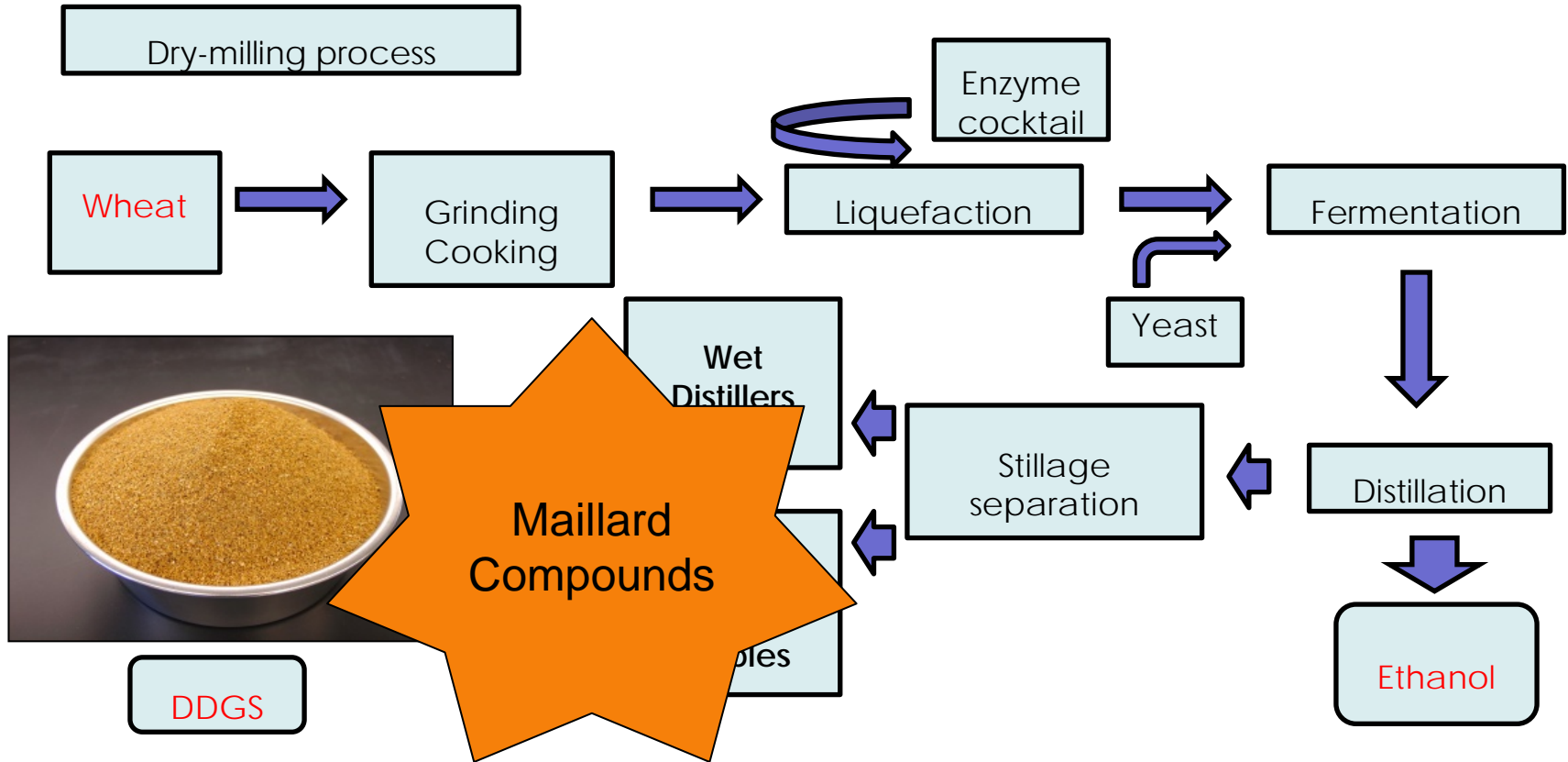


WDDGS Commercial application - pig

What is DDGS?

- Similar to production of brewery co-products
- Fermentation of ground hydrolysed wheat
- Production of:
 - Syrup
 - Distillers wet grains
 - Distillers dried grains with solubles

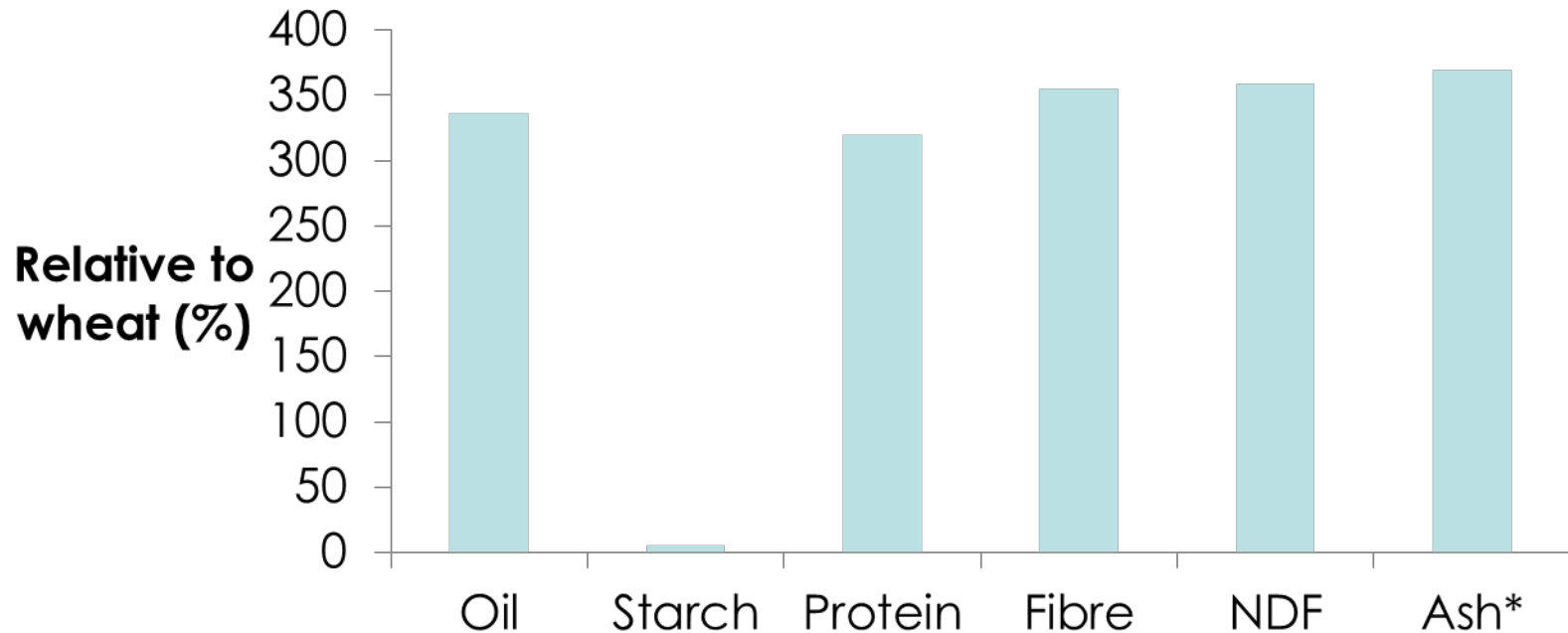
Distillers dried grains with solubles (DDGS)



Determination of nutritional value

- Chemical analyses
- Animal studies
 - Digestibility studies
 - Ileal digestible amino acid values
 - Growth studies
 - Dose response to raw material inclusion

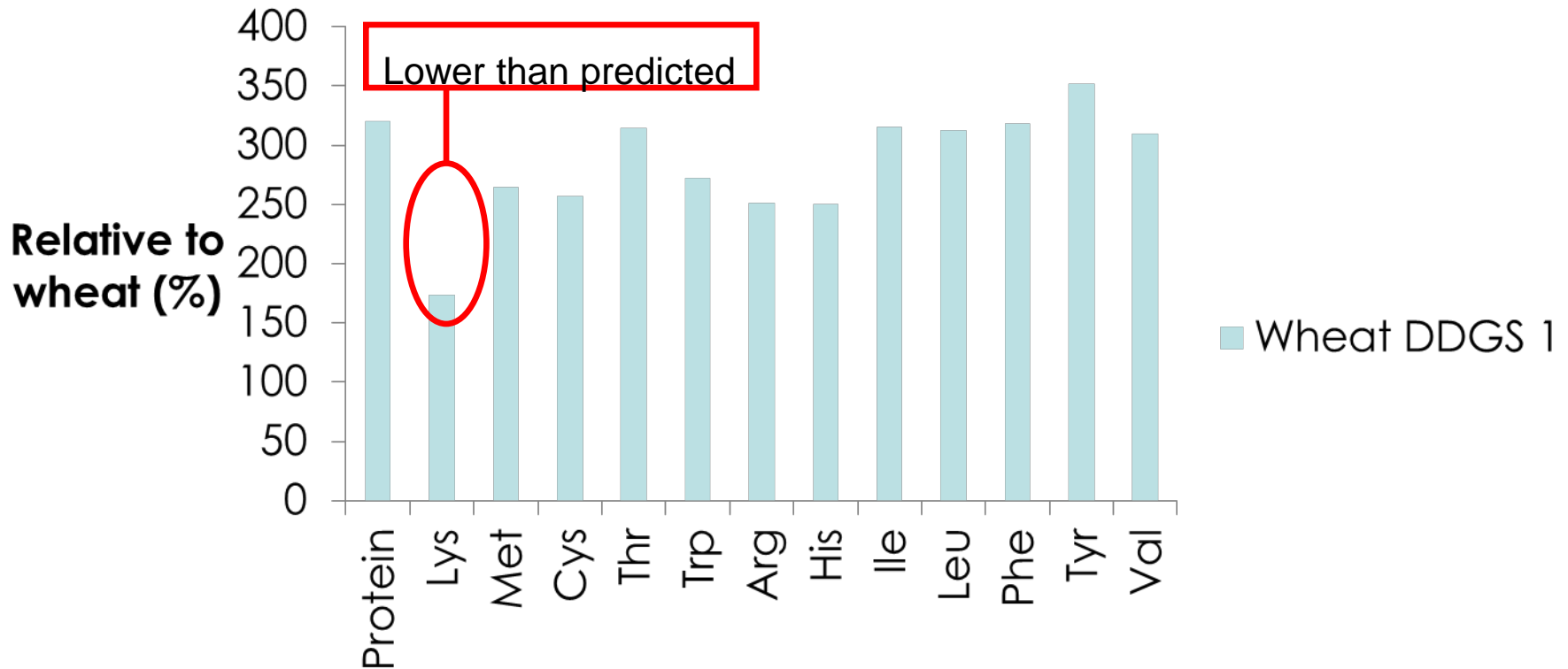
Composition of wDDGS



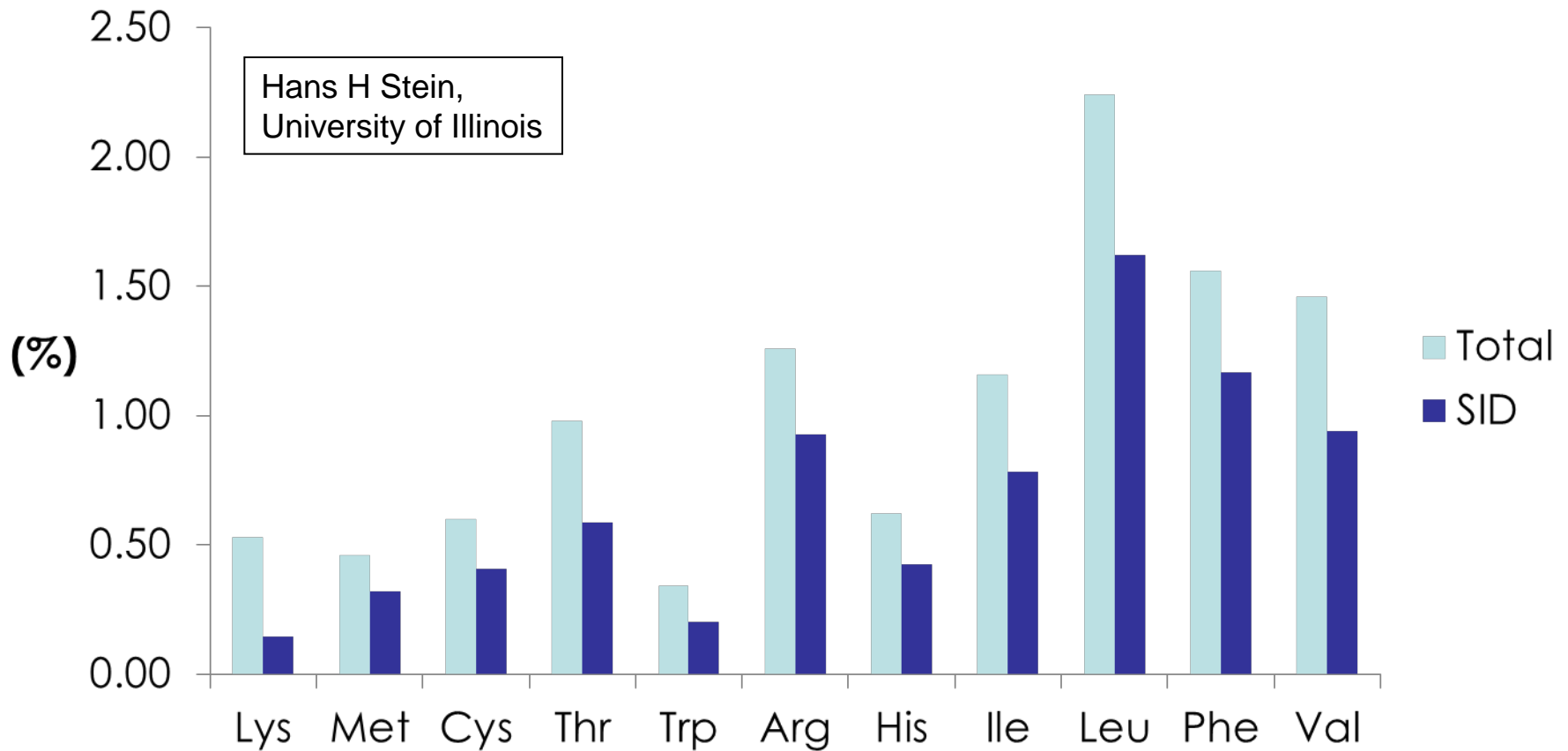
*High in sodium due to addition of sodium hydroxide

Amino acid composition of wDDGS

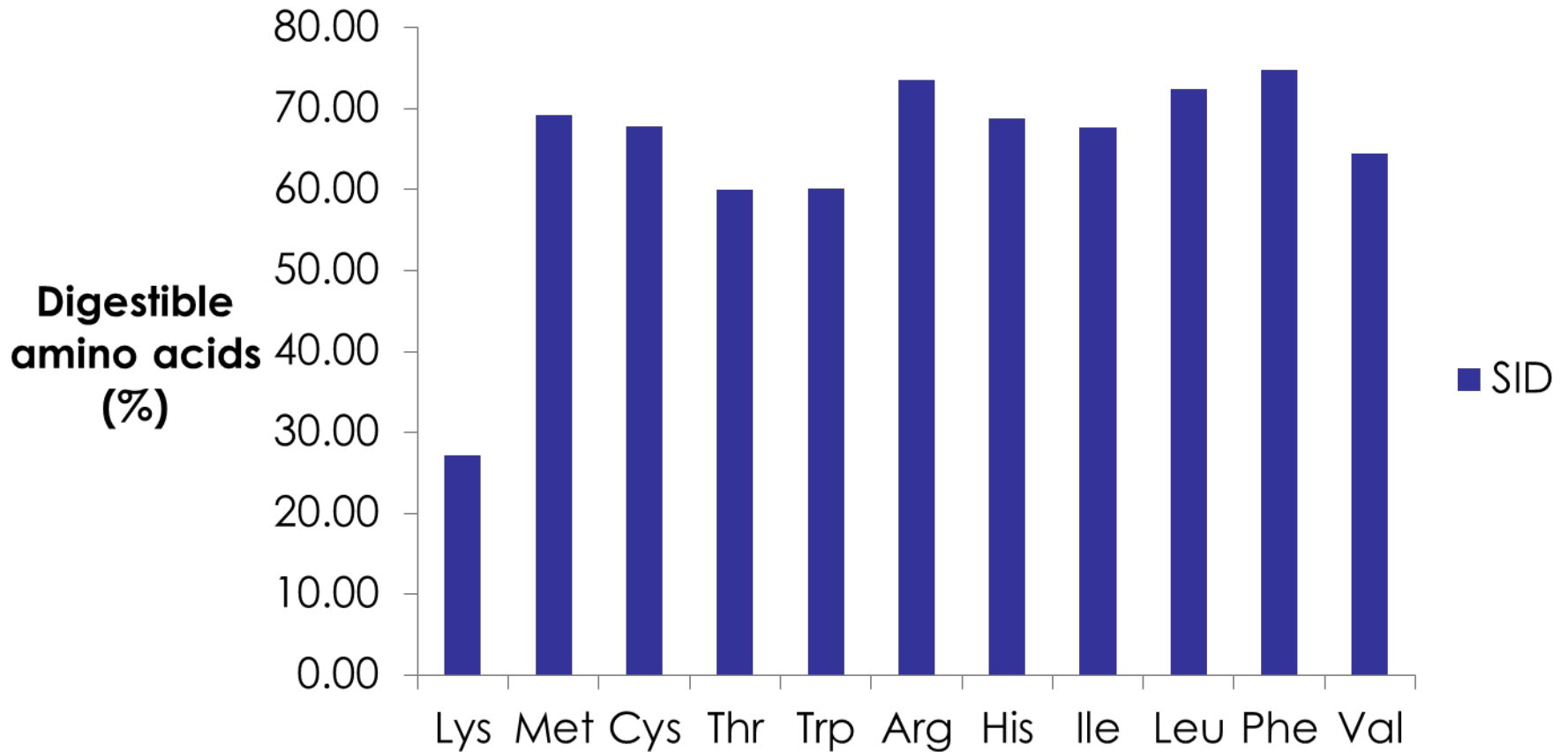
Wheat DDGS 1



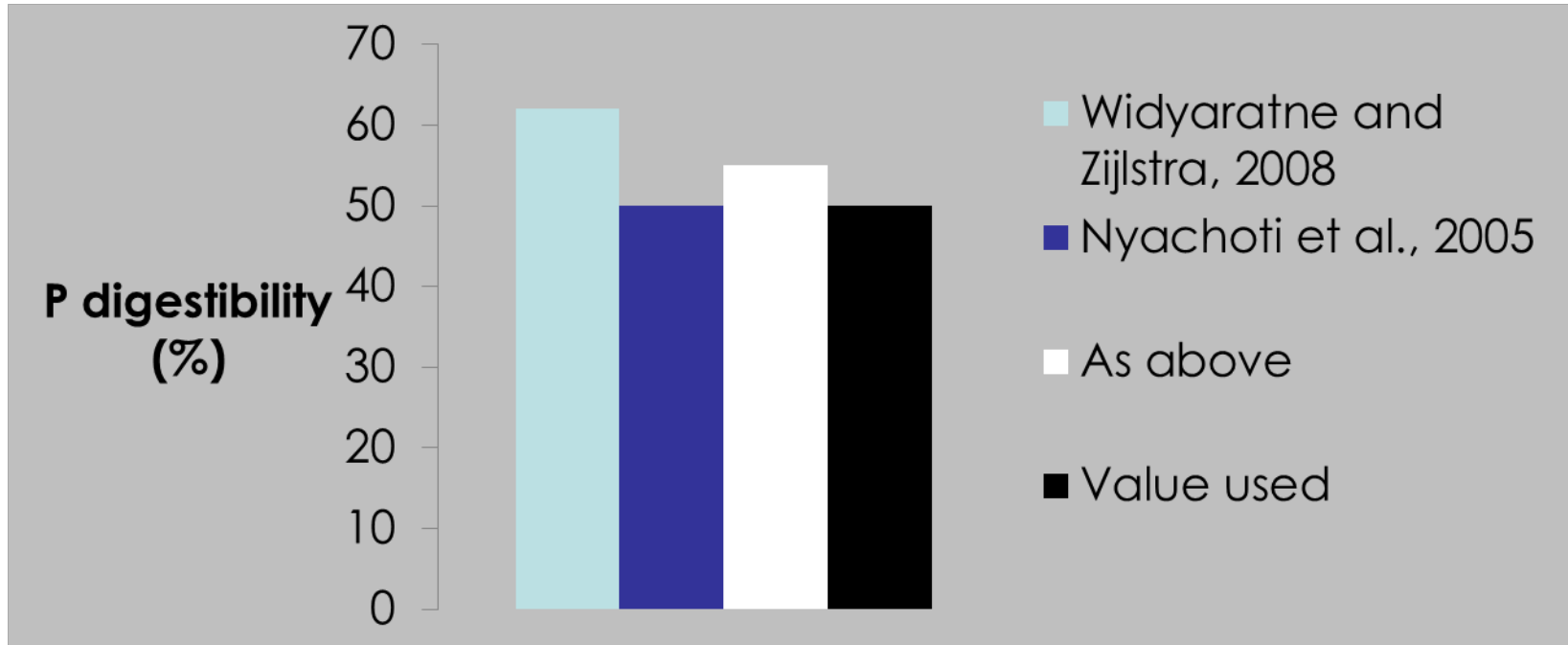
Amino acid composition of wDDGS



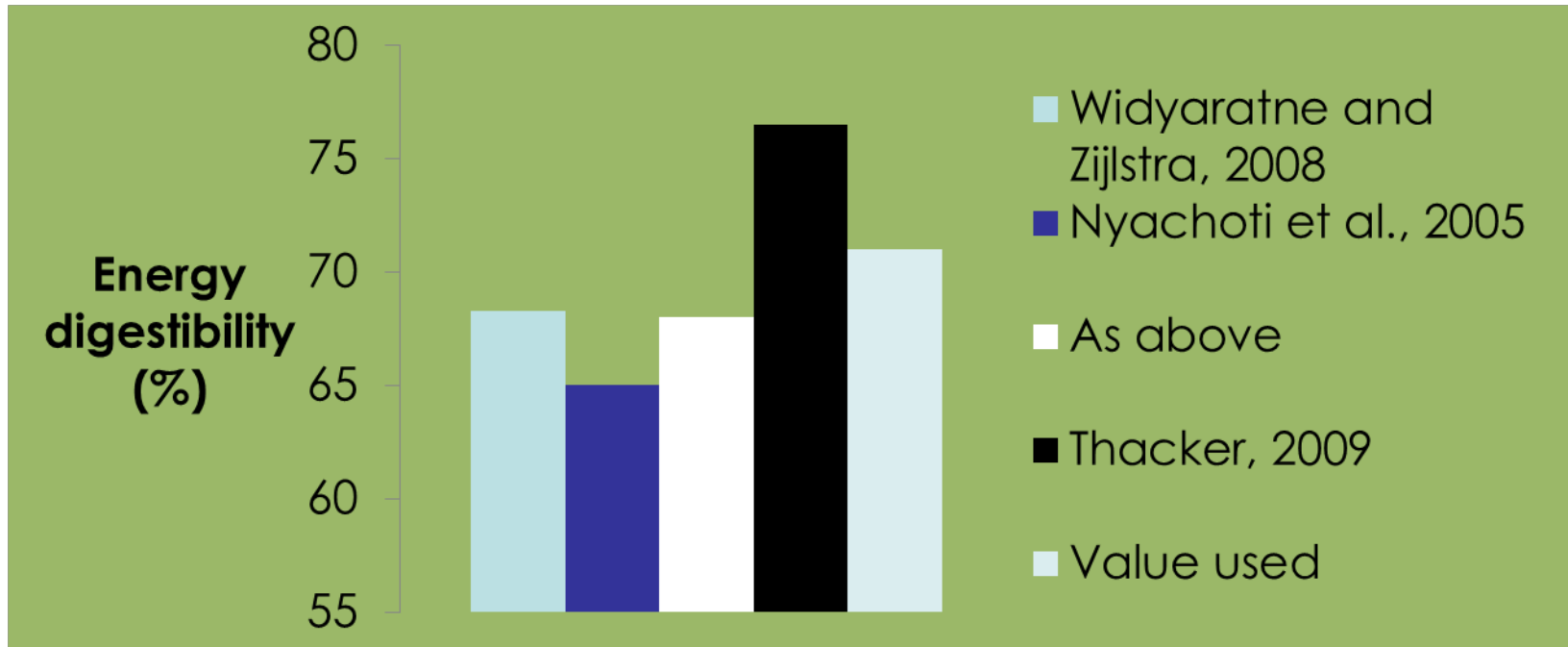
Low lysine digestibility



Digestibility of phosphorus in wDDGS may be higher than wheat



Digestibility of energy in wDDGS



Digestible energy used in study – 12.85 MJ/kg

Growth Studies

- University of Nottingham
 - Boars only
 - Single pig per pen
 - 35 – 65 kg, 65 -105 kg
- Harper Adams University
 - Mixed sex
 - Group housed
 - 40 – 60 kg, 60 – 98 kg

Diet Specification	Grower	Finisher
NE (MJ/kg)	8.95	8.90
SID Lysine (%)	0.95	0.70
wDDGS (%)	0	
	10	
	20	
	30	

Performance comparison - growth

	Nottingham						
	Gain (g/day)						
	Grow	Fin					
0 %	1030	1110					
10 %	1100	1190					
20 %	1080	1180					
30 %	1040	1080					
P	0.259	0.618					

Performance comparison - growth

	Nottingham				Harper			
	Gain (g/day)				Gain (g/day)			
	Grow	Fin			Grow	Fin		
0 %	1030	1110			806	876		
10 %	1100	1190			884	892		
20 %	1080	1180			840	853		
30 %	1040	1080			872	912		
P	0.259	0.618			0.002	0.170		

Performance comparison - FCR

		Nottingham					
		FCR					
		Grow	Fin				
0 %		1.94	3.10				
10 %		1.86	3.15				
20 %		1.86	3.01				
30 %		1.99	3.07				
P		0.793	0.821				

Performance comparison - FCR

	Nottingham				Harper			
			FCR				FCR	
			Grow	Fin			Grow	Fin
0 %			1.94	3.10			2.26	2.77
10 %			1.86	3.15			2.14	2.75
20 %			1.86	3.01			2.13	2.77
30 %			1.99	3.07			2.08	2.67
P			0.793	0.821			0.011	0.266

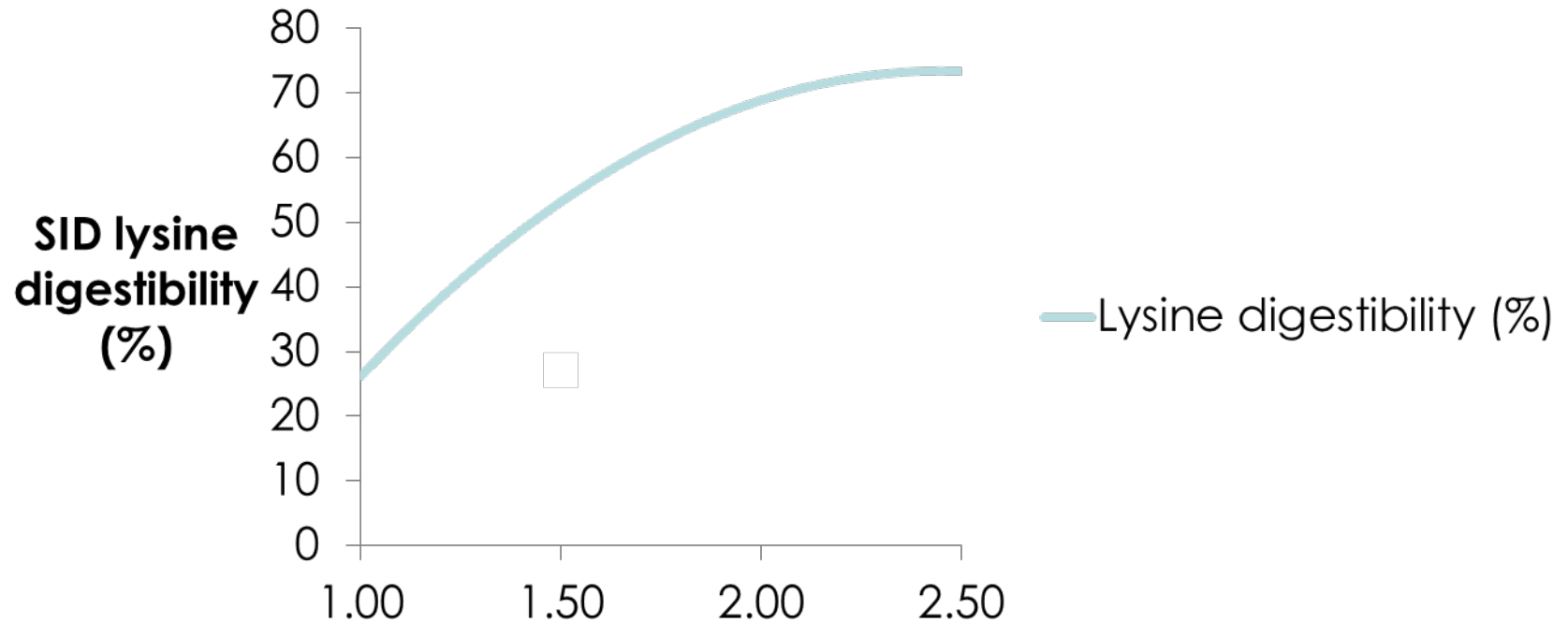
30% inclusion of wDDGS did not reduce performance

	Nottingham				Harper			
	Gain (g/day)		FCR		Gain (g/day)		FCR	
	Grow	Fin	Grow	Fin	Grow	Fin	Grow	Fin
0 %	1030	1110	1.94	3.10	806	876	2.26	2.77
10 %	1100	1190	1.86	3.15	884	892	2.14	2.75
20 %	1080	1180	1.86	3.01	840	853	2.13	2.77
30 %	1040	1080	1.99	3.07	872	912	2.08	2.67
P	0.259	0.618	0.793	0.821	0.002	0.170	0.011	0.266

How can lysine digestibility be predicted?

- Lysine as percentage of crude protein
 - Published range 1.1 – 2.9 (Piron *et al.* 2008)
 - current material 1.53 (SID digestibility 27%)
 - 68% SID digestibility if >1.95 ($R^2 = 0.80$)
 - SID digestibility = $-22.5 \text{ LCP}^2 + 110\text{LCP} - 62$
($R^2 = 0.87$)

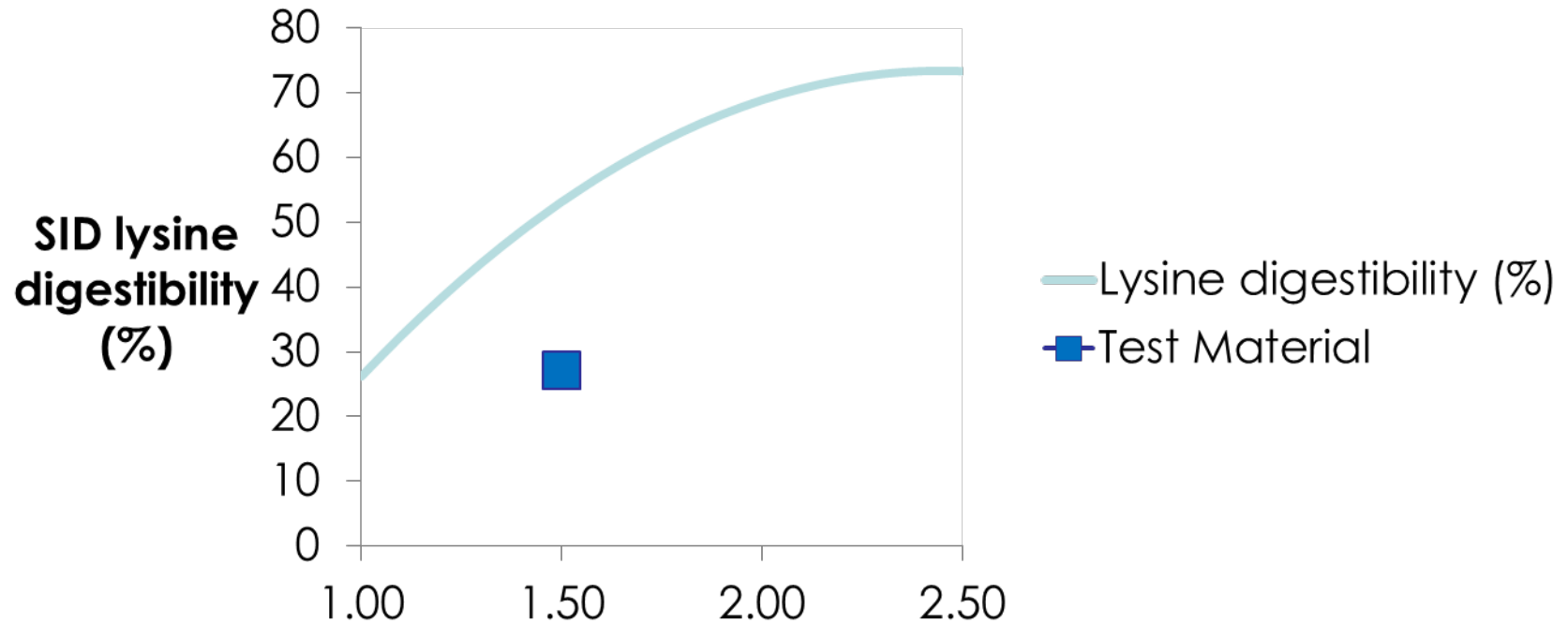
Predicted SID lysine digestibility



$$\text{SID lys} = -22.5 \text{ LCP}^2 + 110\text{LCP} - 62 \quad [R^2 = 0.87 \quad P < 0.001]$$

(LCP = lysine (g/100g protein))

Predicted SID lysine digestibility



$$\text{SID lys} = -22.5 \text{ LCP}^2 + 110\text{LCP} - 62 \quad [R^2 = 0.87 \quad P < 0.001]$$

(LCP = lysine (g/100g protein))

Prediction of lysine digestibility

- Correlated with ADF (SID nitrogen)
 - $SID\ N = -0.2ADF\ (g/kgDM) + 105.3\ (R^2 = 0.75)$



- Correlated with luminance (0-100)
 - $SID\ Lys = 2.5L - 78.2\ (R^2 = 0.47)$

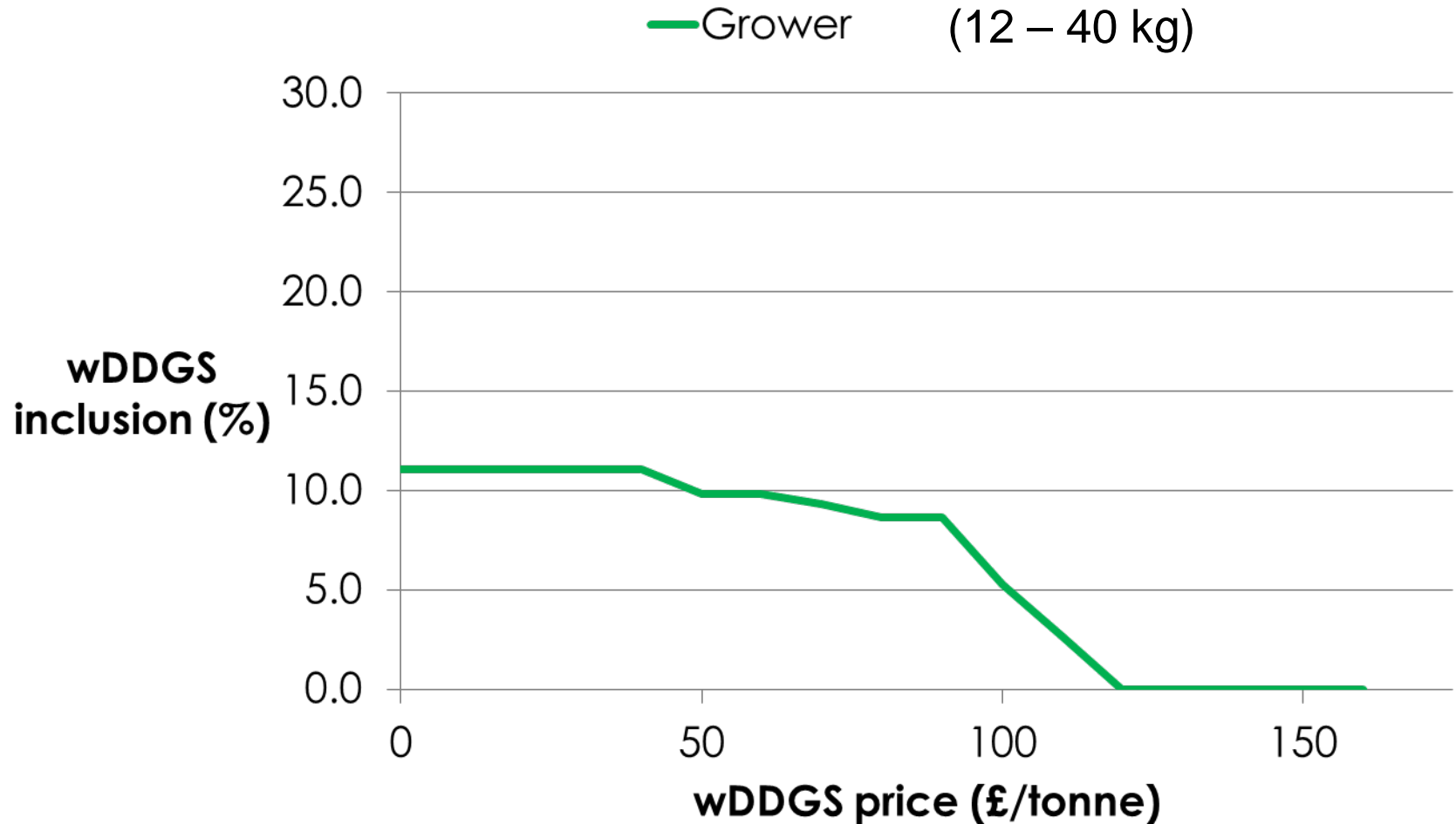
DDGS inclusion levels

Stage	Inclusion (%) Published	Reference	Inclusion (%) ENBBIO
Nursery	>10	Avelar et al., 2010	
Grower	20	Beltranena and Zijlstra, 2010	30
Finisher	25	Thacker, 2006	30
Gestation	30	Swiatkiewicz and Hanczakowska, 2011	
Lactation	20	Swiatkiewicz and Hanczakowska, 2011	

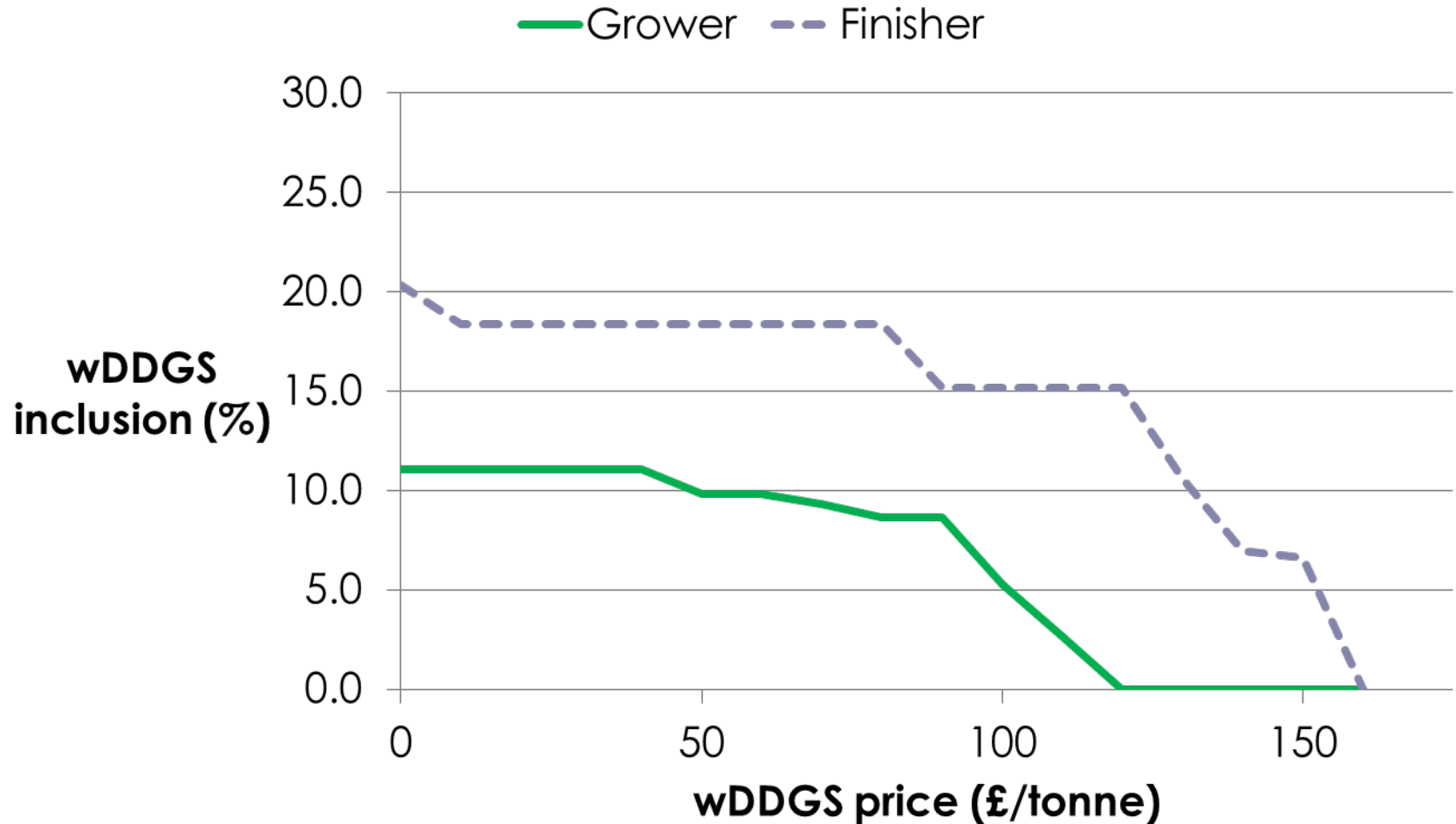


Commercial evaluation

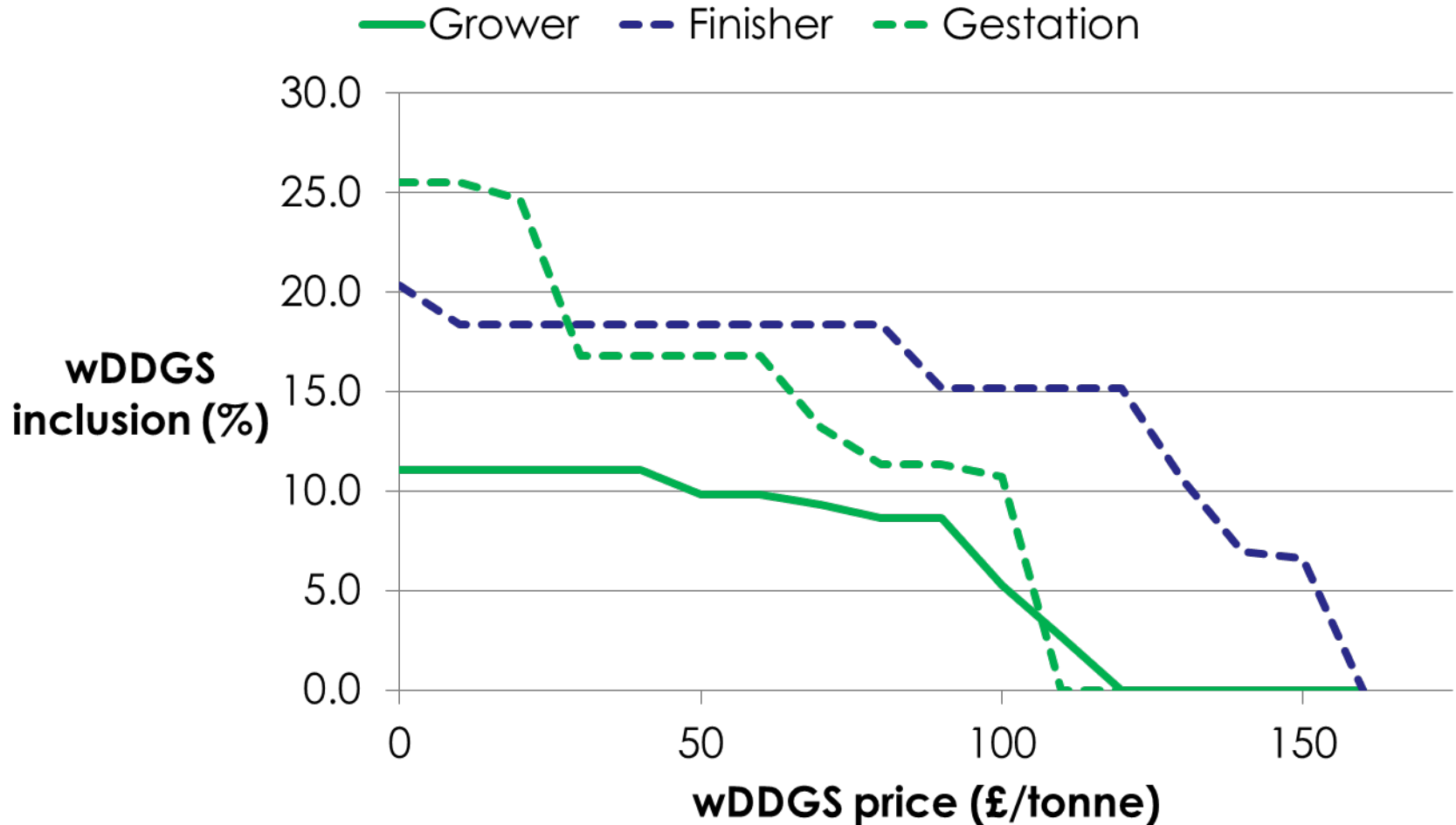
Effect of production stage on value of wDDGS



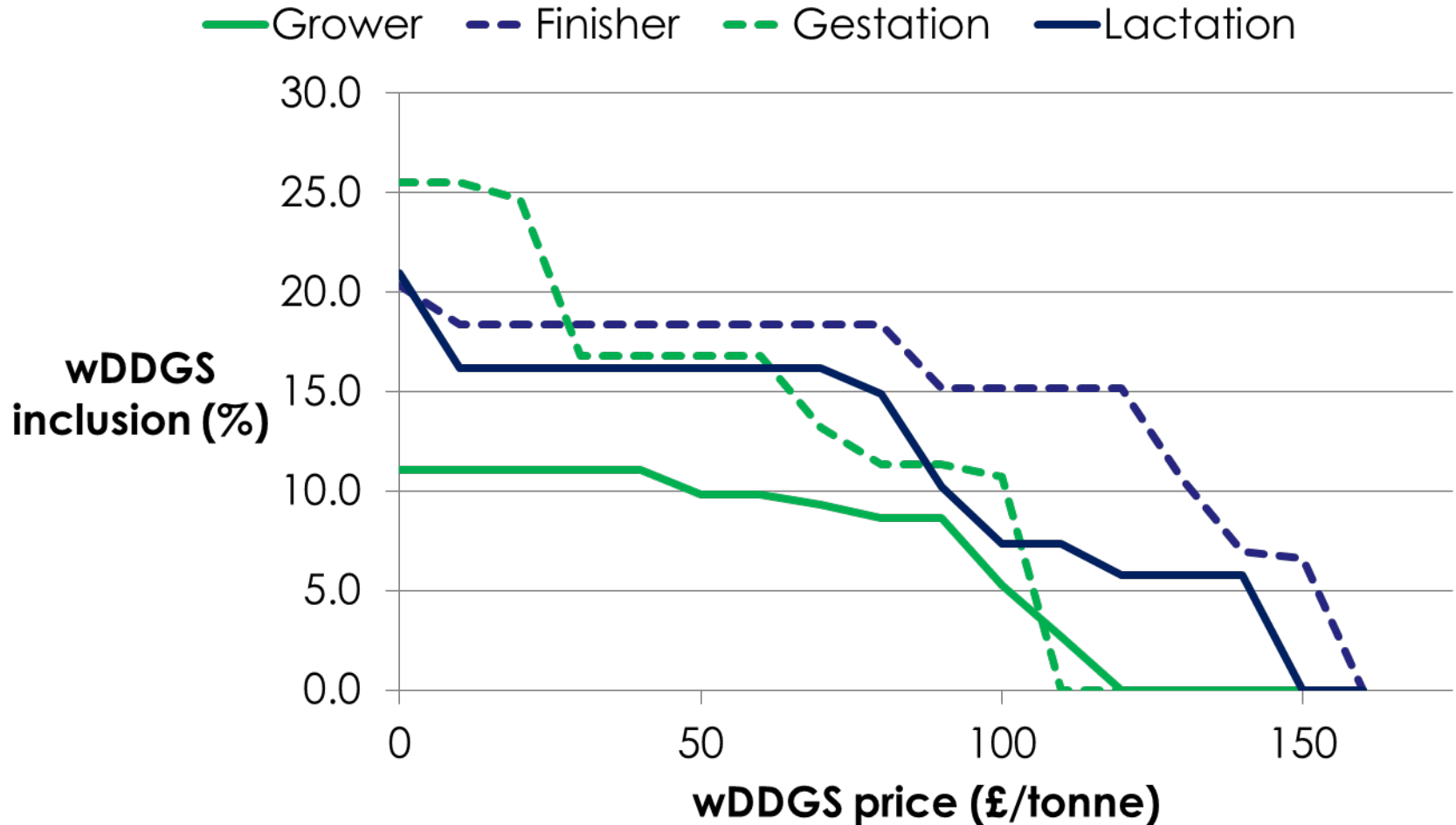
Effect of production stage on value of wDDGS



Effect of production stage on value of wDDGS



Effect of production stage on value of wDDGS

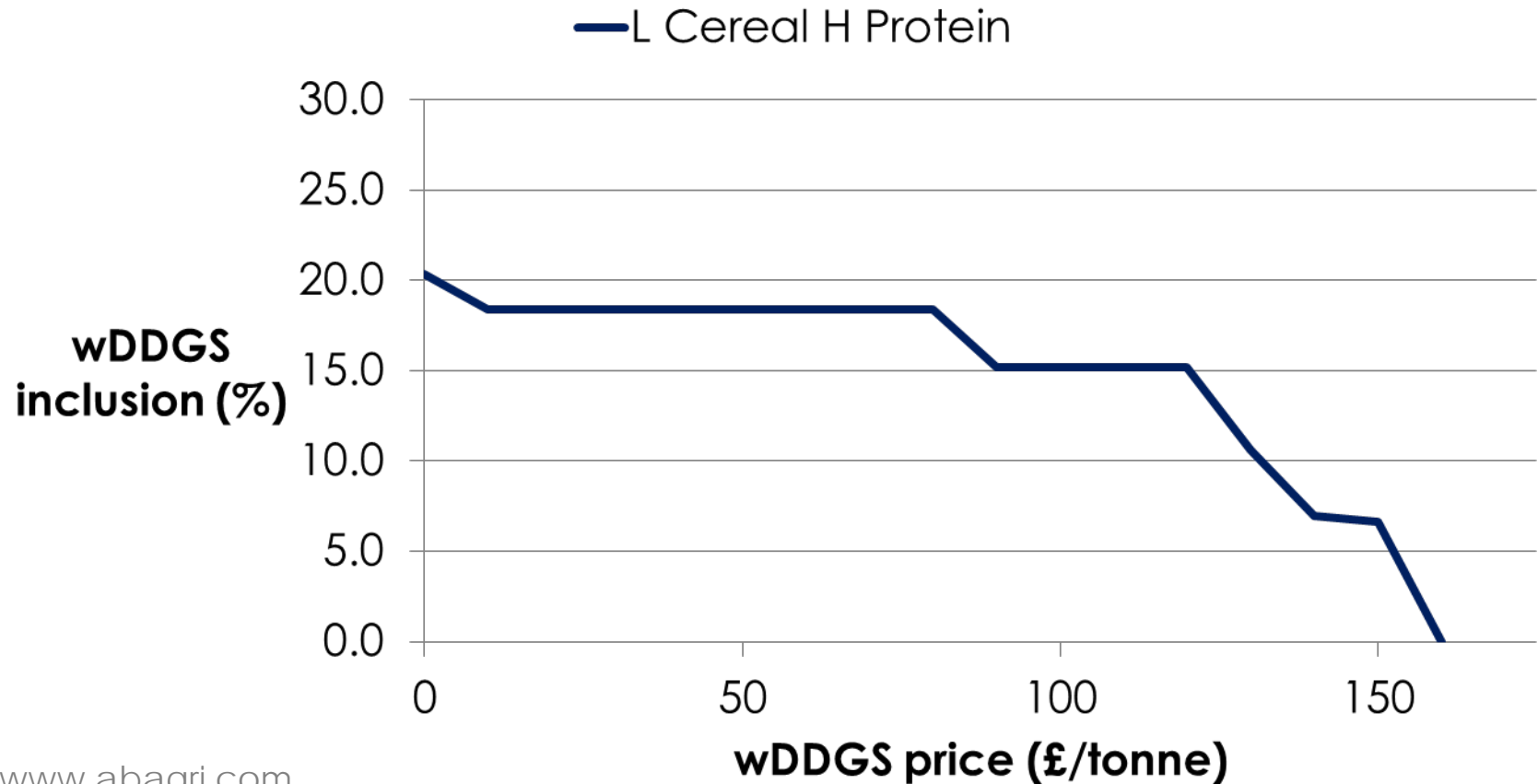


Effect of raw material prices on value of wDDGS

	High Cereal Low Protein	Low Cereal Low Protein	High Cereal High Protein	Low Cereal High Protein
Barley	160	112	160	112
Wheat	175	110	175	110
Wheatfeed	163	105	163	105
Soya	298		375	
Rape Meal	177		220	

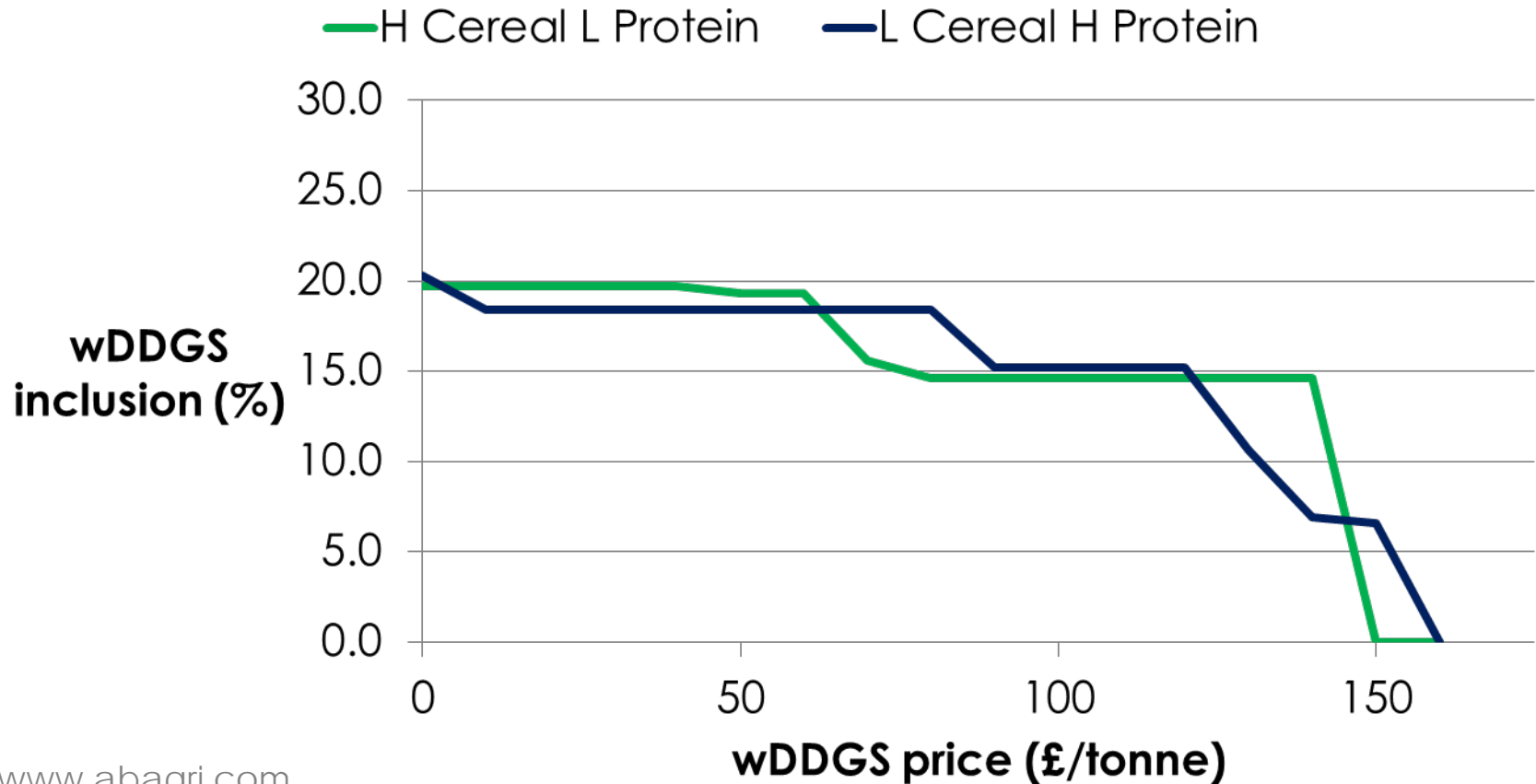
Effect of raw material cost scenarios on value of wDDGS

Finisher diet



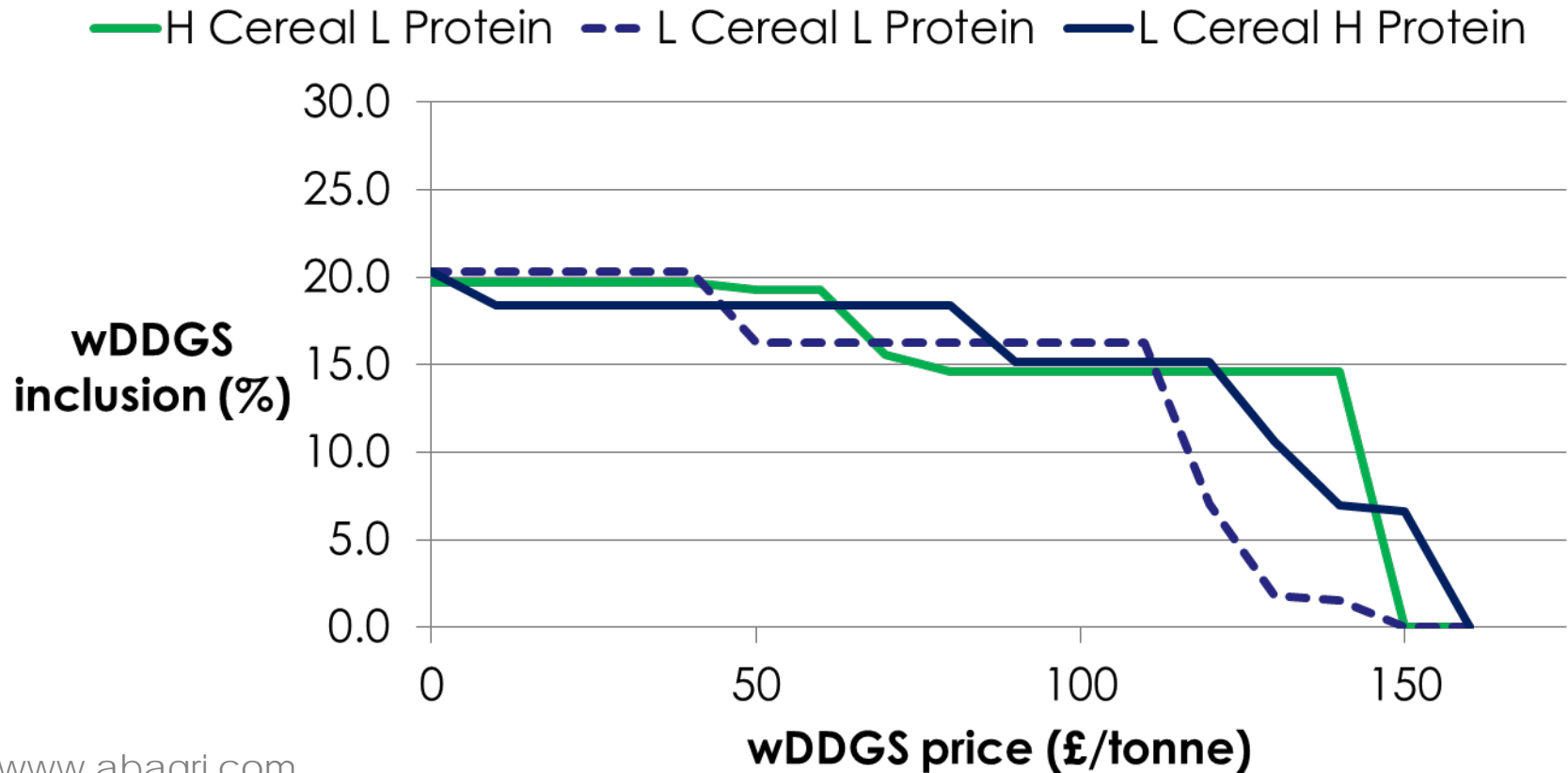
Effect of raw material cost scenarios on value of wDDGS

Finisher diet



Effect of raw material cost scenarios on value of wDDGS

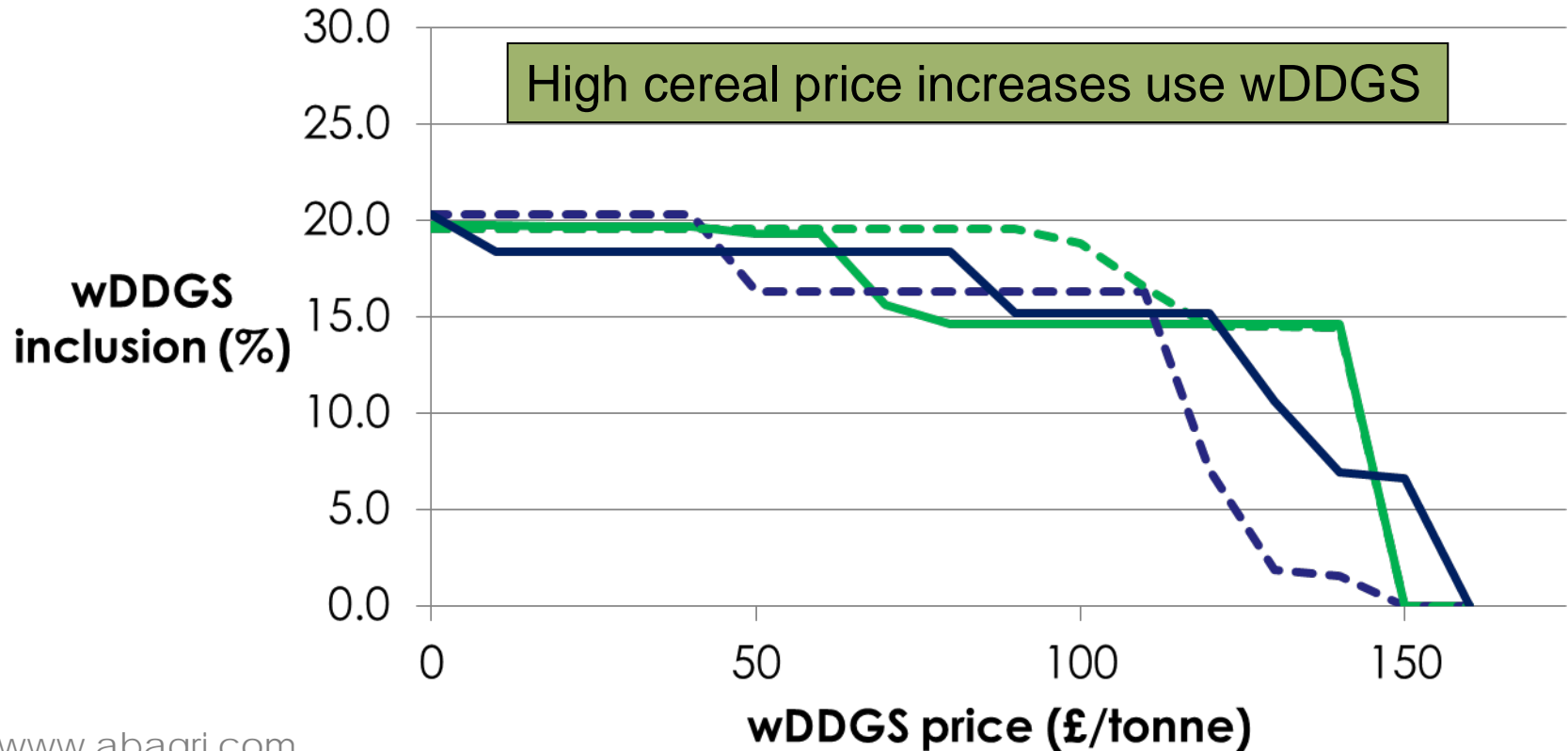
Finisher diet



Effect of raw material cost scenarios on value of wDDGS

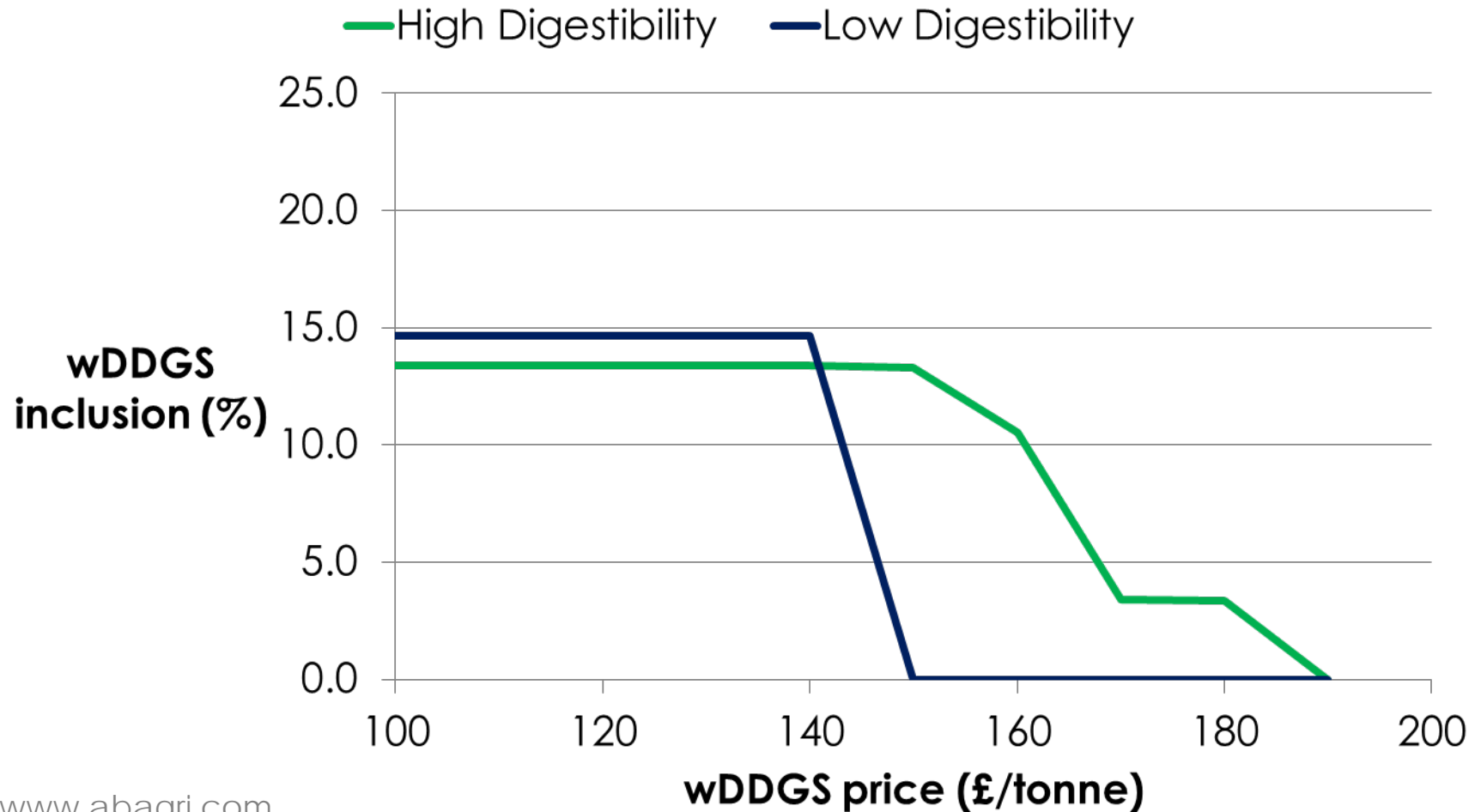
Finisher diet

- H Cereal L Protein - - L Cereal L Protein
- - H Cereal H Protein — L Cereal H Protein

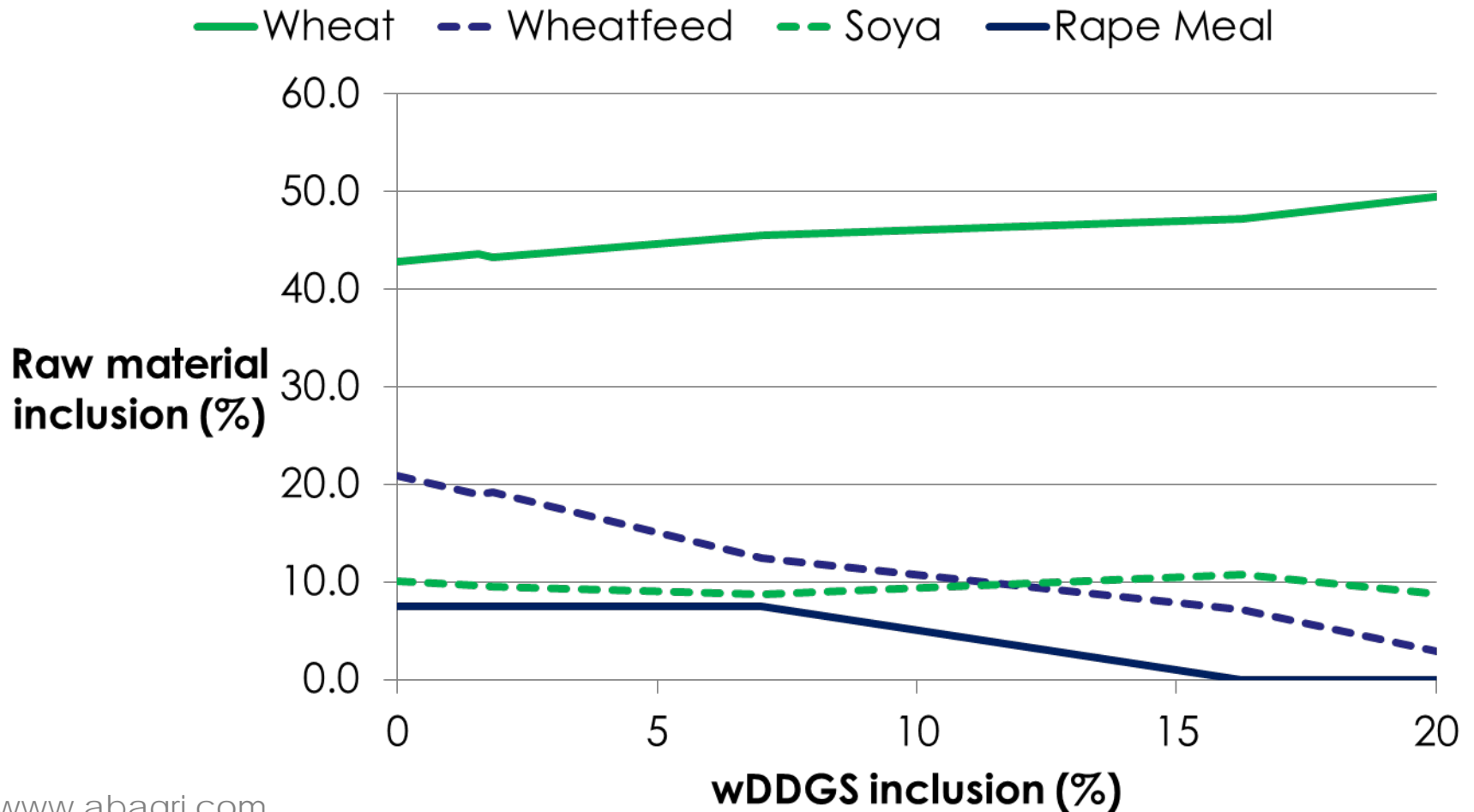


Increased digestibility improves value of wDDGS

Finisher diet
High Cereal, Low Protein cost set



Effect of wDDGS inclusion on levels of other raw materials



Summary

- Up to 30% wDDGS in grower and finisher diets
- Important to have accurate digestibility values
- Ability to predict digestibility is required
- Financial value affected by:
 - stage of production
 - raw material pricing scenarios
 - amino acid digestibility

Summary

- Growth studies demonstrated that up to 30% wheat DDGS can be incorporated into growing pig diets without affecting performance.
- It is important to formulate the diets using accurate digestible amino acid values to obtain consistent animal performance.
- In vitro methods of predicting amino acid digestibility would offer significant benefit to the industry.
- Wheat DDGS is a viable source of nutrients for the pig reducing the reliance on other sources of protein.