Pig diets in a circular food system; consequences and challenges

Pig Research Summit, Copenhagen Denmark 2024

Paul Bikker and Alfons Jansman

WAGENINGEN
UNIVERSITY & RESEARCH

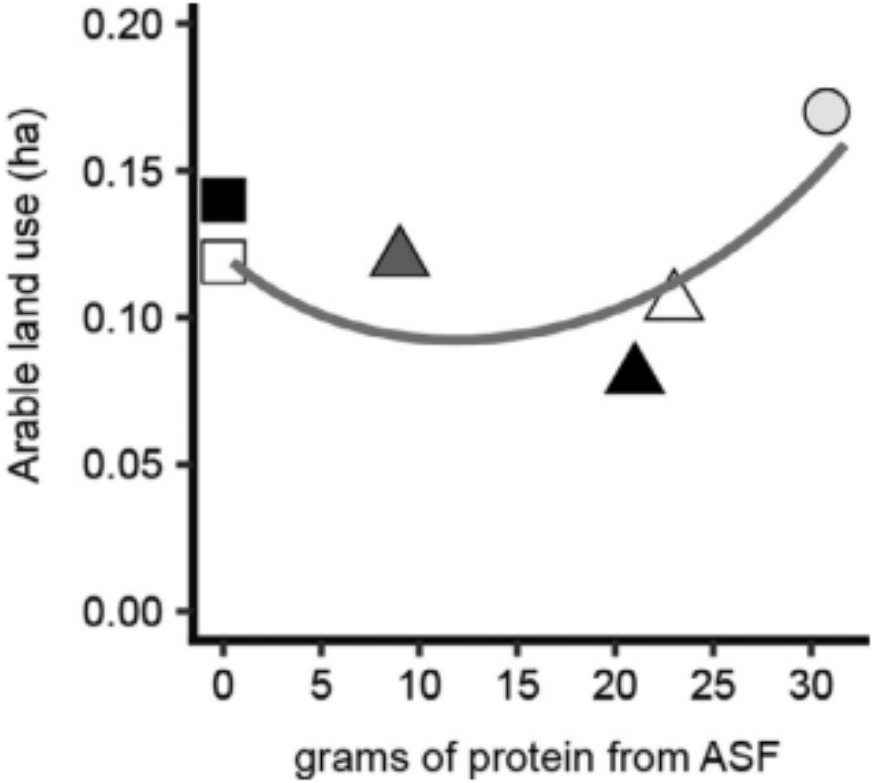
Background

- Feeding the world population within boundaries of our planet
- The global food system
    - ~25% human induced GHG
    - ~33% of terrestrial acidification
    - ~80% of eutrophication
    - Livestock: 55-60% of emissions
- Agriculture: 43% of ice/desert-free land (87% food, 13% non-food)
    - Livestock: 70% of agricultural land, 40% feed crops

Animal source food (ASF) and land use

Arable land (ha/person) required for human food with livestock consuming low-opportunity cost feed (LCF) (triangles) compared to vegan diets (squares) and a current diet (circle).

Van Zanten et al. (2018)



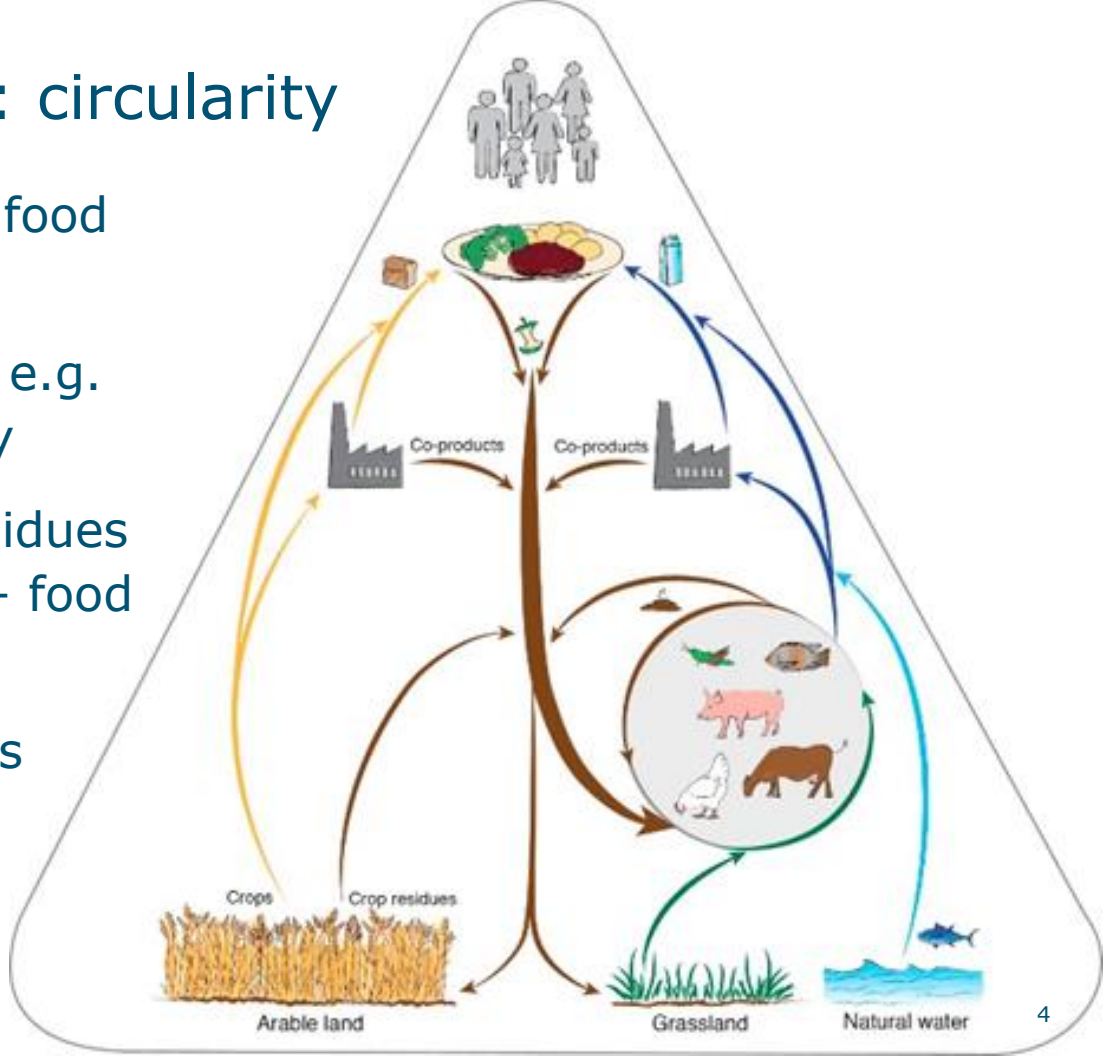
Lowest land use with modest amount of ASF

WAGENINGEN
UNIVERSITY & RESEARCH

Food systems approach: circularity

- Crop land primarily used for food production
- Losses prevented or reused, e.g. as animal feed or soil fertility
- Animals eat co-products, residues and grass to minimise feed – food competition.
- Availability of LCF determines production of ASF

Van Zanten et al. (2019)



WAGENINGEN
UNIVERSITY & RESEARCH

Circular food production systems

- Consequences for availability and quality of feed materials
- Allocation to different animal species
- Composition of future feeds
- Research questions and opportunities

Availability of low opportunity cost feed materials

- LCF: Co-products, residues (and waste) of the human diet, and grass
- Present production and consumption in EU as starting point
    - Grain milling, starch and sugar production – bran, SBP
    - Beer and alcohol / ethanol production – brewers grains, DDGS
    - Oil crushing – SBM, RSM, SSM
    - Meat and dairy industry – PAPs, whey products
    - Food industry – former foods – bakery products
- Human diets and processes develop over time → trends in availability and quality of (novel) LCF

Optimal allocation of feed materials

- What (combination of) animals and husbandry systems can optimally valorise the available feed materials (LCF) to food?
    - Capacity of farm animals to convert LCF to animal products
    - Demand for animal products in human diet
- Reconsider criteria for animal performance and feed efficiency, e.g. human inedible → human edible protein (HIP → HEP)

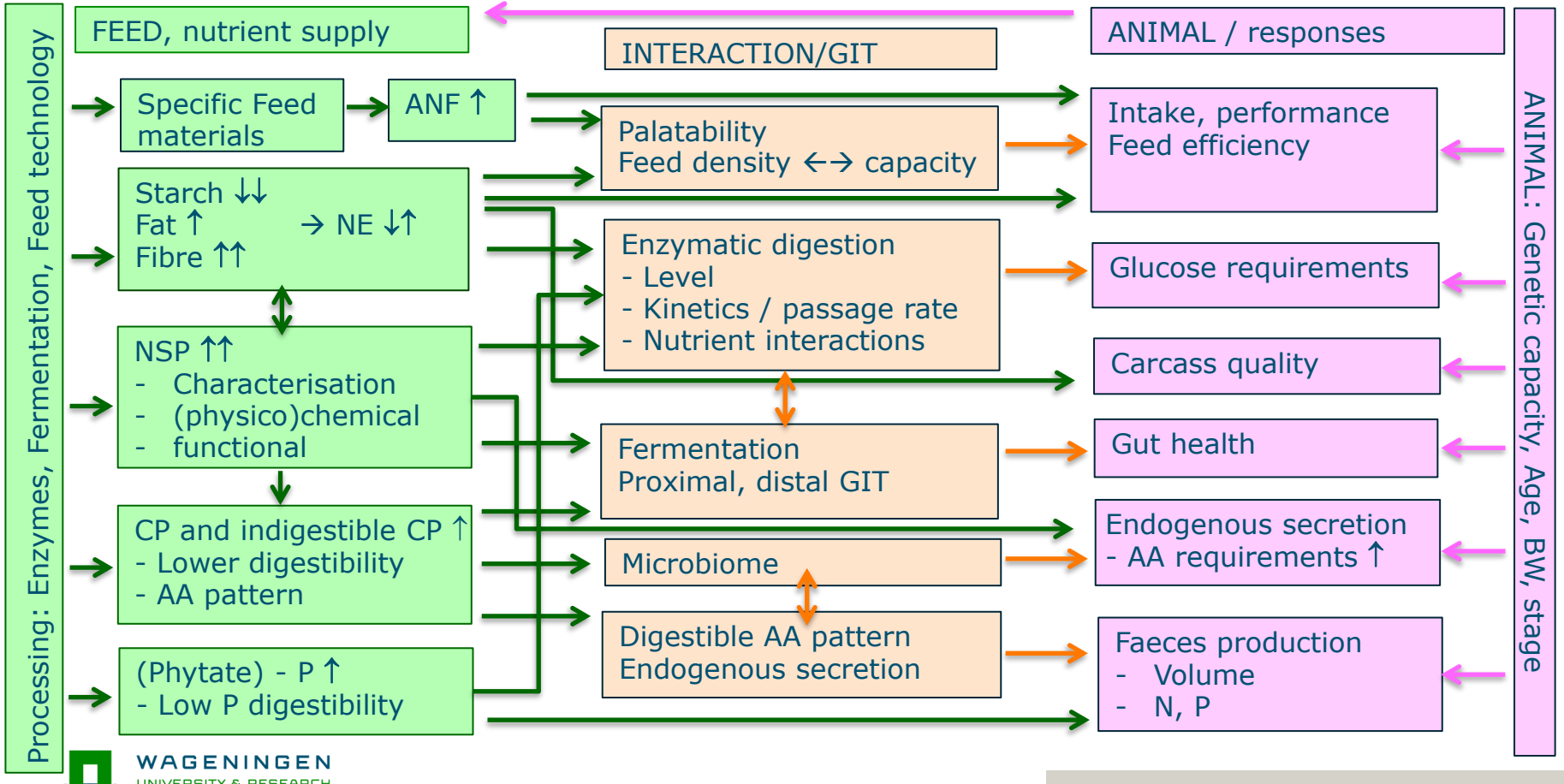
Composition of an LCF-based pig diet

Ingredients, g/kg	Control	LCF	LCF, low NE	Nutrients, g/kg	Control	LCF	LCF, low NE
Wheat	35.0	-	-	Net energy, MJ	9.8	9.8	8.8
Barley	20.0	-	-	Crude protein	165	191	183
Maize	14.4	-	-	Crude fat	63	115	84
Soybean meal	10.3	5.5	2.0	Crude ash	46	61	59
Rapeseed meal	7.5	10.0	10.0	Crude fibre	45	96	117
Sunflowerseed meal	4.0	10.0	10.0	Starch	384	109	109
Maisgluten feed	-	10.0	10.0	Sugar	44	86	84
Wheat middlings	-	10.0	10.0	NSP, calculated	182	341	380
Wheatgluten feed	-	10.0	10.0	Na	1.5	1.8	1.8
Sugarbeet pulp	-	10.0	10.0	K	7.5	10.6	10.7
Mais DDGS	-	10.0	10.0	Cl	2.8	2.8	2.8
Biscuit meal	-	10.0	10.0	Ca	7.7	7.8	7.0
Soybean hulls	-	2.9	9.9	P	4.3	6.0	5.9
Palm oil	3.8	-	-	Inositol-P	2.8	4.0	3.9
Animal fat, acid oil	-	7.5	4.4	ATTD-P	2.7	2.7	2.4
Beet molasses	2.0	2.0	2.0	Phytase	1000	416	327
Amino acids	0.71	0.62	0.53	SID lysine	9.44	9.44	8.52
Vit. & min.	2.22	1.46	1.21	SID of lysine	0.88	0.83	0.81

Consequences for diet composition

- Animal diets increasingly reflect the characteristics of LCF
  - Starch ↓↓
  - Crude protein ↑
  - Crude fat ↑
  - Dietary fibre, NSP ↑↑
  - Total P, phytate ↑
  - Minerals ↑
  - Dietary energy (NE) ↓↑

Characteristics of LCF diets and animal interactions



WAGENINGEN
UNIVERSITY & RESEARCH

Alfons Jansman & Paul Bikker, 2021

Specific characteristics of individual feed materials

Quality and safety to be addressed before use of individual feed materials, examples.

- Impact of processing for food (or non-food)
- Adequacy of present feed evaluation systems, e.g. protein quality, classification of fibre, feed-animal interactions, ...
- Concentration and accumulation of ANF and mycotoxins
- Residues and contaminants, e.g. in food waste and aquatic proteins

Reduction of feed – food competition in pig diets

Wheat and SBM replaced by cereal grain by-products
Summary of response study with 8 dietary treatments

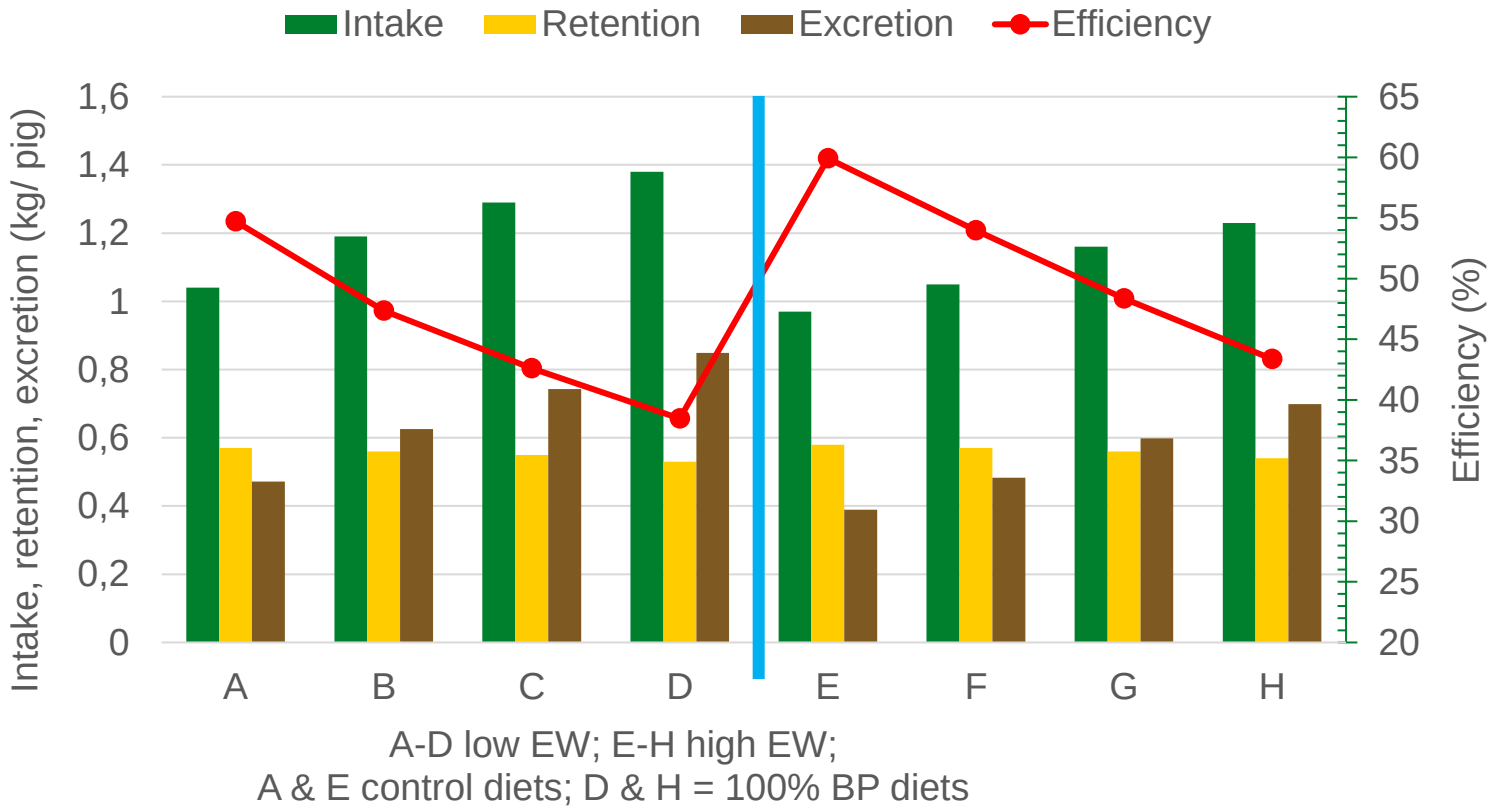
Treatment	A	D	E	H				
	Control	100% BP	Control	100% BP	SEM[1]	P-value	P-value	P-value
	low NE	low NE	high NE	high NE		NE	BP	NE*BP
Days to slaughter	102	106	103	105				
Slaughter weight (kg)	128.0^{AB}	120.8^{D}	130.5^{A}	122.0^{CD}	2.14	0.006	<0.001	0.827
Dressing (%) 1)	77.4^{ABC}	75.9^{D}	78.2^{A}	76.4^{CD}	0.6	0.006	<0.001	0.145
Fat depth (mm) 1)	11.8^{B}	12.9^{A}	12.7^{BA}	13.4^{A}	0.4	<0.001	0.006	0.794
Muscle depth (mm) 1)	68.5^{AB}	66.0^{AB}	69.1^{A}	65.3^{B}	2.3	0.792	0.001	0.745
Meat percentage (%) 1)	60.6^{A}	59.7^{BC}	60.0^{ABC}	59.4^{C}	0.3	<0.001	0.001	0.859

1) BW at slaughter used as covariate

Schop et al., 2024

WAGENINGEN
UNIVERSITY & RESEARCH

Impact of by-products on P-excretion in pigs



Schop et al., 2024

Starch, fat and NSP as energy source

- LCF diets: starch → fat and SCFA
- Glucose homeostasis – gluconeogenesis – minimum starch content?
- Interaction starch - protein deposition:
    - Insulin – AA uptake and protein synthesis / breakdown
    - Protein sparing effect, use of AA for energy
- Interactions with NSP and fat concentration and composition
- Carcass quality: lean meat content and fat composition

Concluding remarks

- Moving towards more circular food systems
  - has a major impact on availability and quality of animal feed
  - challenges commonly accepted paradigms in animal production
  - creates numerous research questions and challenges in the area of animal nutrition, physiology and metabolism
  - requires flexibility to combine current and future food production systems
- Provides us with opportunities to make an important contribution to human food supply

Thank you for your kind attention

alfons.jansman@wur.nl
paul.bikker@wur.nl

WAGENINGEN
UNIVERSITY & RESEARCH