

Can eastern pigs be fed western diets?

Rebalancing rations in the era of corn root worm

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Objective:

The following slides are designed to provide swine producers with information required to gain confidence in the utilization of alternate ingredients (especially wheat) in swine rations

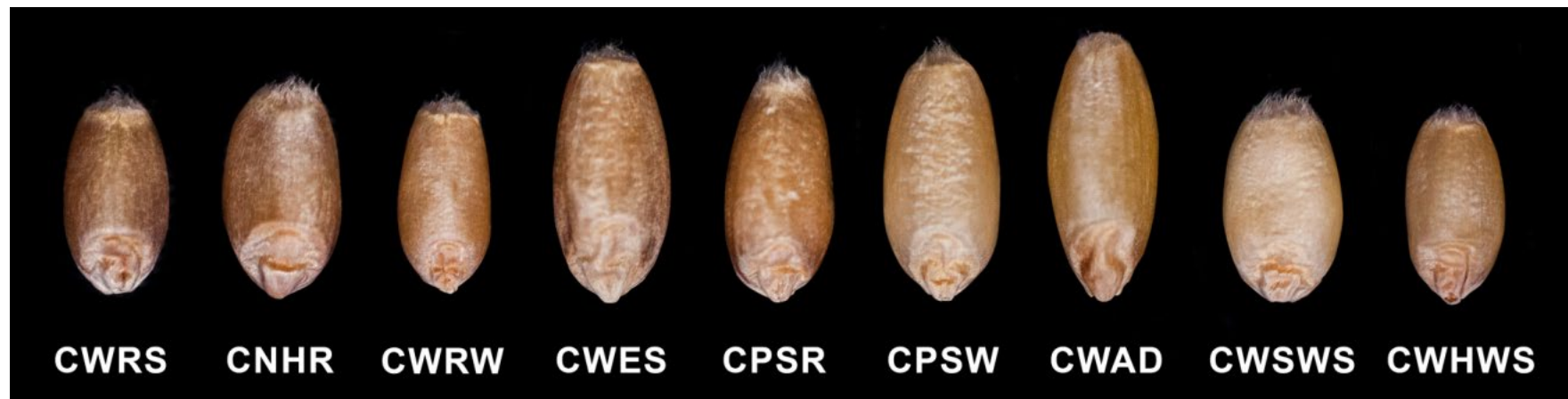


The Problem



CORN ROOTWORM LARVAE ON CORN ROOTS. PHOTO COURTESY OF JOCELYN SMITH, UGRC.

Solution?



Western Red
Spring

Western
Red
Winter

Canadian
Western
Extra Strong

Prairie Spring Red
and White

Western
Amber
Durum

<https://grainscanada.gc.ca/en/grain-quality/grain-grading/wheat-classes.html>



Wheat grown in Ontario is primarily Canada Eastern Soft Red Winter



2020 Summary Data, Ontario wheat quality

	Soft red winter wheat	Hard red winter wheat	Soft white winter wheat
Test weight kg/hL (13.5% moisture basis)	75-80	78-83	71-81
Protein	8.9-11.1	11.4-12.7	7.3-13.7
Moisture	13.2-14.7	13.0-14.8	14-16.2
Bushel weight *	62	65	61

*1 kg/hL = 0.802 lb/bu

What about feed wheat?

Quality characteristics of feed wheat

	Canadian Eastern Feed	Eastern Soft Red Winter No 1
Minimum test weight, kg/hL	65	76
Variety	Any, excluding amber durum	CESRW
Degree of soundness	May be immature or weather damaged	Reasonably matured, reasonably free from damaged kernels
Ergot, %	0.1	0.04
Sclerotinia %	0.25	0.04
Fusarium damage, %	5	1
Total foreign material, %	10	0.8
Heated, mouldy, %	2.5	0.1
Shrunken, %	No limit	6
Broken, %	50	6
Sprouted, %	No limit	0.5

Wheat milling co-products

IFN #		
4-05-258	Hard red wheat	2.57 % CF
4-05-190	Wheat bran	(7.77 % CF, NRC 2012)
4-05-199	< 1% CF	“tail of the mill”
4-05-201	< 7% CF	Wheat middlings
4-05-205	< 9% CF	Wheat shorts
4-05-206	<9.5% CF	Wheat mill run

Wheat “red dog” comparable to middlings?

Does bushel weight indicate feed quality?

	Hectolitre weight		P value*
	Low	High	
ADG kg/d	0.54	0.66	0.001
ADFI, kg/d	1.13	1.14	0.69
G:F	0.46	0.58	0.001
F:G	2.17	1.72	
DE Mcal/kg	3.34	3.53	0.001
NE Mcal/kg	2.39	2.53	0.001

Low wheat 66.42 kg/hl (53.3 lb/bu)
High wheat 73.79 kg/hl (59.2 lb/bu)

Diets formulated with 50% wheat

Fed to 12 kg pigs

Discussion!

The low hectolitre wheat had reduced content of GE, CP and lysine

BUT also higher levels of mycotoxins

“Hectolitre weight combined with chemical and mycotoxin analyses can be useful as a predictor of wheat quality”

Using Saskatchewan wheat samples

- 14 wheat samples (12/14 frost damage)
- 57.8 to 77.6 kg/hL
- Xylose content had the highest correlation with DE ($R^2 = 0.61$)
- Correlation of density (kg/hL) with DE, $R^2 = 0.43$

Density not a good correlation with energy content, but is an indication of other potential quality factors

Recommended inclusion rates of small grains into swine diets

Table 1. Recommended maximum inclusion rates of cereal grains for pigs

Grain	Starter Pigs	Grow-Finish Pigs	Gestation	Lactation	Comparative Value vs. Corn
Wheat	45%	95%	90%	40%	100-110
Barley	25%	95%	90%	85%	95-100
Rye	25%	35%	20%	10%	100-105
Triticale	25%	95%	25%	40%	95-105
Oats*	0-5%	40%	90%	0-15%	80-85

**high fibre content of oats means they have lower energy density. Small pigs and lactating sows already struggle to consume enough energy for their needs, so oat inclusion should be limited in these rations. If high test weight oats are used (greater than 36 lb/bu), inclusion rates of 5% for weaner pigs and 15% for lactating sows can be used*

Nutrient composition of corn and wheat (as is basis)*

		Corn	Hard red wheat
Kcal/kg	DE	3451	3313
	NE	2672	2472
%			
	CP, %	8.2	14.5
	NDF	9.1	10.6
	ADF	2.9	3.6
	P, total	0.26	0.39
	STTD P	0.09	0.22
	Ether Extract	3.5	1.8
% SID	Lysine	0.19	0.32
	Methionine	0.15	0.19
	Threonine	0.22	0.34
g/Mcal	Lys/NE	6.92	12.94

Processing

		Wheat source and particle size, um						
Wheat		Hard red winter wheat				Soft white winter wheat		
	Screen size, mm	6.35	4.06	1.00		6.35	4.83	1.52
	Screen #	16	10	2		16	12	4
	Particle size, um	693	465	245		710	402	258

DeJong et al. 2016



Processing

Wheat		Wheat source and particle size, um					
		Hard red winter wheat			Soft white winter wheat		
	Particle size, um	693	465	245	710	402	258
	Bulk Density, g/L	1,134	1,224	1,088	1,192	1,133	1,125
Diet ^a							
	Pellet durability index, %	74.2	81.2	88.5	48.7	50.9	54.5
	Pellet fines, %	26.9	22.9	24.0	24.1	27.2	22.2

^aDiets contained 78 to 89% wheat



Feeding trial

Performance , 43 kg BW to market

	Hard red winter				Soft white winter		
Particle size, um	683	465	245		710	402	258

Summary

Improved ADG and ADFI, feeding hard red winter wheat, relative to soft white winter wheat

Reducing particle size of wheat included in **meal** diets improved ADG and G:F. However, reducing particle size of wheat in **pelleted** diets had no effect on growth or carcass traits

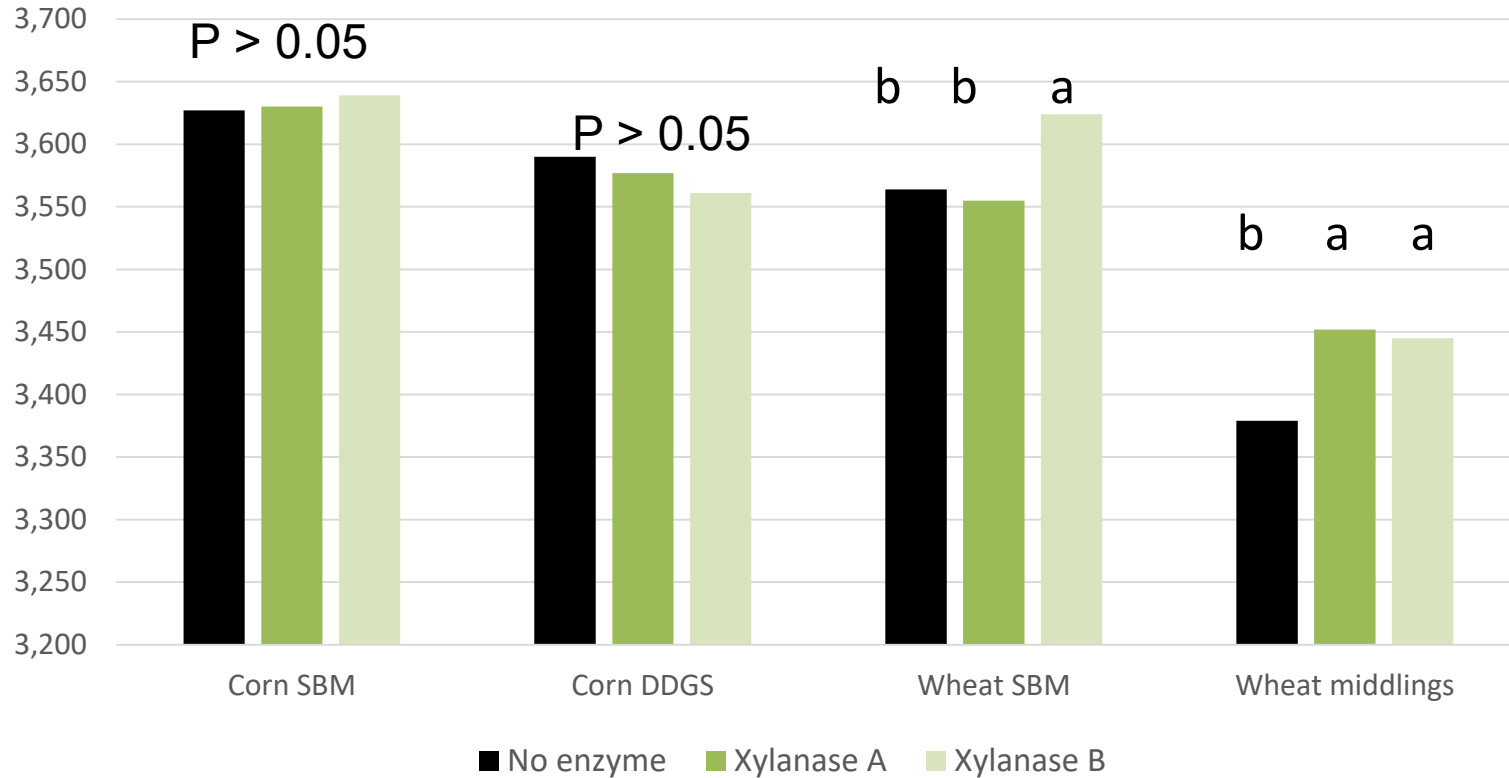
Use of carbohydrases?

	Corn-SBM	Corn-SBM-DDGS	Wheat-SBM	Wheat-SBM-middlings
Corn	71.4	47.6		
DDGS		30.0		
Wheat			73.75	44.9
Wheat middlings				30.0
SBM	24.0	18.0	22.0	21.0
NE, kcal/kg	2,476	2,416	2,348	2,247
Total dietary fibre	11.1	18.4	13.9	23.5
Insoluble dietary fibre	10.5	17.4	12.9	21.9

Each of the diets was divided into 3 treatments:

- No enzyme, xylanase A or xylanase B
- Enzymes added at 4x suggested concentration
- Pigs, approximately 35 kg BW

DE (kcal/kg) content of diets



Xylanase improved digestibility of dietary fibre in wheat, but not corn based diets
Action of xylanase a and b differed

Use of carbohydrases?

Conclusion

Potential for carbohydrases to improve digestibility of wheat-based diets

Formulating diets based on wheat for growing swine

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**high fibre content of oats means they have lower energy density. Small pigs and lactating sows already struggle to consume enough energy for their needs, so oat inclusion should be limited in these rations. If high test weight oats are used (greater than 36 lb/bu), inclusion rates of 5% for weaner pigs and 15% for lactating sows can be used*

Examples of wheat based swine diets

	Ingredient cost, Ontario March 2021			
Corn	293			
Wheat	310			
SBM,	642			
Corn DDGS	372			
Wheat midds	310			
Barley	290			
Oat groats				
Tallow	1100			
Dical P				
Lysine				
Methionine				
Threonine				
Vit/Min/Salt				

Examples of wheat based swine diets

	10 to 25 kg BW			
DIET #	1	2	3	4
Corn	60.00			15.0
Wheat		55.45	45.0	46.0
SBM, 47% CP	26.4	20.4	20.5	21.5
Corn DDGS < 4% EE	8.94	10.0	10.0	10.0
Wheat midds		10.0	10.0	
Barley			10.4	
Oat groats				3.19
Tallow	1.97	1.89	1.88	1.50
Dical P	1.05	0.82	0.81	1.15
Lysine	0.50	0.50	0.50	0.57
Methionine	0.08	0.06	0.06	0.09
Threonine	0.12	0.08	0.08	0.14
Vit/Min/Salt	0.93	0.84	0.84	0.85

Examples of wheat based swine diets

	75 to 100 kg BW			
DIET #	1	2	3	4
Corn	65.0	63.5		
Wheat			87.1	72.8
SBM, 47% CP	4.56	34.8		16.2
Corn DDGS < 4% EE	27.2		10.0	10.0
Wheat midds				
Barley				
Oat groats				
Tallow	1.27	0.75		0.03
Dical P	0.78	0.54	0.71	0.61
Limestone			1.30	
Lysine	0.50		0.51	
Methionine				
Threonine	0.29		0.08	
Vit/Min/Salt	0.35	0.39	0.33	0.33

Examples of wheat based swine diets

30% millrun

	90 to 125 kg BW	
Wheat	45.7	18.4
Wheat millrun	0	30.0
Barley	43.0	42.3
Soybean meal	8.0	6.0
Canola oil	1.20	1.40
DE, Mcal/kg (measured)	3.50	3.32
NE, Mcal/kg (calculated)	2.46	2.34

Performance response to 30% wheat millrun

	Millrun, %			Enzyme			Pooled SEM		P-value	
Item	0	30		No	Yes				Millrun	Enzyme
BW, kg										
Initial	60.1	60.3		59.8	60.6		1.27		0.63	0.10
Final	120.6	118.9		119.6	120.0		0.72		0.10	0.69
ADG, kg d ⁻¹										
d 0 to 56	1.10	1.07		1.09	1.08		0.02		<0.05	0.65
ADFI, kg d ⁻¹										
d 0 to 56	2.85	2.90		2.85	2.90		0.05		0.41	0.51
G:F										
d 0 to 56	0.39	0.37		0.38	0.37		0.01		0.01	0.20

The millrun was substituted for the wheat, resulting in a reduction of ~ 150 kcal NE/kg

Reduction in gain:feed kg/kg, \$\$ per kg will depend on cost of millrun vs wheat

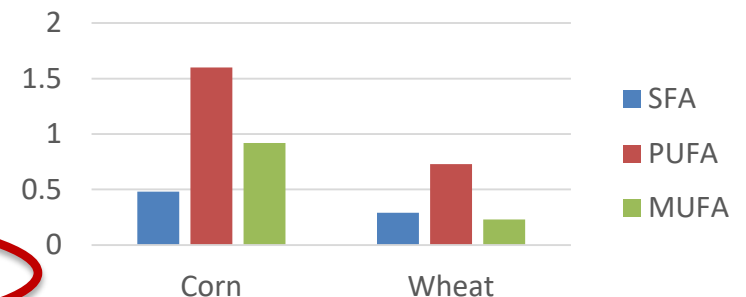
What about pork quality?

		Corn	Hard red wheat
Kcal/kg	DE	3451	3313
	NE	2672	2472
%			
	CP, %	8.2	14.5
	NDF	9.1	10.6
	ADF	2.9	3.6
	P, total	0.26	0.39
	STTD P	0.09	0.22
	Ether Extract	3.5	1.8



Wikipedia.com

FA, % as fed



Pork Quality?

	Wheat	Corn
Corn	0.00	80.45
Wheat	87.13	0.00
SBM	8.49	15.37
Tallow	0.46	0.00
Dical P	1.27	1.49
Limestone	0.95	1.08
Salt	0.50	0.50
Lysine	0.21	0.11
Vit/Min Premix	1.00	1.00

Diets fed throughout the finishing period.

Marketed at ~ 115 kg BW

No effect of diet on carcass characteristics, pork fat composition or colour,

Formulating diets with wheat

(or decreasing corn content of swine diets)

- Use the net energy (NE) system, SID amino acids and STTD (or available) P
- Allow the NE content to decrease ?
- Formulate based on nutrient (ie LYS) to NE ratio
- Assume calorie intake will be maintained, thus feed efficiency will be reduced
 - Example from the NRC 2012 model, pigs growing from 100 to 135 kg BW
- Ensure adequate feeder space

	100 to 135 kg BW
Diet NE, kcal/kg	2475
Gain, kg	35
Feed intake, kg	112.5
G/F	0.311
Diet NE, kcal/kg	2350
Feed intake, kg	118.5 (constant NE intake)
G/F	0.295

Formulating diets with wheat (or decreasing corn content of swine diets)

Economics

- Use least-cost formulation
- Or – take advantage of on-line tools:
- Example: Stein, Pahm and Roth, Swine Focus #002 Feeding Wheat to Pigs 2010

Mycotoxins

- Monitor, specifically deoxynivalenol (DON)
- DON will concentrate in most wheat by-products
- Follow CFIA guidelines for purchasing, feeding contaminated feeds

Table 7. Maximum price (\$/bushel) that can be paid for wheat at different costs of corn and soybean meal (SBM) without increasing cost of the complete diet ^{a,b,c}

SBM, \$/ton	Corn, \$/bushel			
	3.0	4.0	5.0	6.0
200	3.23	4.27	5.31	6.35
250	3.29	4.33	5.37	6.41
300	3.35	4.39	5.43	6.47
350	3.41	4.45	5.49	6.53
400	3.47	4.51	5.55	6.59

^a Calculations based on soybean meal containing 47.5% crude protein.

^b For each combination of costs for corn and soybean meal, the price indicated for wheat will result in identical diet costs for a corn-soybean meal diet and a wheat-soybean meal diet. Total diet costs will be reduced if wheat can be purchased at prices that are less than indicated in the table.

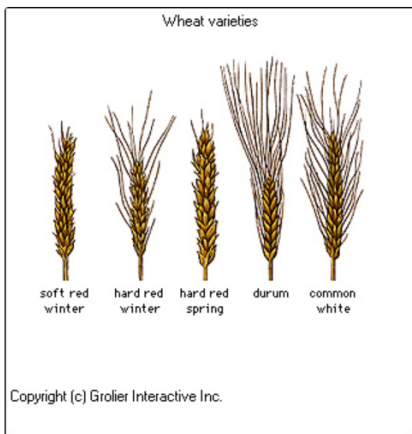
^c One bushel of corn = 25.45 kg; one bushel of wheat = 27.22 kg; one ton of soybean meal = 907 kg.

Dept. of Anim. Sci. College of ACES, The University of Illinois at Urbana-Champaign

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Questions? Comments?

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Feed Grade

Grade #3

	Test Weight	% of Sprouts	% Max FDK
CEWW	69 kg/hl	8.00%	1.00%
CEHRW	69 kg/hl	8.00%	1.50%
CERS	69 kg/hl	8.00%	1.50%
CESRW	69 kg/hl	8.00%	1.50%
CER	69 kg/hl	8.00%	1.50%

FDK = Fusarium
damaged kernels

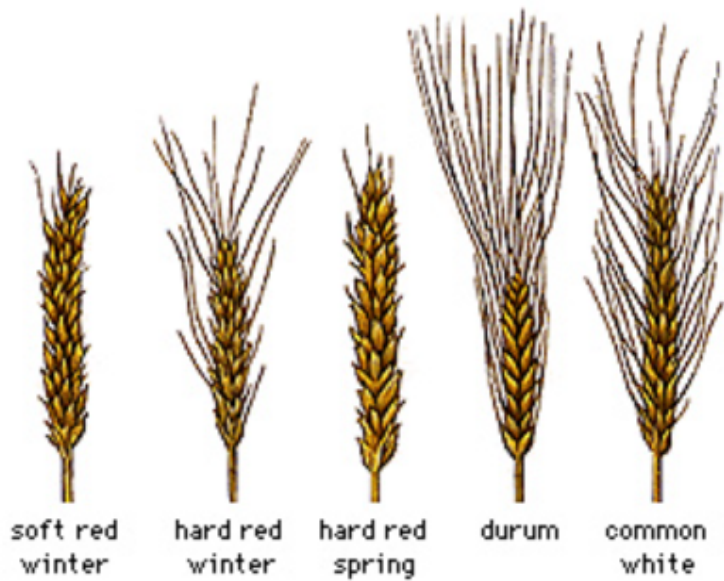
CE: If graded Canada Feed only because of sprouts and test weight.

Grade Discounts

Feed discounts will apply at time of delivery. Grain Farmers of Ontario does not accept sample grade wheat.

Soft White Winter (Pool A)	Grade #3	\$10/tonne
Hard Red Winter (Pool B)	Grade #3	\$10/tonne – no protein payment
Hard Red Spring (Pool C)	Grade #3	\$10/tonne – no protein payment
Soft Red Winter (Pool E)	Grade #3	\$10/tonne
Hard Red (Pool F)	Grade #3	\$10/tonne

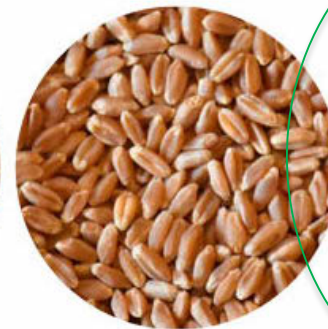
Wheat varieties



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Hard Red Winter



Hard Red Spring



Soft Red Winter



Soft White



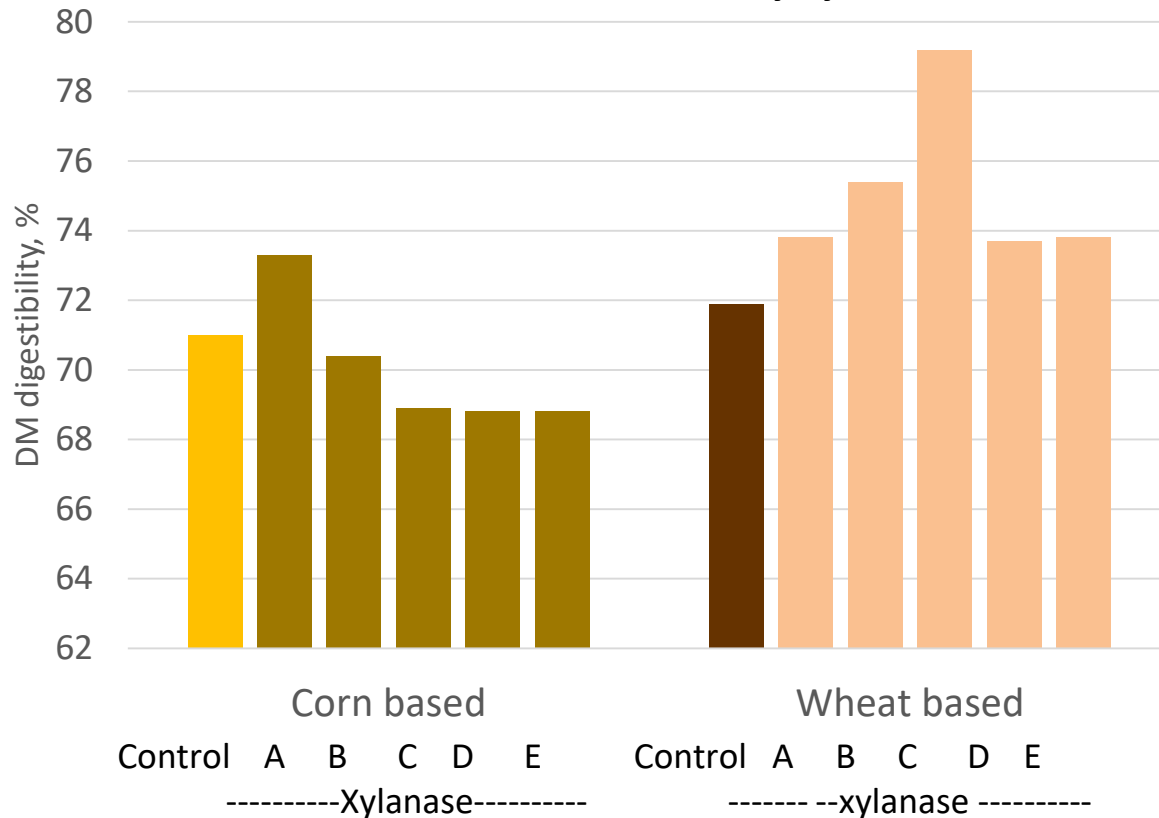
Hard White



Durum

Xylanase and grain source

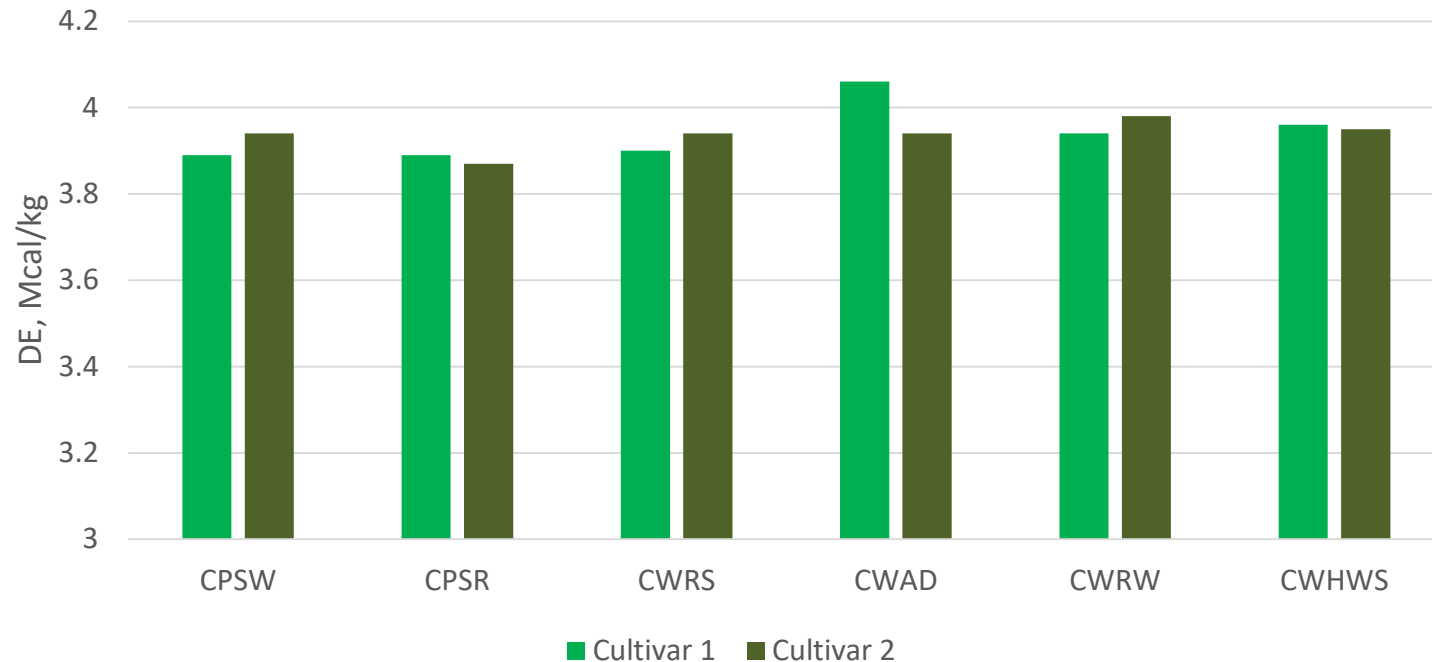
Diet by xylanase $P = 0.06$



Differential effect of xylanase on **DM, energy and CP** digestibility depending on grain source.

This led to differential effects on diversity of piglet gut microbiota

Research suggests that the DE content of wheat may differ among classes



In this study, the performance of weaned piglets was comparable when fed diets formulated with these wheat classes (~ 65% inclusion) for a 21 day trial.