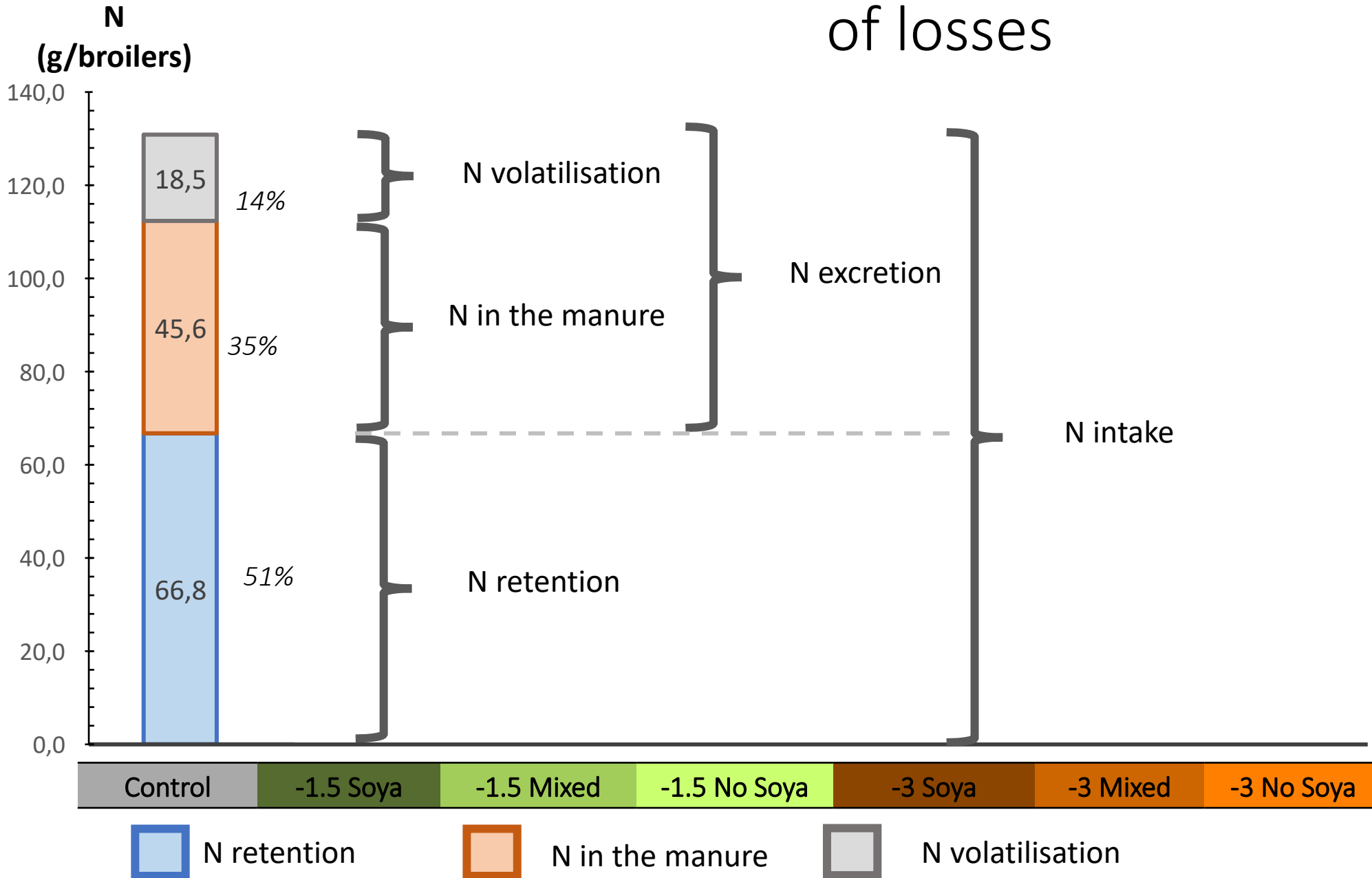
NS

NS

NS

# Nitrogen balance: increase of efficiency and decrease of losses

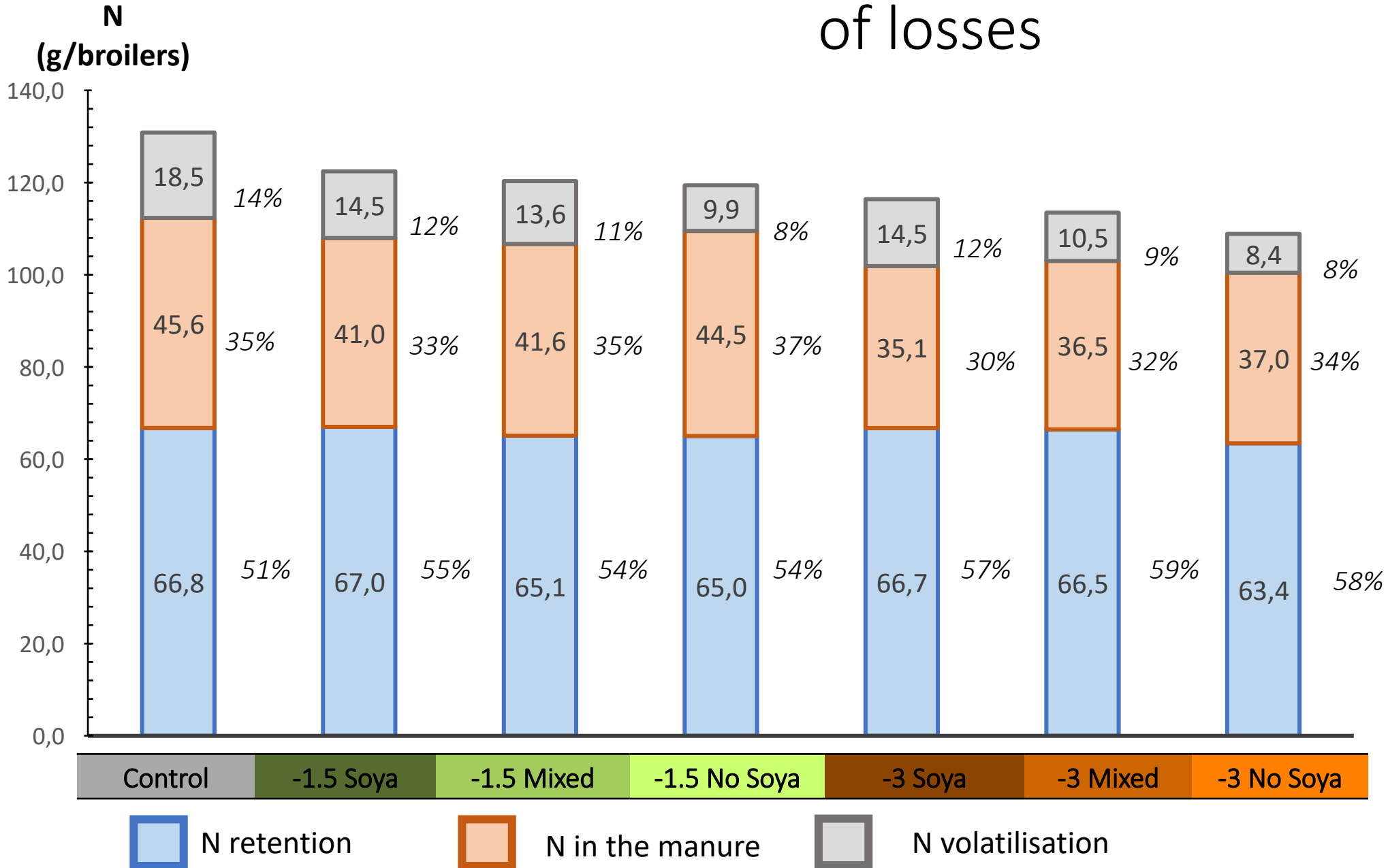
0-35 days



Results

# Nitrogen balance: increase of efficiency and decrease of losses

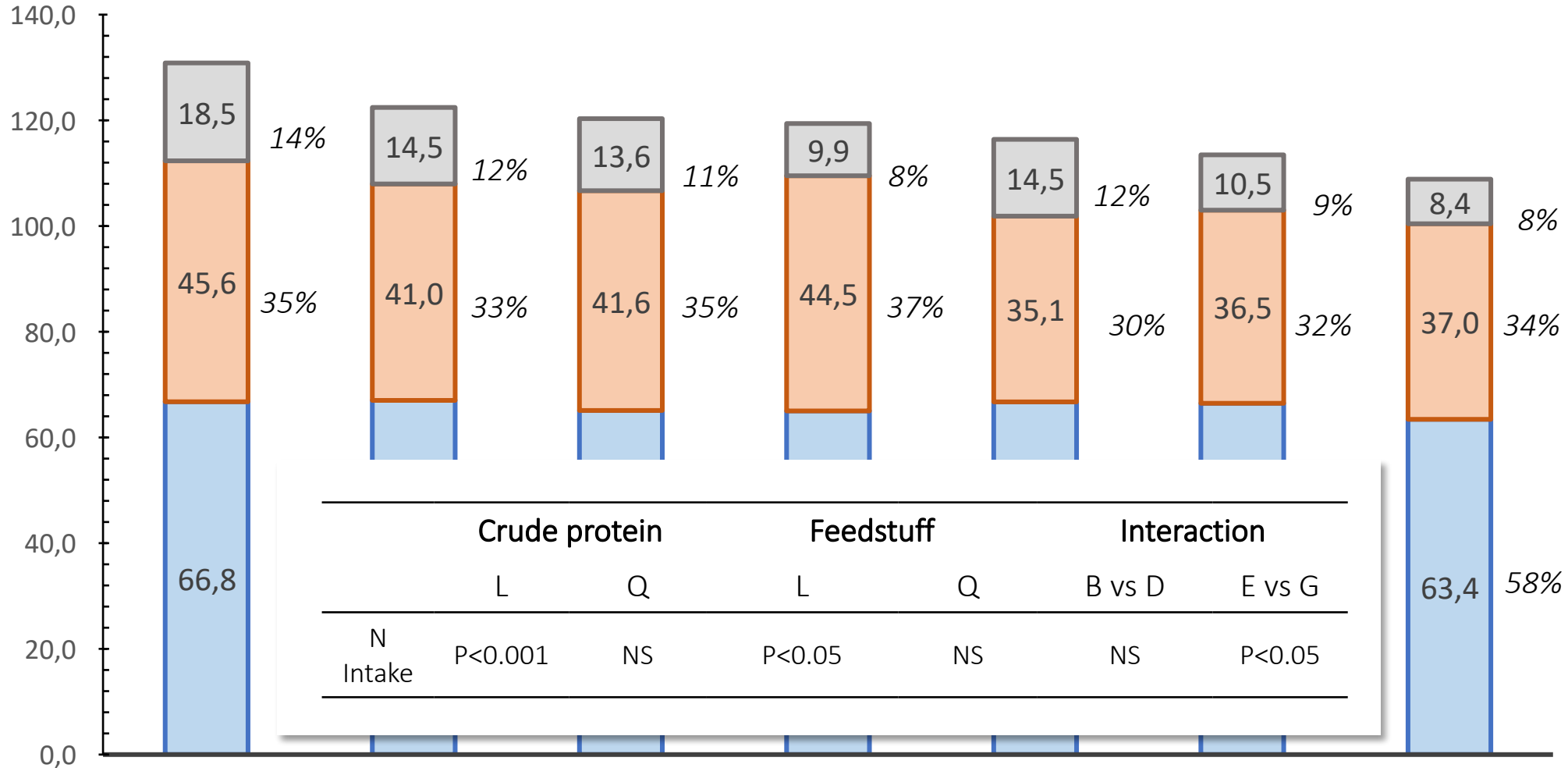
0-35 days



**Results**

# Nitrogen balance: increase of efficiency and decrease of losses

**N**  
(g/broilers)



**0-35 days**

**N intake**

Control    -1.5 Soya    -1.5 Mixed    -1.5 No Soya    -3 Soya    -3 Mixed    -3 No Soya

N retention   
  N in the manure   
  N volatilisation

**Results**

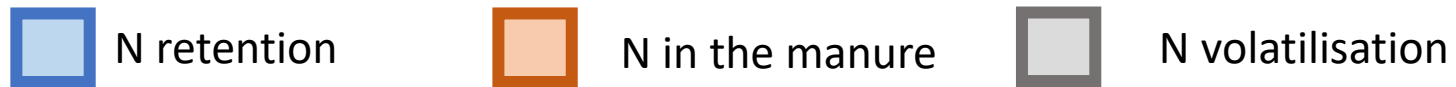
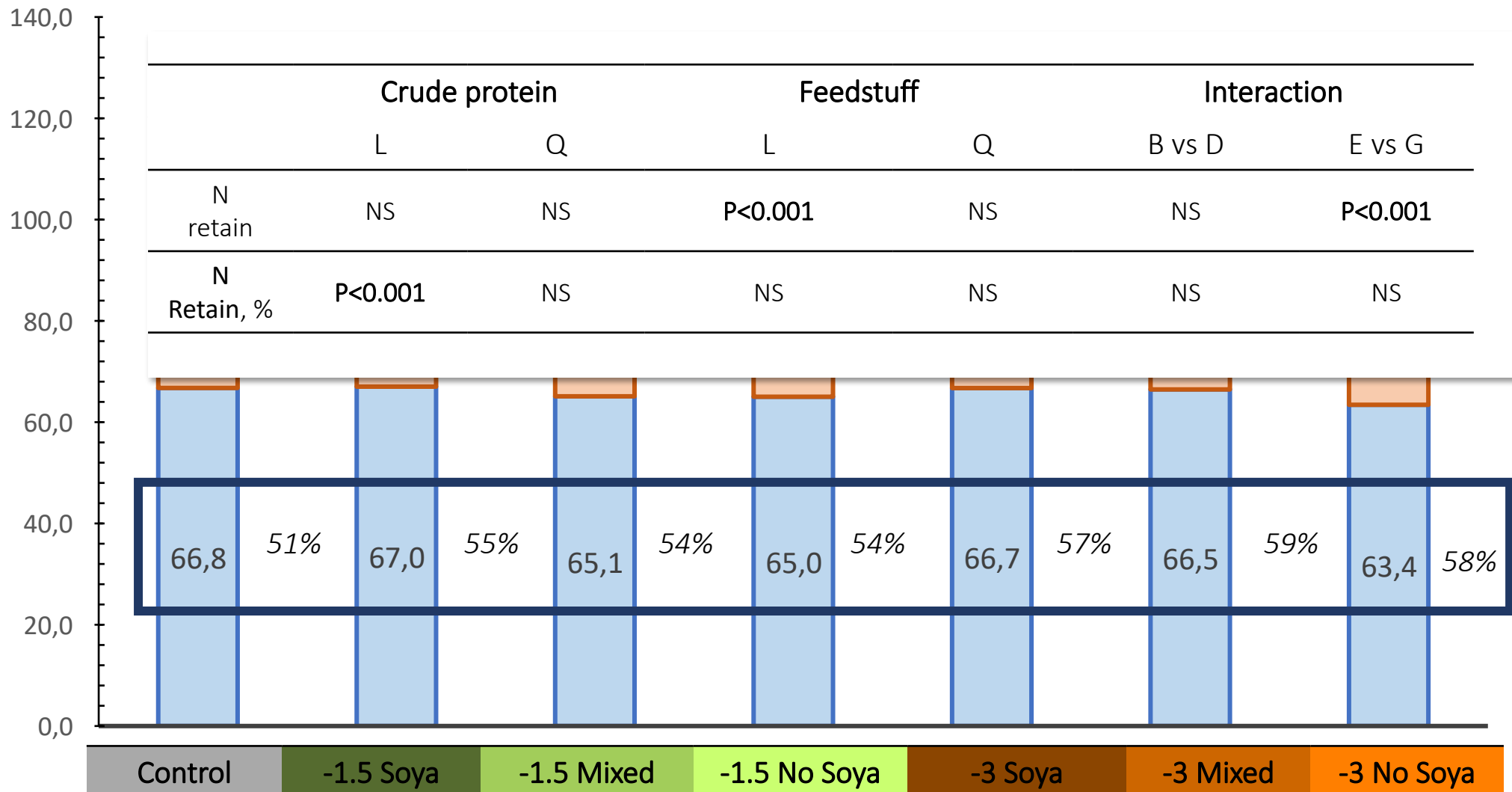
# Nitrogen balance: increase of efficiency and decrease of losses

**N**  
**(g/broilers)**

**0-35 days**

**N retention**

	Crude protein		Feedstuff		Interaction	
	L	Q	L	Q	B vs D	E vs G
N retain	NS	NS	P<0.001	NS	NS	P<0.001
N Retain, %	P<0.001	NS	NS	NS	NS	NS



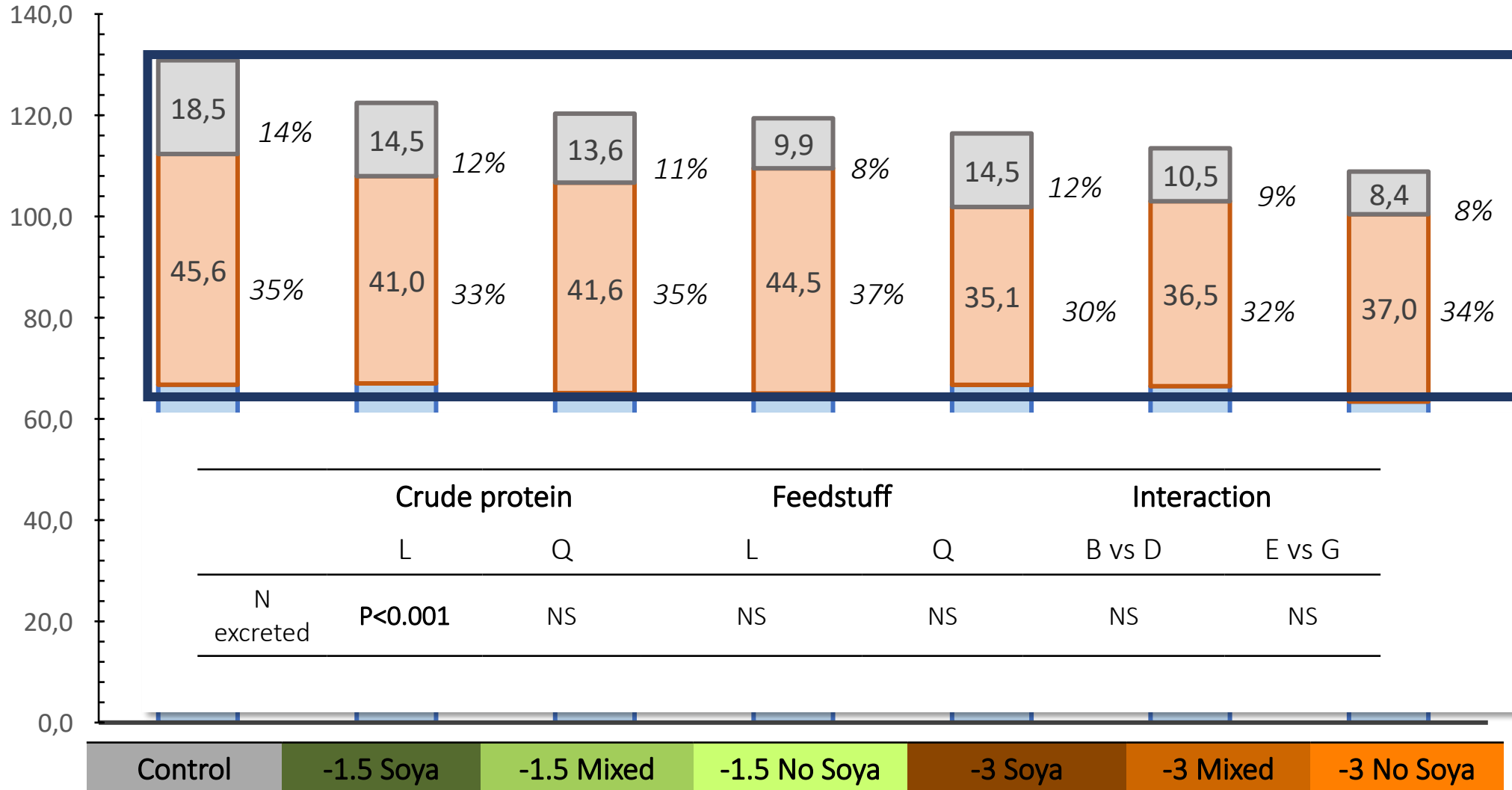
**Results**

# Nitrogen balance: increase of efficiency and decrease of losses

**N (g/broilers)**

**0-35 days**

**N excretion**



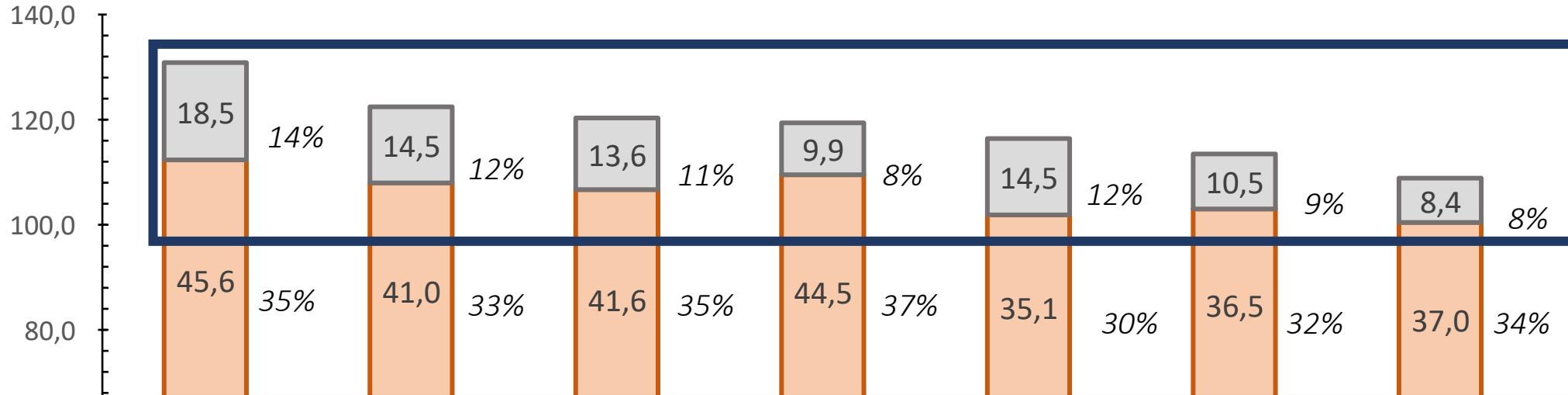
N retention
  N in the manure
  N volatilisation

**Results**

# Nitrogen balance: increase of efficiency and decrease of losses

**N**  
**(g/broilers)**

**0-35 days**



**N volatilisation**

	Crude protein		Feedstuff		Interaction	
	L	Q	L	Q	B vs D	E vs G
N volatilised	P<0.001	NS	P<0.001	NS	NS	P<0.05
N volatilised, %	P<0.001	NS	P<0.001	NS	NS	P<0.05

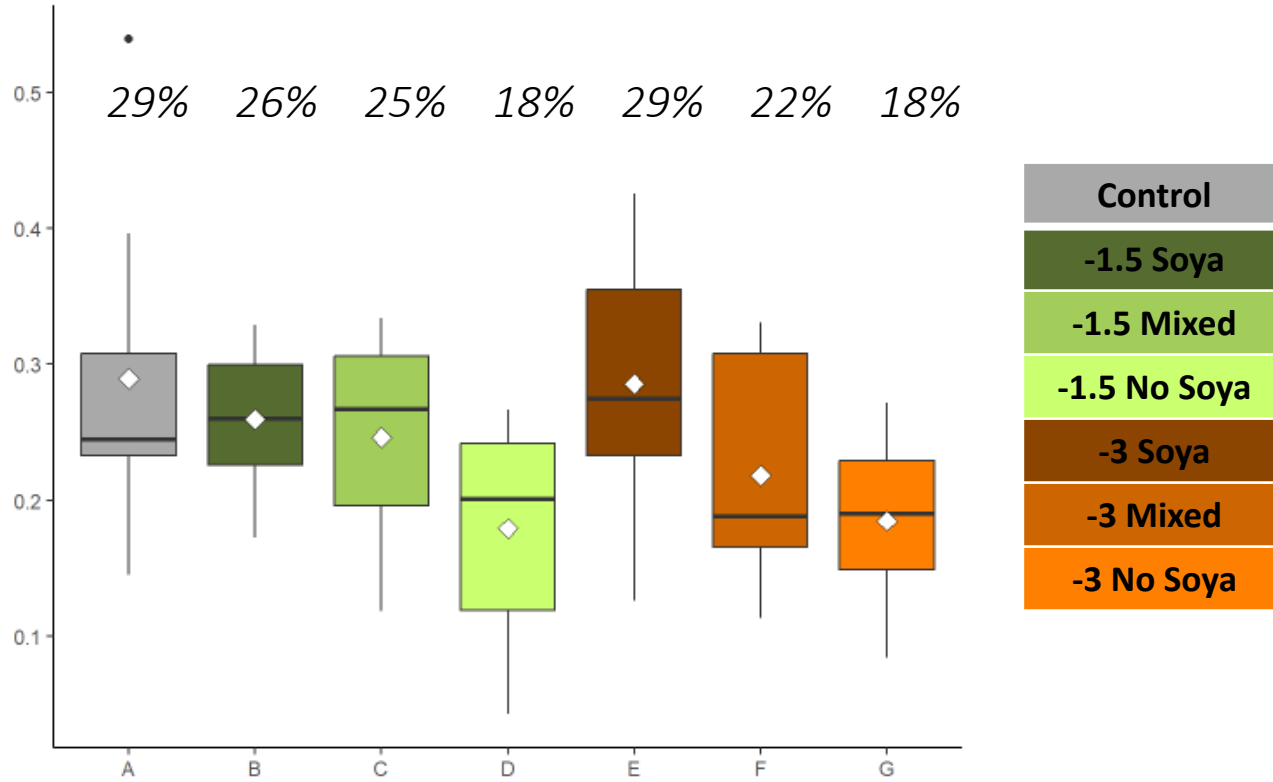
Control   -1.5 Soya   -1.5 Mixed   -1.5 No Soya   -3 Soya   -3 Mixed   -3 No Soya

N retention  
  N in the manure  
  N volatilisation

# Results

## Excreted N is less volatilisable when CP & soybean meal are reduced

N volatilisation  
(% N excretion)



Crude protein

Feedstuff

Linear

Quadratic

Linear

Quadratic

B vs D

E vs G

N  
volatility

**0.08**

NS

**P<0.01**

NS

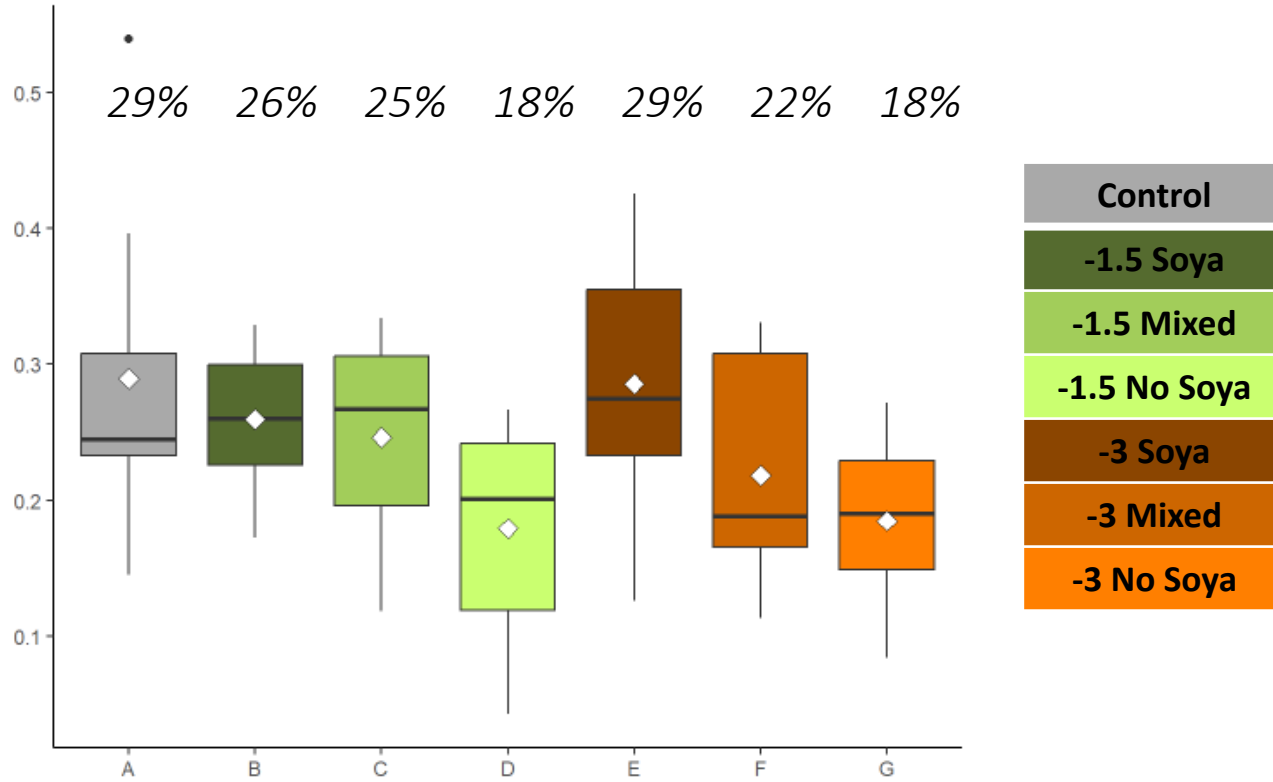
**0,07**

**P<0.05**

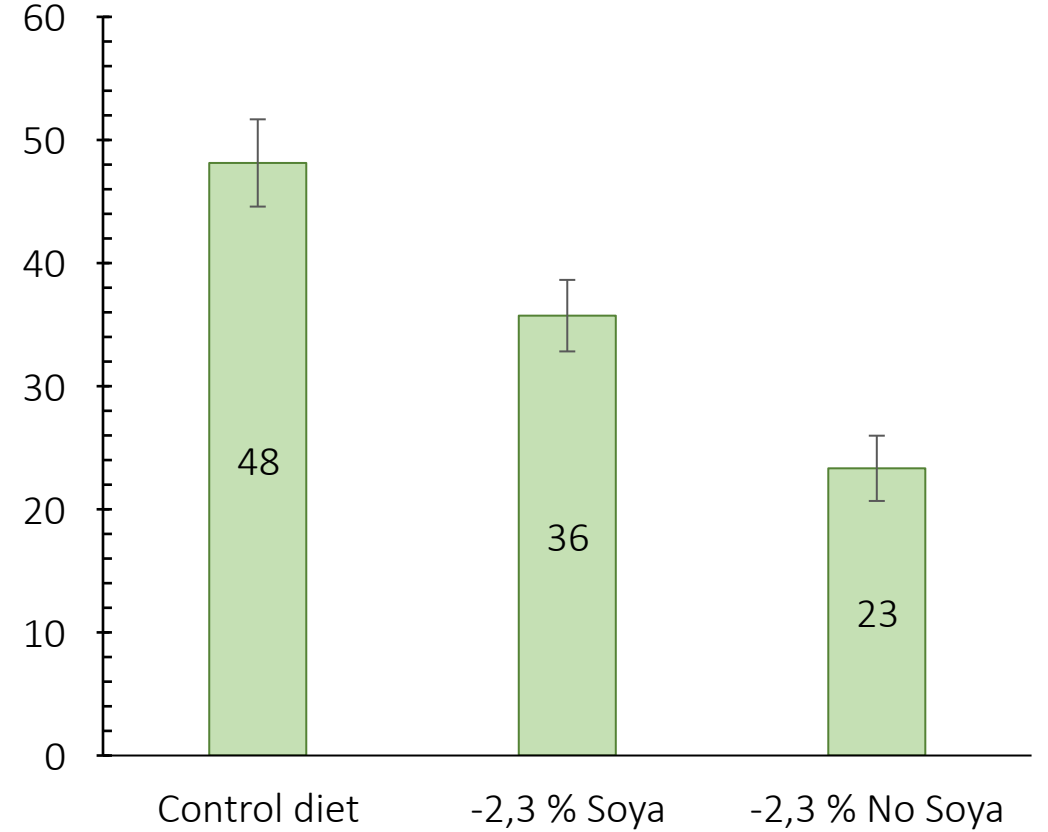
# Results

## Excreted N is less volatilizable when CP & soybean meal are reduced

N volatilisation  
(% N excretion)



N volatilisation  
(% N excretion)



Méda et al., 2019

Synergetic effect

	Crude protein		Feedstuff		B vs D	E vs G
	Linear	Quadratic	Linear	Quadratic		
N volatility	0.08	NS	P<0.01	NS	0,07	P<0.05

# How can LCP and SBM could be use to meet environmental challenges ?

Is was possible to :

✓ Reduce CP by 30 g/kg without impairing growth performance, and N retention

✓ Soy Free strategy possible only at -15 g of CP/kg



Treatment -3 % CP + No soybean meal



? DEB effect  
CP/fibre effect

11-35 days

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Treatment -3 % CP + No soybean meal



? DEB effect  
CP/fibre effect

11-35 days

## These strategies allowed to :

✓ Increase N retention efficiency: **51 % → 59 % of N intake**

✓ Reduce N losses volatilisation: **29% → 18 % of N excretion**

✓ Reduce the need for soybean meal: **827 → 0 g/broilers**



Effect on NH<sub>3</sub> & N<sub>2</sub>O emissions



Life cycle impact



Work in progress



Contrast test	
CP : Linear effect	A vs [E, F, G]
CP : Quadratic effect	A vs [B,C,D] vs[E, F, G]
Raw material : Linear effect	[B,E] vs [D,G]
Raw material : Quadratic effect	[B,E] vs [C,F] vs [D,G]
B vs D	B vs D
E vs G	E vs G

# Excreted N is less volatilizable when CP is reduced

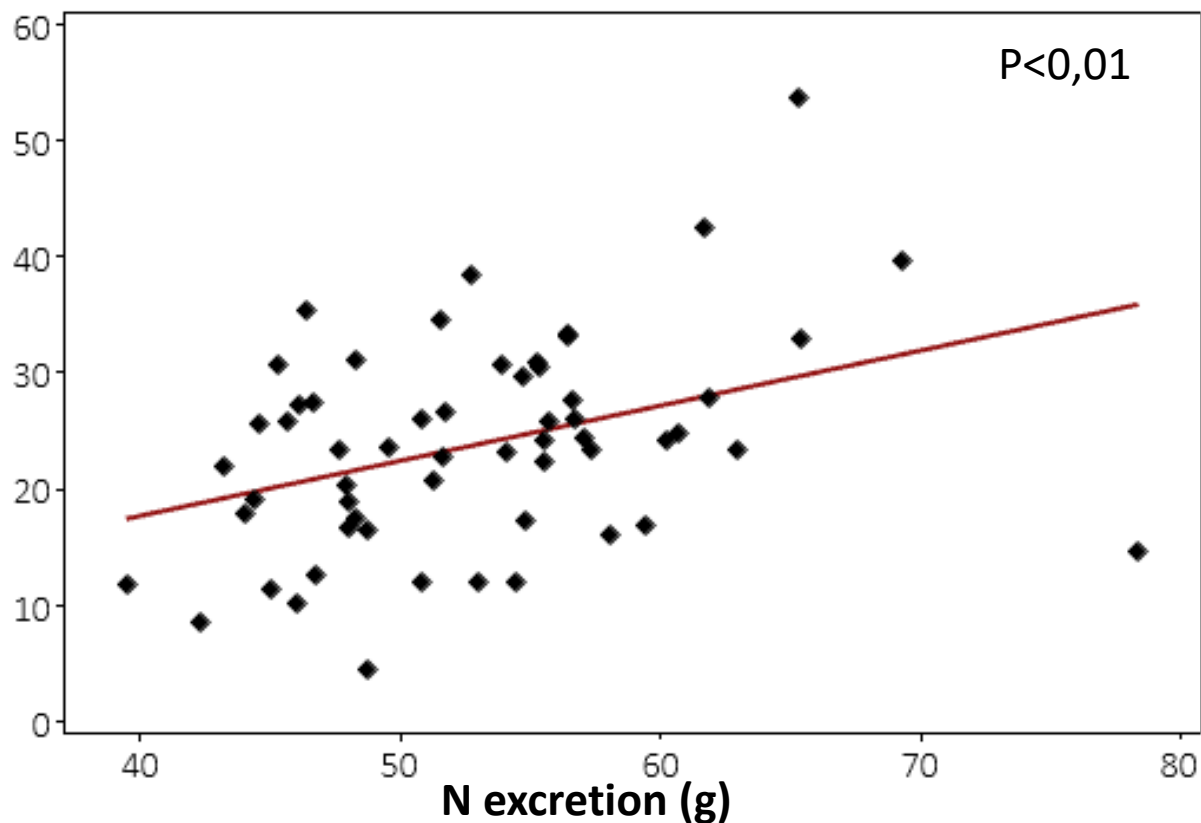
CP effect ? K effect ?  
BE effect ?

$$N_{\text{volatility}} = 0,47 \times N_{\text{excretion}} - 1,30 ; P < 0,01 ; R^2 : 19\%$$

$$N_{\text{volatility}} = -0,403 \times \text{DM} + 7,68 \times \text{pH} - 11,5 ; R^2 : 18\%$$

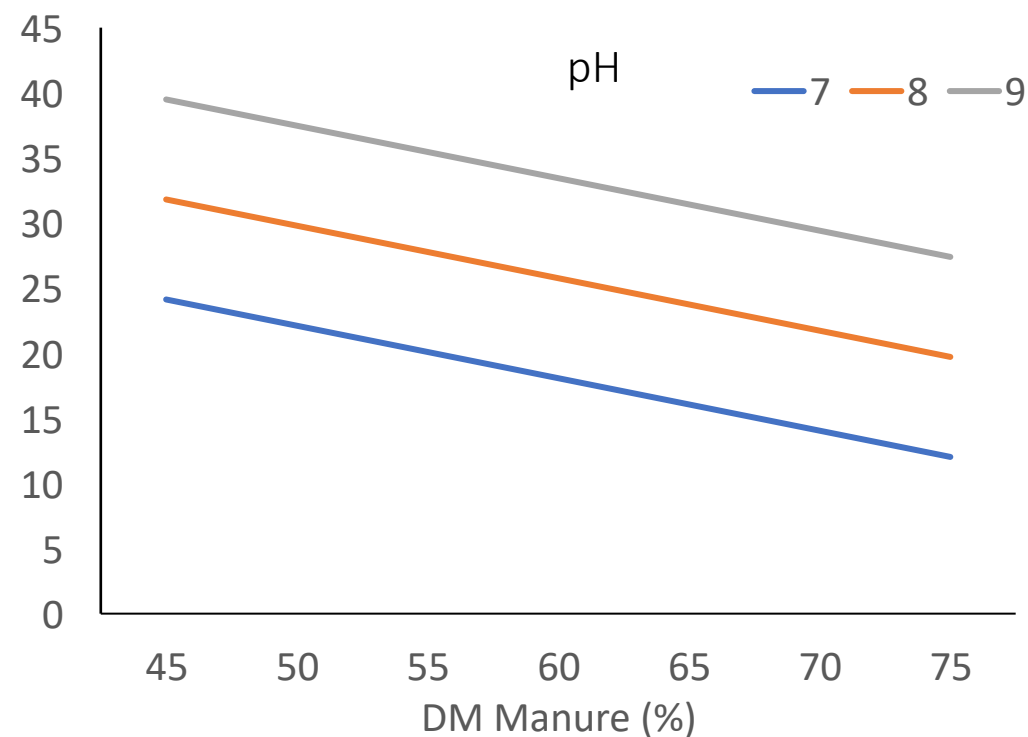
N volatility

(N volatilised % N excreted)



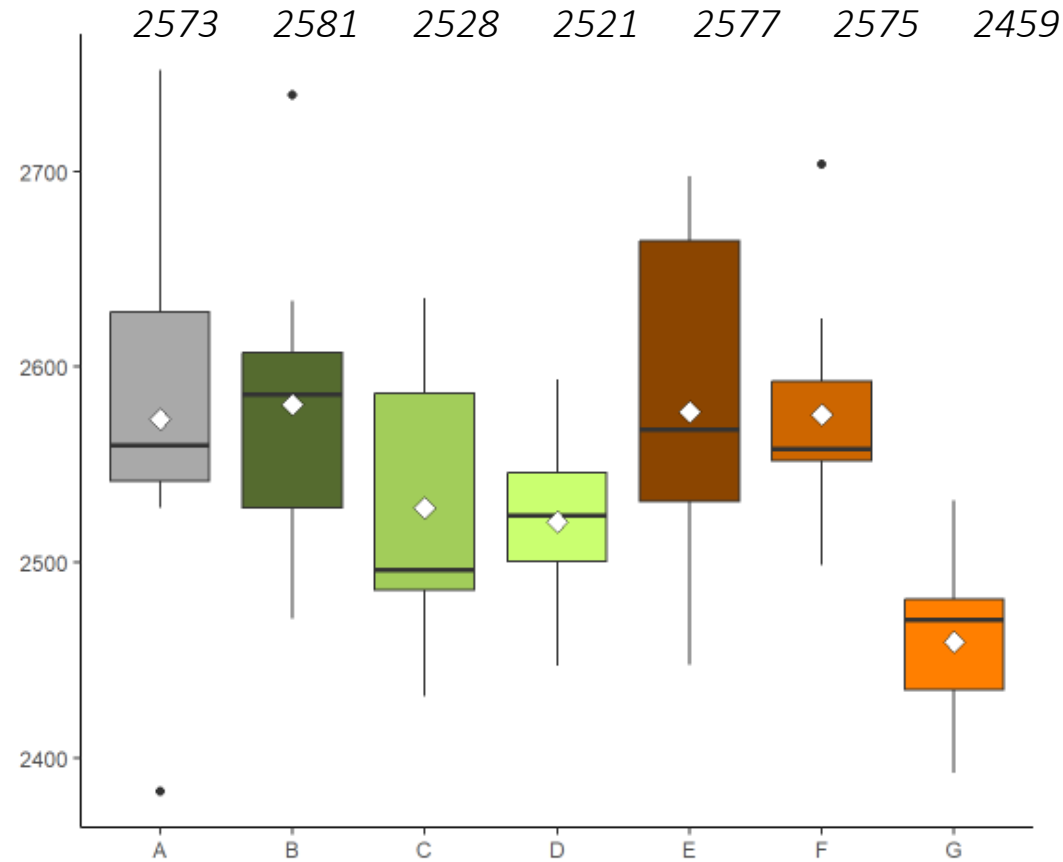
N volatility

(N volatilised % N excreted)



# Weight at slaughter age

Slaughter weight (g)



	Crude protein		Raw material		Interaction	
Contrast test	Linear	Quadratic	Linear	Quadratic	B vs D	E vs G
Final weight	NS	NS	P<0.001	NS	NS	P<0.01

N volatilised  
(% of the control)



# N volatilised

