Feed-a-Gene

Adapting the feed, the animal and the feeding techniques to improve the efficiency and sustainability of monogastric livestock production systems

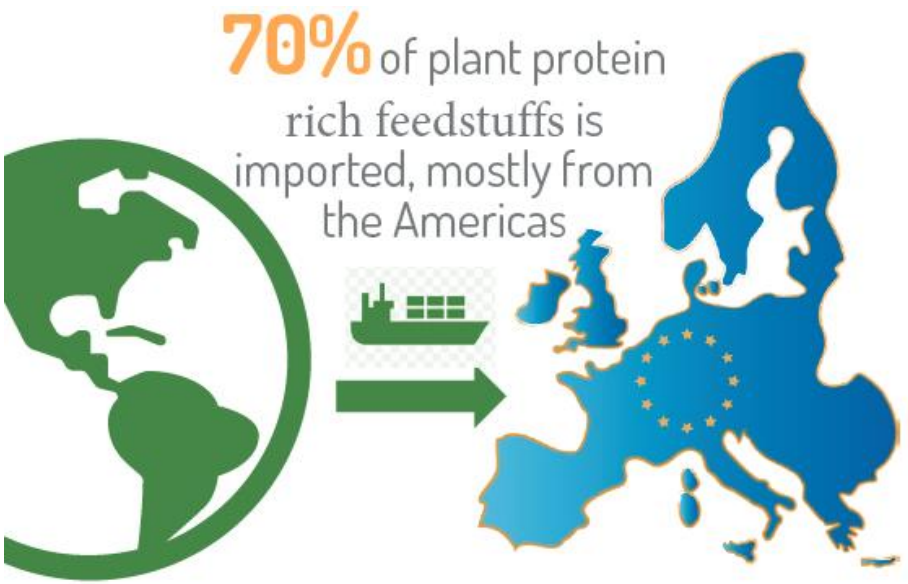
In the search for European protein autonomy – more and better

Aarhus University,
Department of Animal and Veterinary Sciences

The Feed-a-Gene Project has received funding from the European Union's H2020 Programme under grant agreement no 633531.

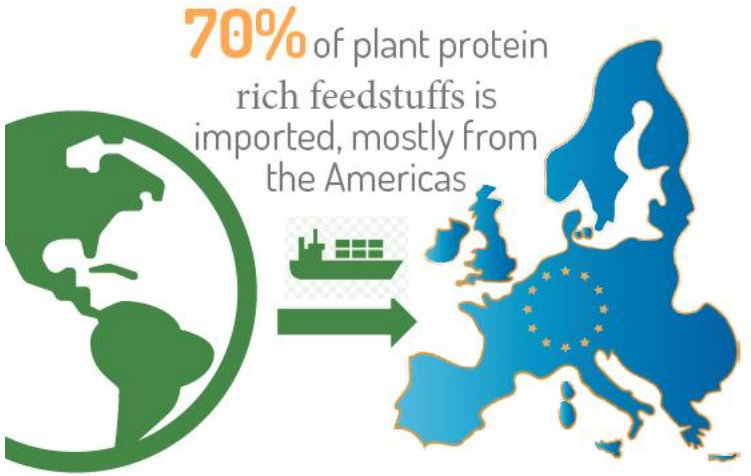
Background

- Europe has a chronic protein deficit; approximately 70% of protein rich feedstuffs is imported
- **Rapeseed**, sunflower and **soybean** are the three main protein crops in Europe with annual productions of 22.6, 9.1 and 2.5 mill tons
- The land used for **soybean** has quadrupled over the last 5 years and with a potential to increase even further
- **Green biomass** may have a potential to become a regional protein source in Europe

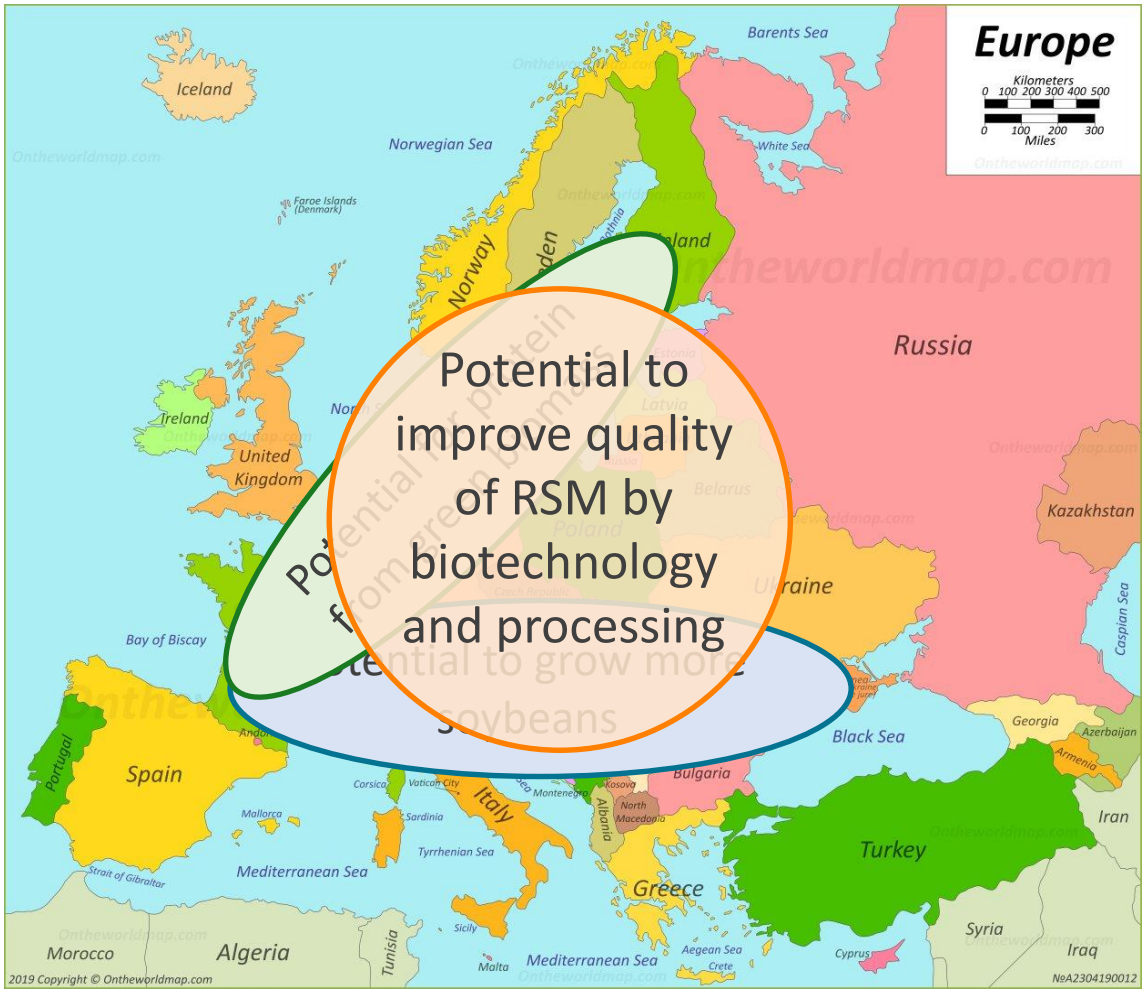


Strategic actions in the Feed-a-Gene project

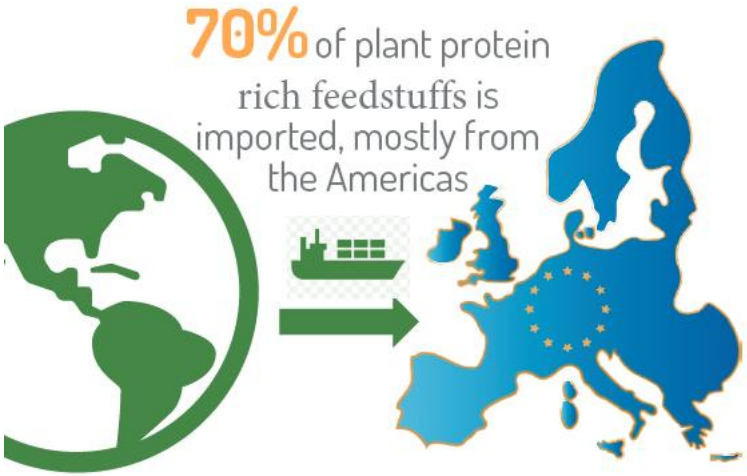
- European grown soybeans and new processes technologies to improve nutritive value of SBM
- Green biomass as a sustainable protein source
- Processing of RSM for improved quality
- Biotechnological means to improve quality of RSM
- New technologies for evaluating nutritional quality in real-time



More and better protein in Europe



European grown soybeans



European grown soybeans

New processing technologies to improve nutritive value of SBM

Processes used in Feed-a-Gene involve **extrusion or cooking with or without dehulling** to produce expeller SBM

- ⇒ reduced content of antinutritional compounds
- ⇒ high protein and amino acids digestibility

FaG study: evaluate extrusion-pressing & flaking-pressing-cooking with European soybeans

- One batch of soybeans → 2 x 2 factorial design → 4 products
  - extrusion-pressing (EP) vs. flaking-cooking-pressing (FCP)
  - preparation of beans with dehulling (D) or not (WB)
  - *effects of process factors (preparation, temperature) + variations of flow rate/speed + specific mechanical energy*
- Composition and nutritive values
  - chemical values
  - in vitro rate of degradation (pH-Stat)
  - amino acids & reactive lysine contents
  - NIR
- Animal studies: piglets + broiler chickens.

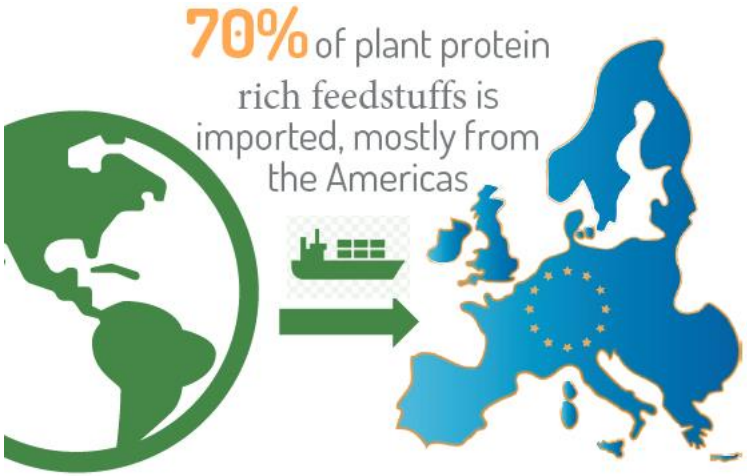
Effect of dietary treatments on standardised ileal digestibility of amino acids – piglets study

	Control	Flaking-cooking pressing		Extrusion pressing	
	SBM	Dehulled	Whole beans	Dehulled	Whole beans
Lys	.847^{b}	.819^{b}	.965^{a}	.990^{a}	.946^{a}
Met	.848^{b}	.872^{b}	.994^{a}	1.00^{a}	.985^{a}
Thr	.870^{cd}	.831^{d}	.982^{ab}	1.00^{ab}	.936^{bc}

^{a,b} Values in the same row not sharing the same superscript letter is significantly different ($p<0.05$).

Lower digestibility due to incomplete inactivation of trypsin inhibitor

Protein from green biomass



Biomass from grasses and legumes

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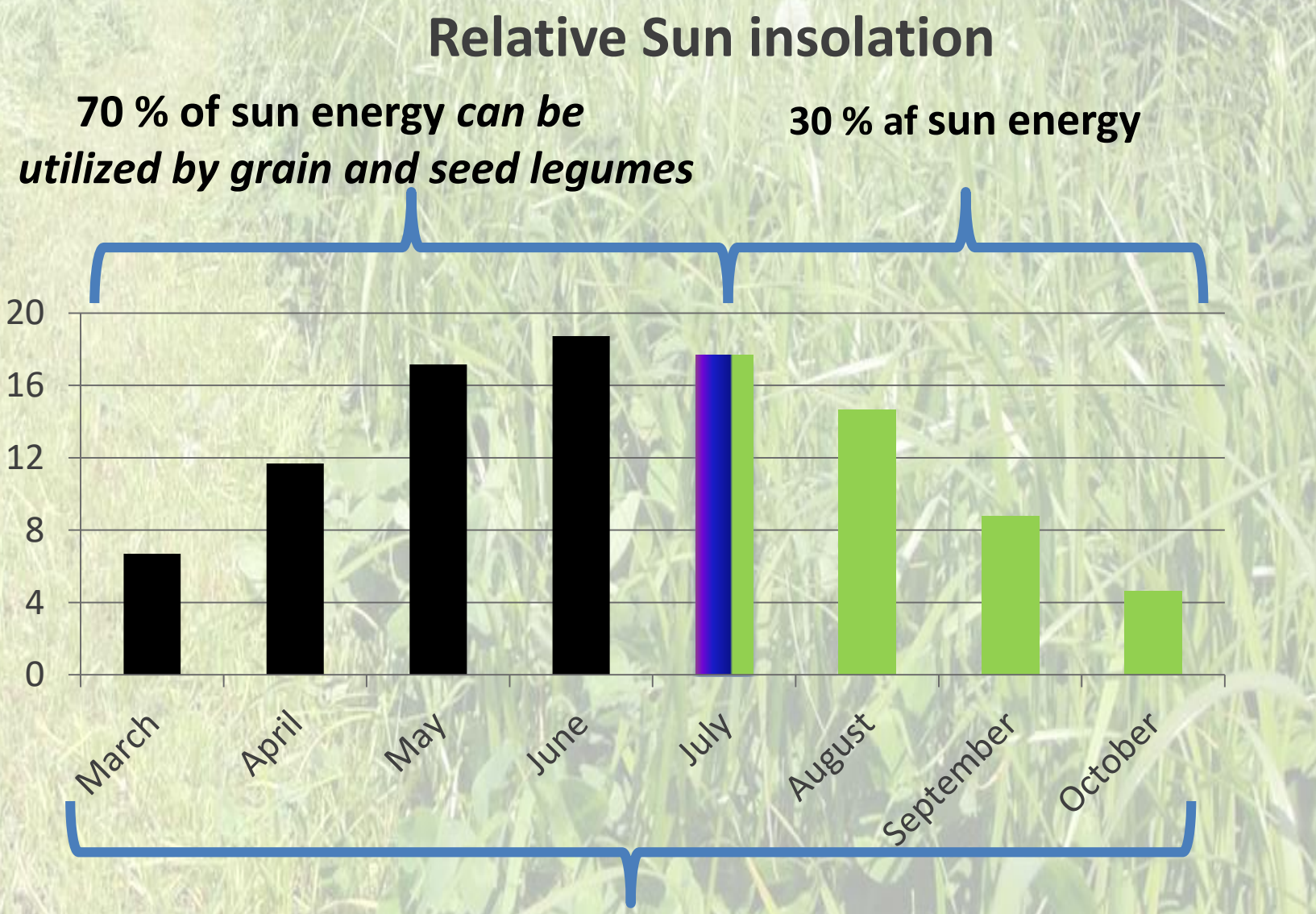
Separation of soluble protein from insoluble protein

Fractionation of green biomass into a protein **concentrate** rich in soluble protein and **pulp** rich in insoluble protein

- ⇒ higher protein and amino acids content
- ⇒ reduced content of antinutritional compounds

Why green biomass?



Protein and amino acid yield under Danish growing conditions

	Yield DM ton/ha	Protein %	Protein kg/ha	Lysine kg/ha	Methionine kg/ha	N leaching
Soya	2	35	700	43	9	Large
Rapeseed	5	20	1000	60	20	Large
Wheat	9	11	1000	30	16	Large
Faba beans	6	25	1500	92	11	Large
Peas	6	22	1300	92	13	Large
Corn silage	13	8	1000	27	14	Large
Grass clover	13	20	2600	200	90	Small
Lucerne	12	21	2600	200	90	Small
Potato	14	9	1300	90	27	Small

ICROFS Organic RDD

Feed-a-Gene

Miljø- og Fødevareministeriet gudp

Biorefining - Processing

Screw press

Pulp: Fiber/insoluble
protein: ruminants

Juice

Protein precipitation
pH 4; 80 °C

Protein fraction: Soluble protein/fibers
Proteinfeed - monogastrics

Braun juice
Salt, sugar, Non-protein N

Main products from processing line

- **Pulp (60-70 % of DM)**
  - Cattle feed
  - Fiber for energy production (Biogas, Biochar, etc)
  - Fiber for lignin production
  - Fiber for insulation
  - Fiber for production of oligosaccharides

- **Precipitated protein (20-30 % of DM)**
  - Protein concentrate as feed for monogastrics
  - White protein concentrate for food purposes

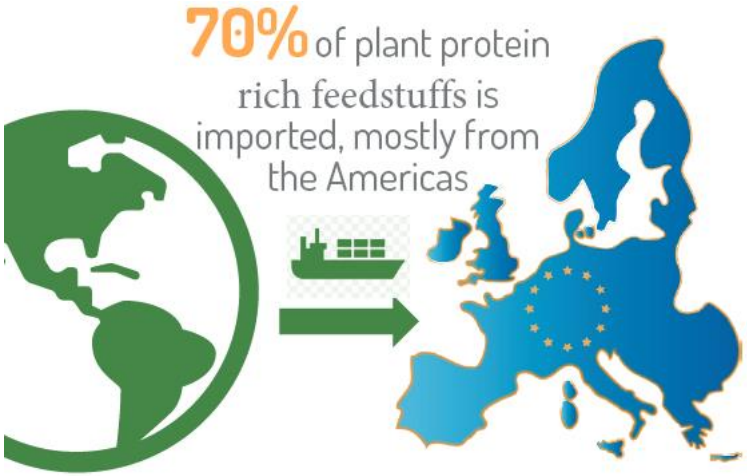
- **Brown juice (10-20 % of DM)**
  - Inorganic salts / fertilizer
  - Organic matter for biogas production
  - Speciality compounds
    (vitamins, phytoestrogens, saponins etc)

Standardized ileal digestibility of green protein extracted from ryegrass, red clover, or lucerne compared to a good quality SBM

Protein source	Ryegrass	Red clover	Lucerne	SBM
Nitrogen	57.6^{b}	64.2^{b}	58.6^{b}	78.3^{a}
Lys	68.6^{b}	71.8^{b}	70.0^{b}	84.2^{a}
Met	72.4^{b}	75.7^{b}	73.4^{b}	86.2^{a}
Thr	64.6^{b}	68.6^{b}	61.9^{b}	78.3^{a}

^{a,b} Values in the same row not sharing the same superscript letter is significantly different ($p<0.05$).

Improving the quality of rape seed meal



European rape seed meal

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Tail-end separation of RSM and use of biotechnological means

Tail-end separation of RSM into fine and coarse fractionations

- ➡ higher protein and amino acids digestibility
- ➡ removal of fibre and antinutritional compounds

Biotechnological means to improve nutritional value

- ➡ removal of antinutritional compounds
- ➡ improved feed efficiency

BÜHLER

DUPONT

HAMLET PROTEIN

Feed-a-Gene

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Novel feed processing technology to upgrade

Mixing

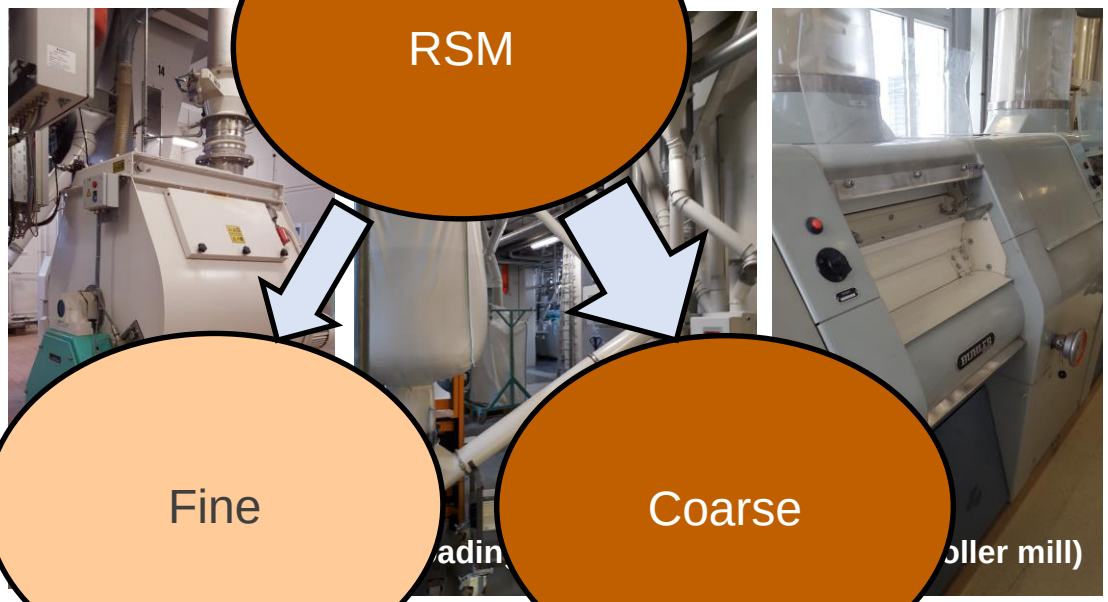
Crushing

Sifting

RSM

Fine

Coarse



BÜHLER

IRTA pig study, Material & Methods

- Factorial design 2x2x2
  - RSM: raw vs fine
  - die size: 4x40 vs 4x60 mm
  - Pelleted with/without steam
- 144 pigs in 72 pens
- 7 weeks, ~27 – 60 kg BW

- **Growth performance**
- **Total tract apparent digestibility**

RSM Fraction, growth performance and ATTD

	Performance				ATTD			
	Raw	Fine				Raw	Fine	
ADFI, kg/d	1.55	1.54	ns		CP	78.4	80.5	***
ADG, g/d	704	763	**		Fat	84.7	86.3	**
FCR	2.20	2.03	**		CFibre	33.5	54.4	***
BW (49 d)	62.0	65.0	**		NDF	62.0	64.7	**
					GE	84.6	86.4	***

Diego A. B. Melo, E. Esteve-García & R. Lizardo, 2019

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Evaluation of nutritive value in real-time

Development of calibration equations from NIR scans based on chemical and biological in vivo database with feedstuffs and mixtures

AARHUS UNIVERSITY

Developments of equations for macronutrients, amino acids, ileal and total tract digestibility of amino acids, total tract digestibility of energy and nutrients and metabolizable energy in pigs

eME by using table values for composition and digestibility of nutrients, **R^2 = 0.89**

eME calculated from NIR estimated components and NIR digestibility estimates, **R^2 = 0.94**

eME directly from NIR calibration, , **R^2 = 0.94**

The researchers behind

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- IRTA – Animal Nutrition: Rosil Lizardo, A.D.B. MELO
- Newcastle University: Ilias Kyriazakis, Panagiotis Sakkas
- Wageningen University & Research: Paul Bikker
- DuPont: Jens Frisbæk Sørensen
- Hamlet Protein: Jonathan Dickow
- Bühler: Thomas Oberholzer
- Terres Inovia: Alain Quinsac
- Olead: Patrick Carré

….and the organisations

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Newcastle University
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Terres Inovia l'agronomie en mouvement
KAPOSVÁR UNIVERSITY
IRTA RESEARCH & TECHNOLOGY FOOD & AGRICULTURE
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Thank you very much for your attention!