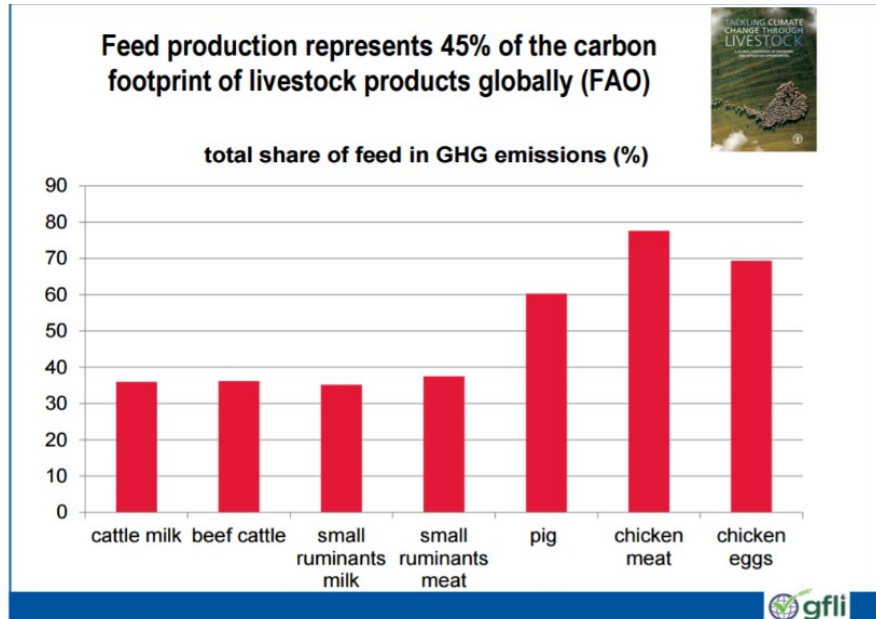




The impact of white sorghum inclusion in growing-finishing pig diets on growth performance and feed digestibility

Reduction of the environmental impact in the porcine industry



Imported feed ingredients:

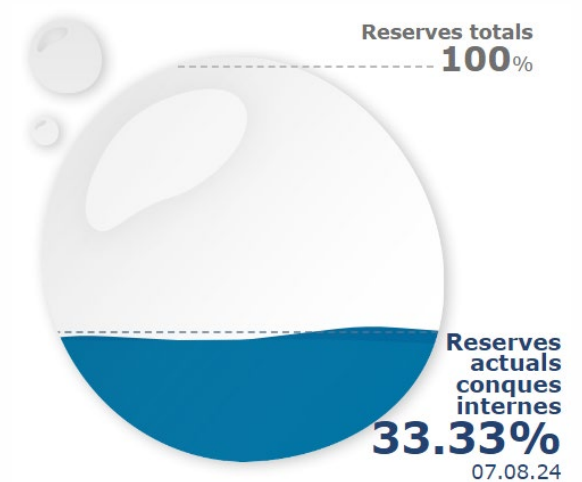
- Deforested areas.
- Need for transportation.



Feed ingredients adapted to local conditions

(Catalonia, Spain):

- Periodic droughts
- Poor soil quality.



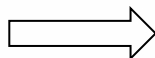
AGRONUTRICC project

Implementation of an agricultural and livestock production system (pork) linked to nutritional strategies with cereal varieties adapted to climate change.



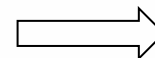
New varieties of alternative cereals

- Productivity
- Nutritional value



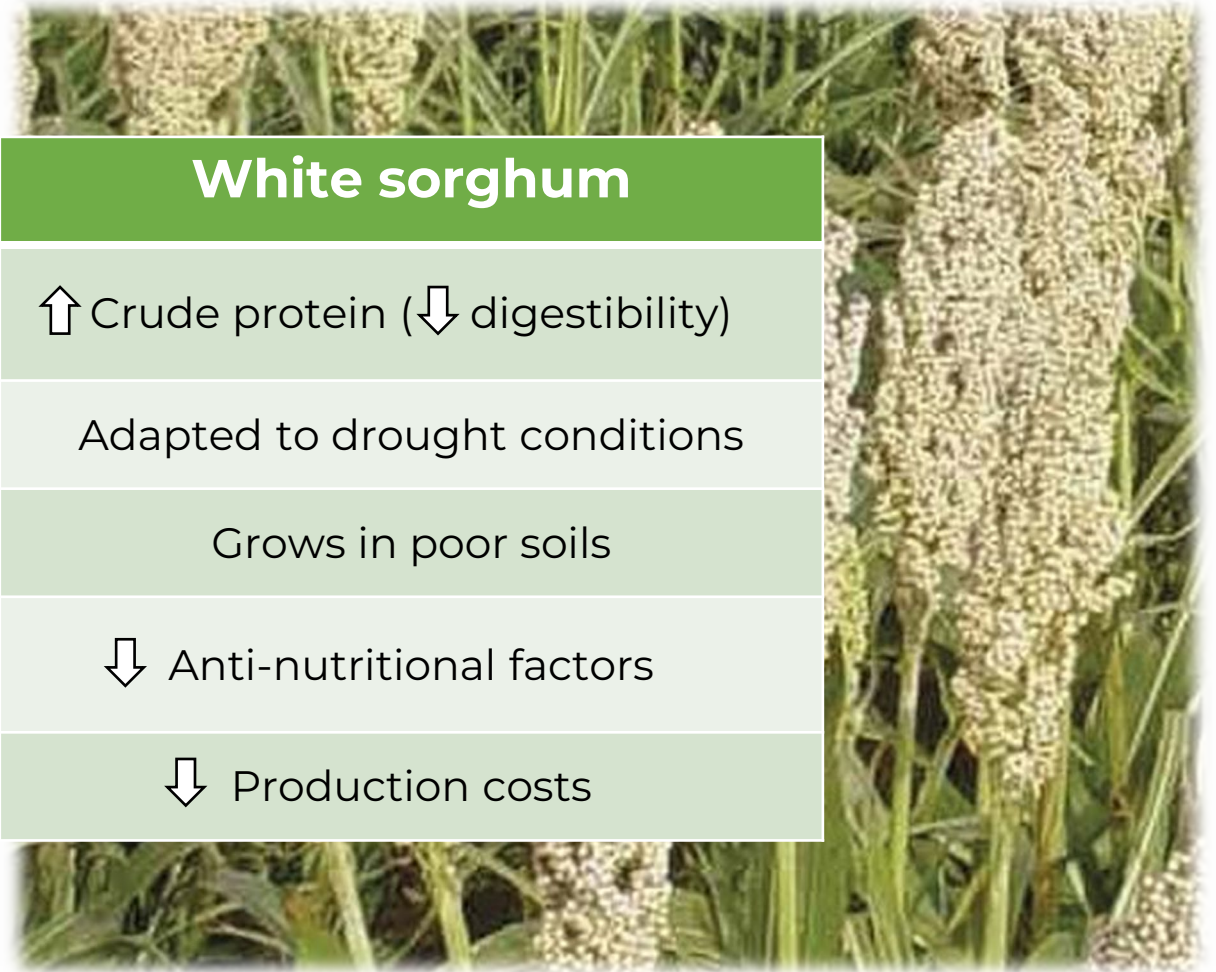
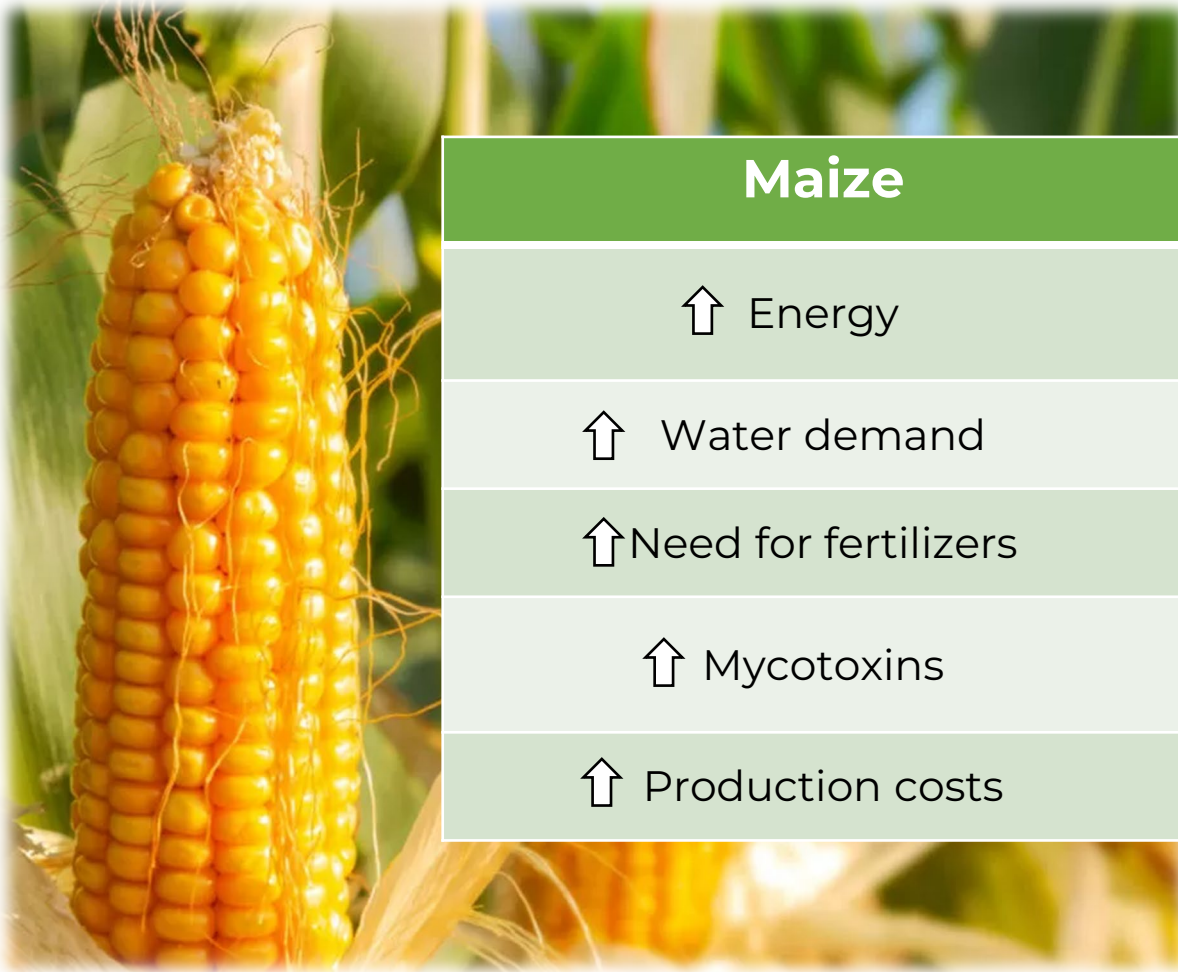
Feed production

- Life cycle analysis



- Growth performance
- Feed digestibility
- Slaughterhouse results

Maize vs. white sorghum



Maize	White sorghum
↑ Energy	↑ Crude protein (↓ digestibility)
↑ Water demand	Adapted to drought conditions
↑ Need for fertilizers	Grows in poor soils
↑ Mycotoxins	↓ Anti-nutritional factors
↑ Production costs	↓ Production costs

Objectives of the study

Evaluate the impact of dietary replacing conventional ingredients by a **white sorghum** variety, adaptable to Mediterranean drought conditions, on **growth performance** and **feed digestibility** in growing-finishing pigs.

Perform a **life cycle analysis (LCA)** of the diets provided in the study.

Poster **90.16**: Effect of dietary hybrid rye inclusion on growth performance of growing-finishing pigs.



90.16 Effect of dietary hybrid rye inclusion on growth performance of growing-finishing pigs

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INTRODUCTION

Hybrid rye is a drought-tolerant cereal variety with good adaptability to poor-quality soils. It is more resistant to ergot and fusarium and has lower content of anti-nutritional factors compared to common rye.

Objective

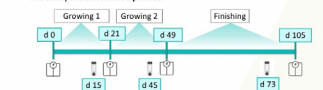
This study assessed the effect of feeding hybrid rye substituting wheat and maize grain as source of energy in diets fed to growing-finishing pigs on their growth performance and ATT digestibility.

MATERIAL AND METHODS

Experimental phase

A total of 528 pigs ([Landrace x Yorkshire] x Pietrain), weighing 26 ± SD 4.6 kg, were distributed across 48 pens based on weight and sex.

The study included three phases:



Pens were allotted into two isoenergetic and isoproteic dietary groups: CON and HR (Table 1).

Table 1. Four main ingredients included in the dietary formula of CON and HR for each phase.

Ingredient	Growing 1		Growing 2		Finishing	
	CON	HR	CON	HR	CON	HR
Maize	30.83	15.83	30.58	20.74	35.00	23.13
Wheat	28.31	-	34.09	-	30.82	-
Rye	-	40.00	-	40.00	-	40.00
Soybean meal 46%	14.10	15.90	13.80	16.37	12.80	14.06

*Diets included a 1% of distasteful earth as an indigestible marker for average total tract digestibility (ATT) analysis.

- Growth performance was monitored in each phase
- Fecal samples were obtained at the end of each phase ().
- Carcass characteristics were registered.

Laboratory and Data analyses

Nutritional analysis were conducted on both diets and feces to determine ATT using acid-insoluble ash as a marker.

Environmental impact for each diet was calculated using Opteneics™ (BASF, Germany).

Statistical analysis performed in R software v4.2.3.

CONCLUSION

Replacing wheat and maize with a 40% inclusion of hybrid rye as an energy source in pig diets does not affect growth performance but reduces the diet's ATT in all feeding phases. Hybrid rye could be a viable alternative ingredient for growing-finishing periods, particularly in regions facing water stress and poor-quality soil.

Acknowledgements: Research funded through Operation 16.01.01 of Cooperation for Innovation under the Rural Development Program of Catalonia 2014-2020.



RESULTS

Table 2. Growth performance of pigs fed with the CON and HR diets during growing-finishing phase. ADG: average daily gain; ADFI: average daily feed intake; FCR: Feed conversion ratio.

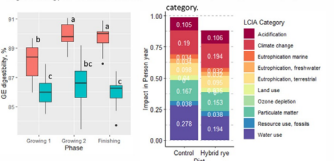
Phase	Parameter	CON	HR	SEM	P-value
d 0		26.1	26.1	0.61	0.901
d 21		41.0	40.8	0.32	0.913
d 49		65.6	66.8	0.73	0.192
Growing 1, d 0-21	ADG, kg	0.69	0.70	0.017	0.786
	ADFI, kg	1.24	1.23	0.016	0.805
	FCR	1.80	1.76	0.032	0.396
	Mortality, %	1.58	0.76	0.641	0.358
Growing 2, d 21-49	ADG, kg	0.87	0.93	0.023	0.074
	ADFI, kg	1.82	1.89	0.023	0.025
	FCR	2.10	2.06	0.047	0.496
	Mortality, %	1.17	0.00	0.640	0.061
Finishing, d 49-105	ADG, kg	0.81	0.79	0.016	0.293
	ADFI, kg	2.97	2.96	0.027	0.821
	FCR	2.55	2.64	0.057	0.296
	Mortality, %	0.79	0.76	0.541	0.965
Growing 1-2	ADG, kg	0.81	0.81	0.010	0.786
	ADFI, kg	1.83	1.85	0.018	0.500
	FCR	2.28	2.29	0.028	0.855
	Mortality, %	3.56	1.52	0.839	0.082
Lean, %		64.0	63.9	0.158	0.546
Carcass yield, %		79.1	79.8	0.187	0.003

• CON and HR groups showed a similar growth performance during the whole growing-finishing period ($P > 0.1$).

• Pigs fed HR showed a tendency for a lower mortality in the whole growing-finishing period than pigs fed CON ($P = 0.082$), possibly attributable to intestinal health effects.

• Pigs fed HR diet showed a higher carcass yield ($P = 0.003$).

Figure 1. Average total tract digestibility (Person year/1000 kg of carcass) by LCA category.



The gross energy ATT of HR diet was lower than CON in all feeding phases ($P > 0.05$). However, HR showed a lower environmental impact than CON.

White sorghum variety selected for the study

A previous study evaluated different varieties of white sorghum based on:

- Productivity
- Nutritional value
- Anti-nutritional factors content



Variety	Dry matter, %	Crude protein, %	Crude fiber, %	Ashes, %	Crude fat, %	Starch, %	Total sugars, %
ARSENIO	86.24	12.1	4.0	1.8	2.8	61.5	0.26

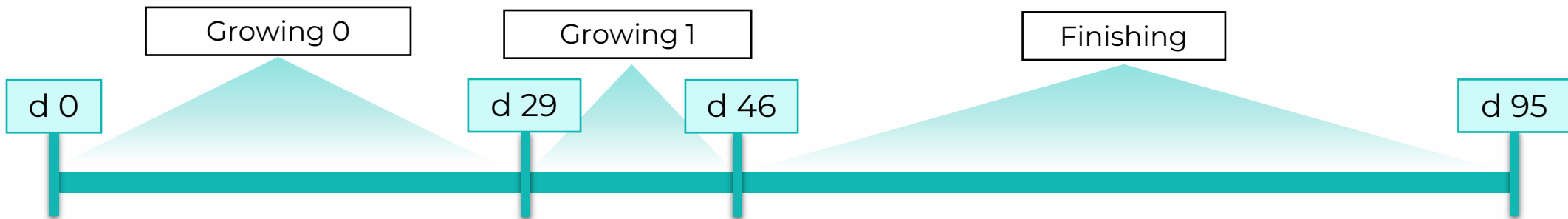
Methods: experimental design

528 pigs ([Landrace x Yorkshire] x Pietrain, initial BW of 31kg $\pm$ SD 3.43) distributed by weight and sex in 48 pens of 11 animals.

24 pens by treatment:

- **Control:** Feed including a 35% of maize.
- **White sorghum (WS):** Feed including a 50% of white sorghum.

Three phases and feeds:



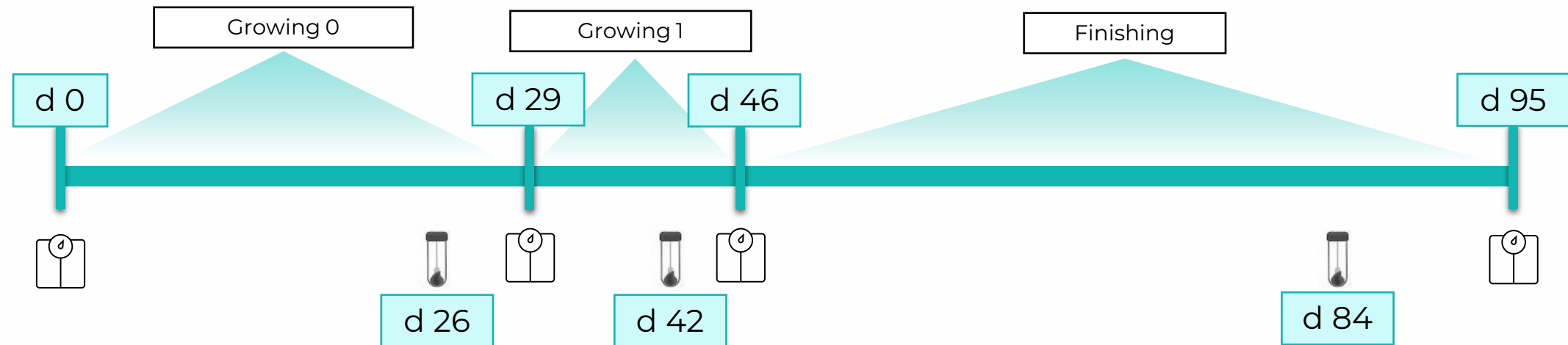
Diets

Ingredient	Growing 0		Growing 1		Finishing	
	CONTROL	WS	CONTROL	WS	CONTROL	WS
Maize	35	-	35	-	35	-
White sorghum	-	50	-	50	-	50
Wheat	21.53	10.34	23.12	11.61	25.54	16.00
Soybean meal 46%	14.19	10.44	11.01	6.47	11.15	8.34
Barley	20	20	15	15	15	15
Rapeseed	-	-	6.52	7.55	2.92	-
Bakery product	2.74	2.25	2.58	2.08	4	4
Lard 1° BAT	1.11	1.29	0.91	1.18	0.16	-
Lard 3/5 acidity	0.6	0.6	1.3	1.3	1.5	1.52
Bicalcium phosphate	0.95	0.94	0.76	0.75	0.37	0.5
Salt	0.4	0.4	0.4	0.4	0.4	0.39
Calcium carbonate	0.35	0.38	0.37	0.38	0.89	0.88
Lysine 50%	0.95	1.12	0.96	1.15	0.94	1.13
Metionine 88%	0.19	0.22	0.14	0.18	0.14	0.21
Treonine	0.24	0.27	0.23	0.25	0.28	0.31
Valine	0.09	0.08	0.08	0.07	0.09	0.08
Triptophan	0.04	0.05	0.04	0.05	0.05	0.06
Vit-min premix	0.2	0.2	0.2	0.2	0.2	0.2
Liquid acids	0.2	0.2	0.2	0.2	0.2	0.2
Enzyme supplement	0.04	0.04	-	-	-	-
Coline	0.02	0.02	0.02	0.02	0.02	0.02
Phitase, xilanase i B-glucanase	0.01	0.01	0.01	0.01	0.01	0.01
Antifungal	0.15	0.15	0.15	0.15	0.15	0.15
Diatomaceous earth	1	1	1	1	1	1

	Growing 0		Growing 1		Finishing	
Ingredient	CONTROL	WS	CONTROL	WS	CONTROL	WS
Maize	35	-	35	-	35	-
White sorghum	-	50	-	50	-	50
Wheat	21.53	10.34	23.12	11.61	25.54	16.00
Soybean meal 46%	14.19	10.44	11.01	6.47	11.15	8.34

	Growing 0		Growing 1		Finishing	
Analyzed nutritional composition	CONTROL	WS	CONTROL	WS	CONTROL	WS
Dry matter, %	87.71	87.34	88.07	87.92	88.43	88.57
Gross energy, kcal	3863	3914	3923	3973	3903	3904
Crude fat, %	3.93	4.18	4.25	4.86	3.92	3.92
Crude protein, %	14.88	15.78	15.21	15.80	14.67	15.66
Ashes%	4.40	4.71	4.38	4.41	4.53	4.64
Neutral detergent fiber, %	12.33	13.04	12.36	12.32	11.70	11.22
Starch, %	49.73	49.15	46.40	46.69	50.03	50.18

Methods: sampling



 Weighing d0, d29 d46 y d95

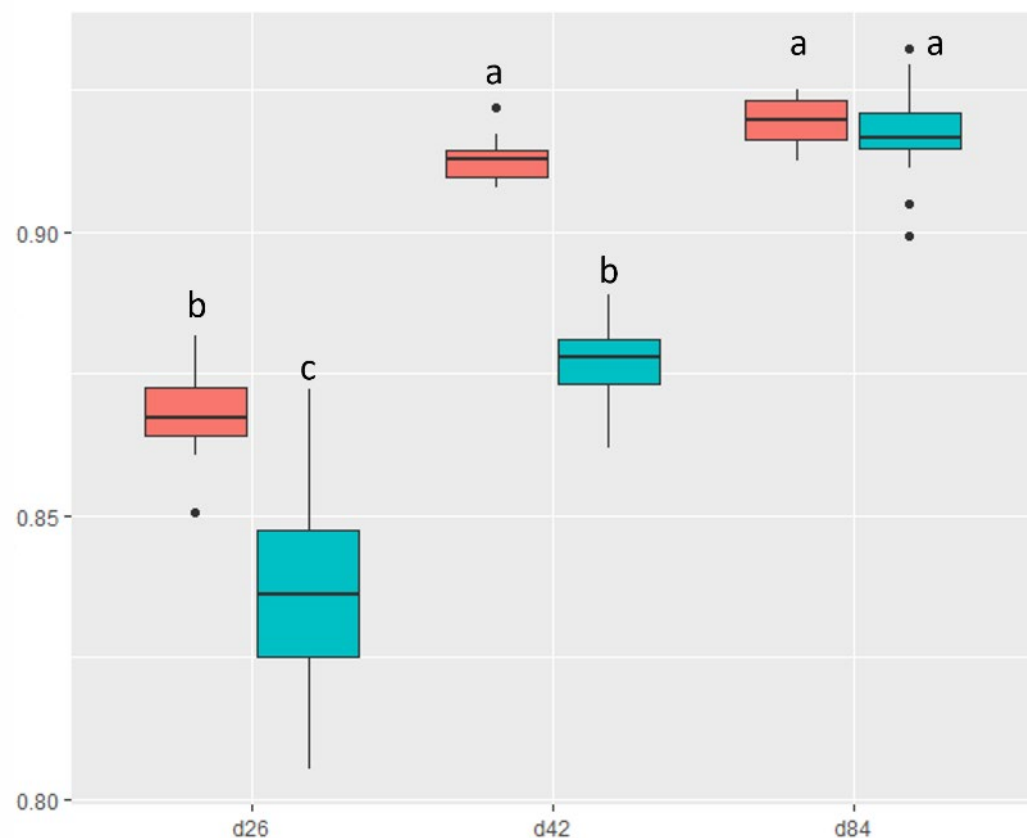
 Fecal sampling d26, d42 y d84 for ATTD análisis (insoluble ashes)

Results: productive performance and carcass measurements

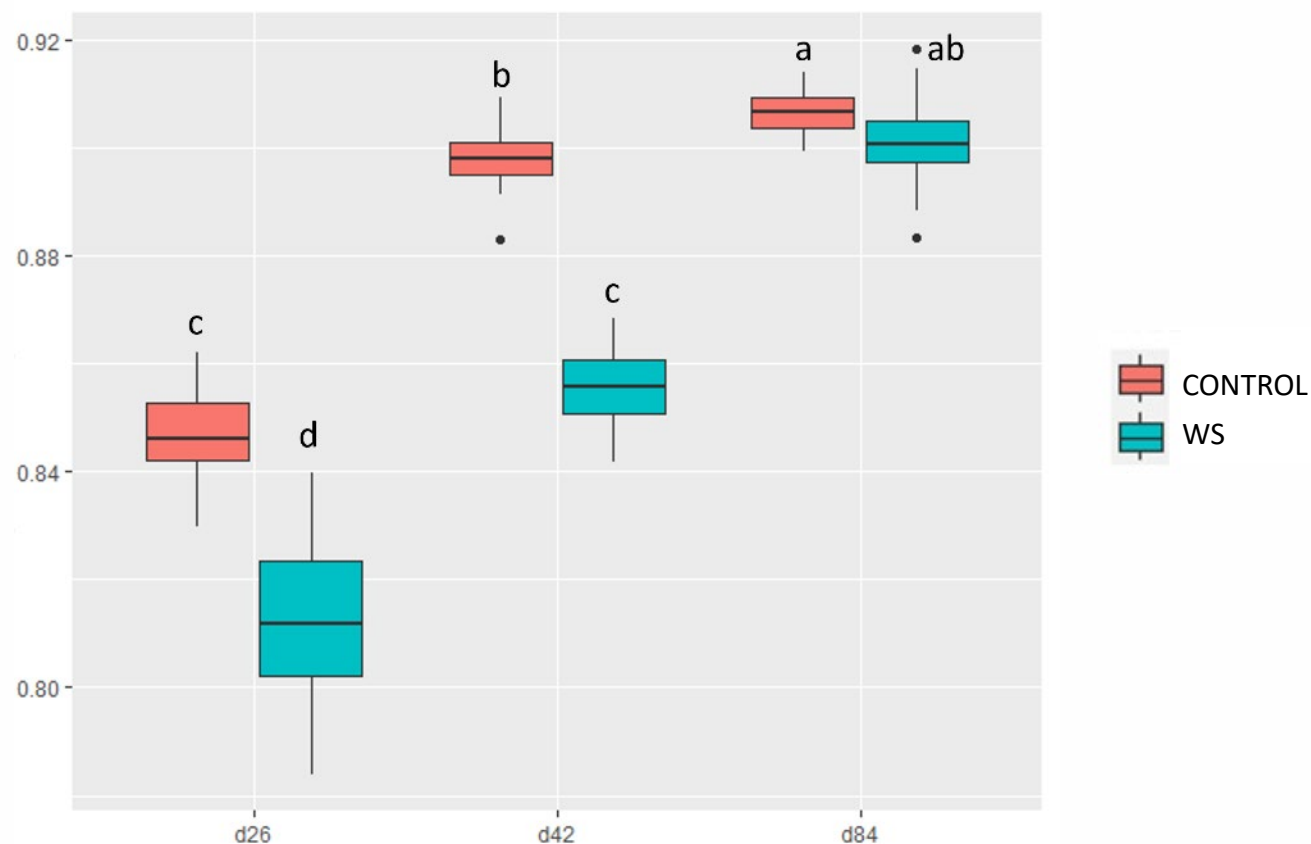
Phase	Parameter	CONTROL	WS	SEM	Pvalue
D 0	BW, kg	30.8	31.1	0.59	0.700
D 29	BW, kg	54.9	53.6	0.32	0.042
D 46	BW, kg	70.4	68.8	0.40	0.039
D 95	BW, kg	106.3	104.9	1.08	0.137
D 0 - 29	ADG, kg	0.828	0.782	0.0108	0.008
	ADFI, kg	1.457	1.431	0.0264	0.317
	FCR	1.76	1.83	0.041	0.016
D 29 - 46	ADG, kg	0.906	0.888	0.0202	0.572
	ADFI, kg	1.452	1.406	0.0245	0.260
	FCR	1.62	1.59	0.043	0.615
D 46 - 95	ADG, kg	0.734	0.735	0.0152	0.966
	ADFI, kg	1.864	1.868	0.0280	0.883
	FCR	2.55	2.55	0.085	0.919
D 0 - 95	ADG, kg	0.794	0.776	0.0119	0.032
	ADFI, kg	1.666	1.652	0.0241	0.488
	FCR	2.10	2.13	0.060	0.142
	Lean %	0.643	0.641	0.34	0.381
	Carcass yield	0.796	0.793	0.59	0.534

Results: fecal average total tract digestibility (ATTD)

Organic matter ATTD

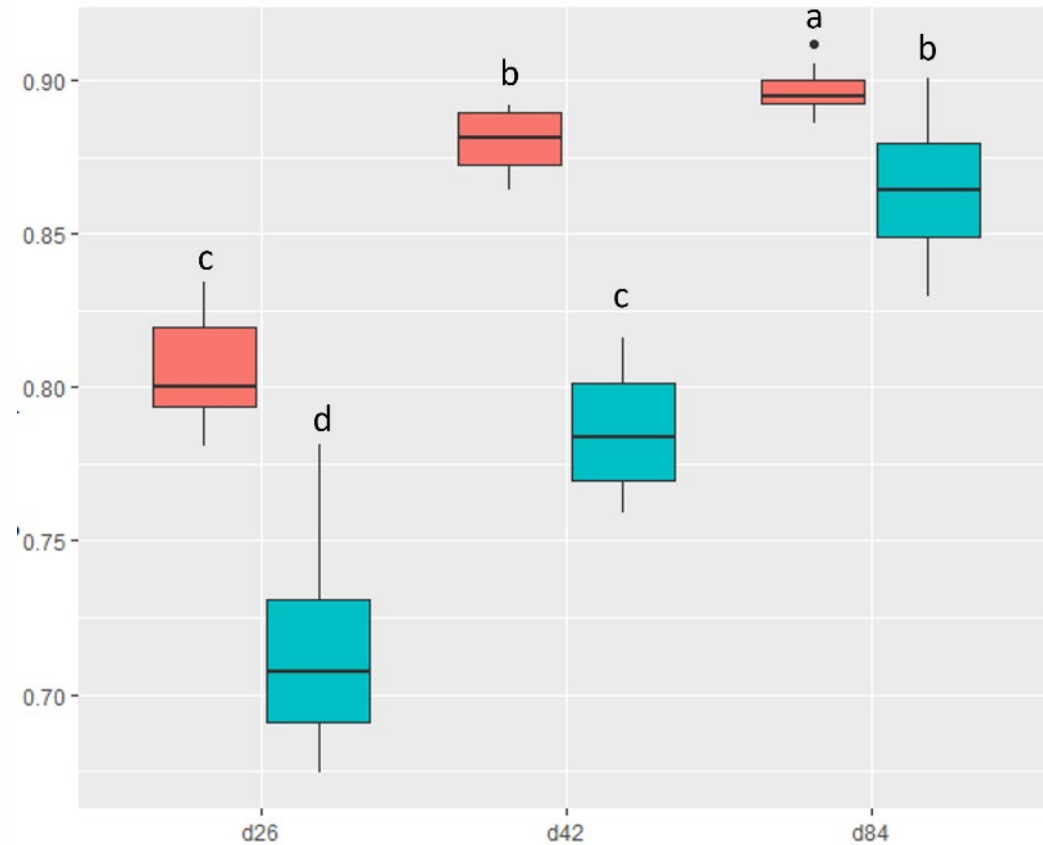


Gross energy ATTD

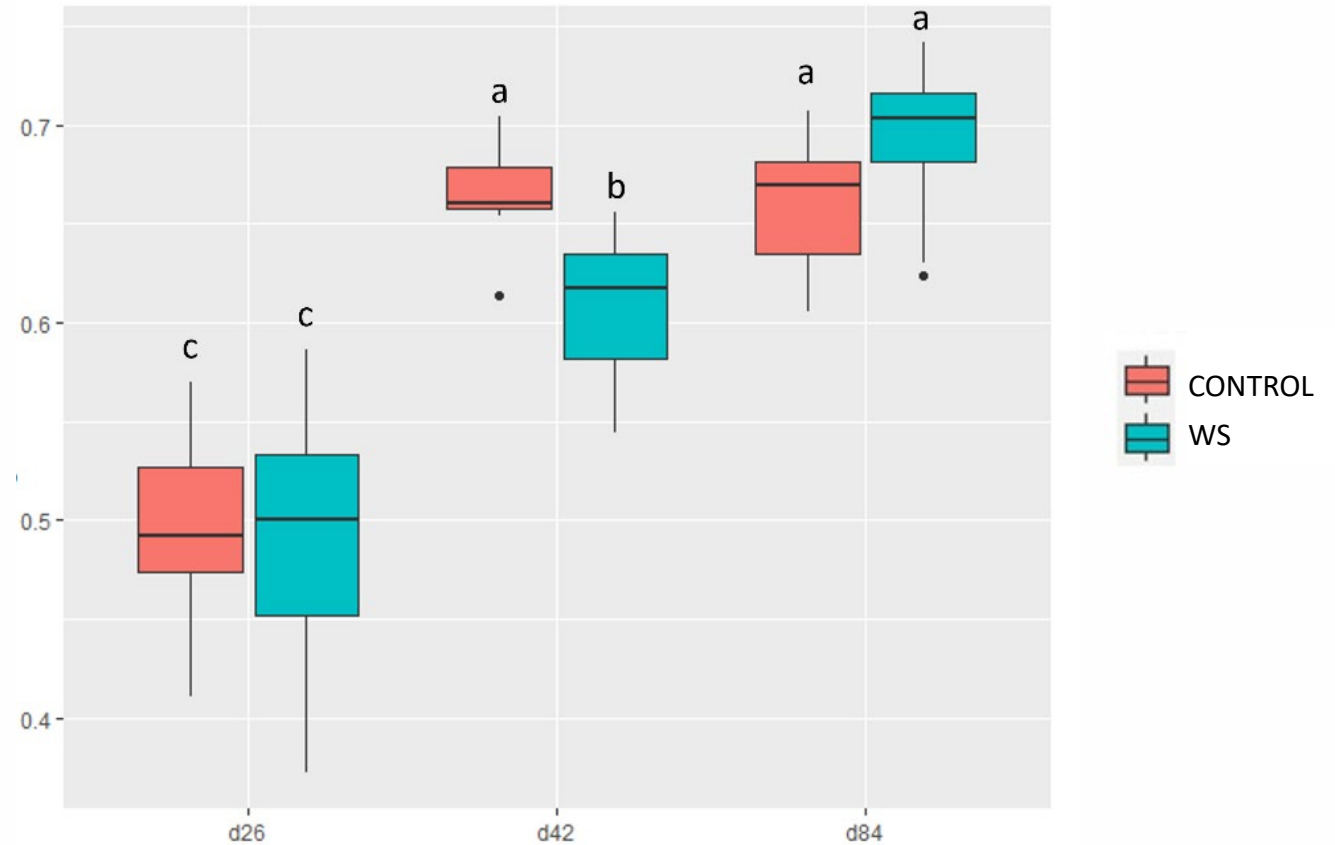


Results: fecal ATTD

Crude protein ATTD



Neutral detergent fiber ATTD





Life cycle analysis (LCA)

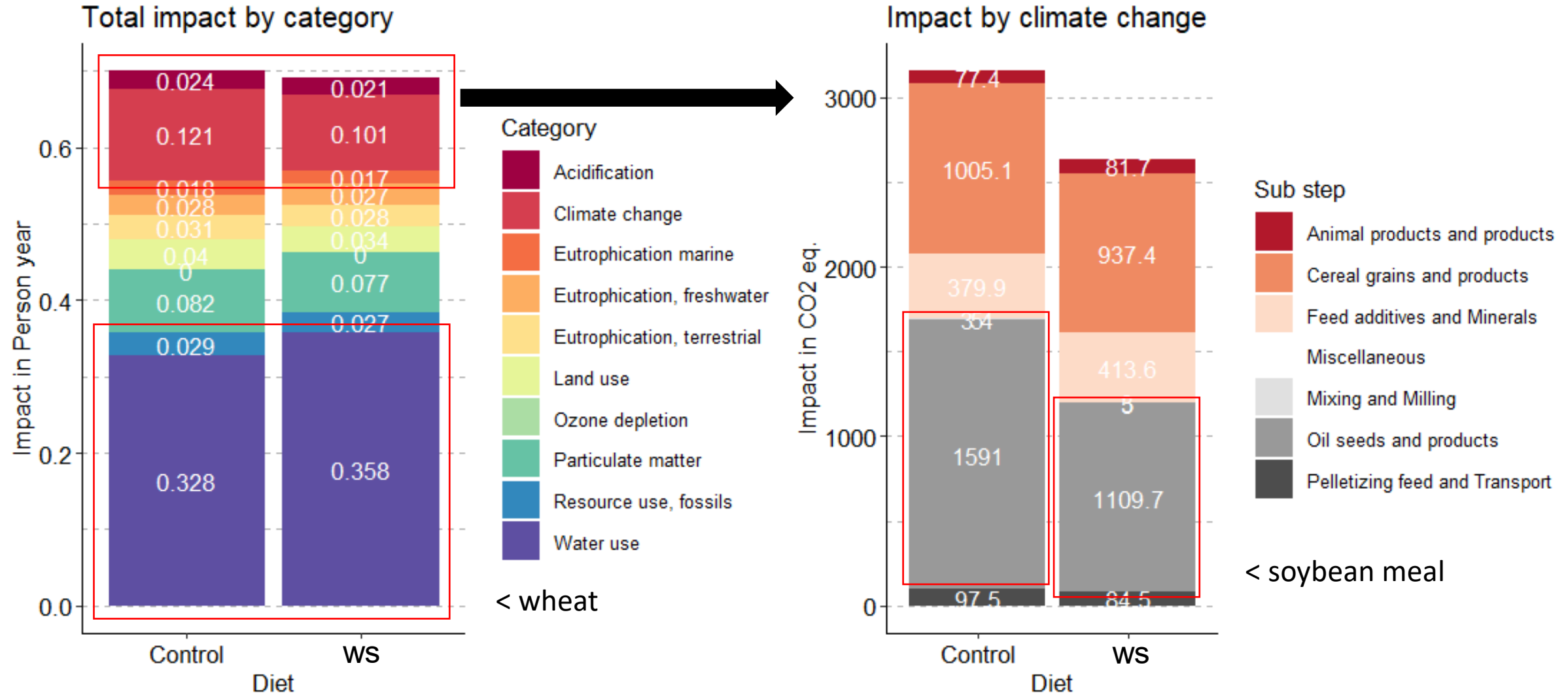
Ingredient LCA (1 ton) – grown in Catalonia

EF 3.1 methodology (Economic allocation)

LCA categories	White sorghum, 1 ton	Maize, 1 ton	Wheat, 1 ton
Climate change (kg CO ₂ eq)	262	257	596
Water use (m ³ depriv.)	21387	27885	27
Acidification (mol H ⁺ eq)	1.81	1.91	4.59
Particulate matter (disease inc.)	1.16E-04	1.01E-04	2.61E-04
Eutrophication, marine (kg N eq)	2.7	2.5	5.5
Eutrophication, freshwater (kg P eq)	0.38	0.30	0.58
Eutrophication, terrestrial (mol N eq)	24.9	23.2	57.1
Land use (Pt)	75975	53384	254439
Ozone depletion (kg CFC11 eq)	1.3E-05	1.5E-05	4.4E-05
Resource use, fossils (MJ)	1008	1200	3393
Total impact (Py)	0.284	0.345	0.143

Feed production LCA (1 ton) using Opteinics™ (BASF, Germany)

GFLI 2.0 reference tables for the rest of ingredients and processes.



Conclusion

Phase	Variable	White sorghum vs control
d 0-29	Growth performance	Worst growth and efficiency
	Fecal ATTD	Worst
d 29-46	Growth performance	Similar
	Fecal ATTD	Worst
d 46-95	Growth performance	Equal
	Fecal ATTD	Similar except for CP: Control: 89.7% vs White sorghum: 86.5%

- The inclusion of **up to 50% white sorghum** (Arsenio) in **finishing feed** formulations for pigs (> 70kg BW) does **not negatively impact** their **growth** performance.
- The inclusion of white sorghum (Arsenio) in the feed formula offers a **sustainable alternative** that can help reduce the environmental impact of production.

THANK YOU!

