Blood products as sustainable ingredients in livestock nutrition: protein source and alternative to antibiotics

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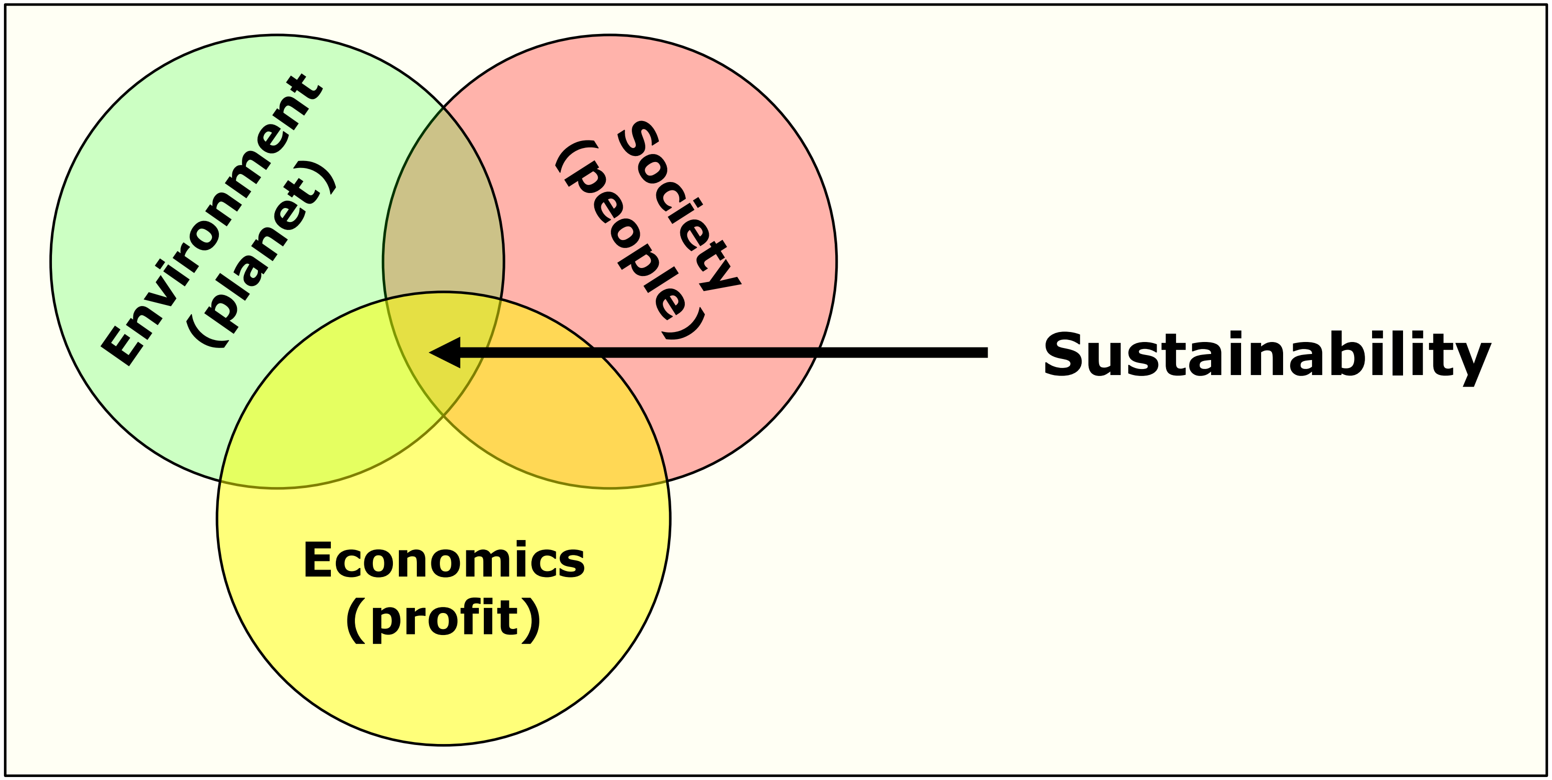
KEYNOTE LECTURE

veos group

The Concept of Sustainable Livestock Production

- widespread concept
- covering a broad array of issues

  that vary in: urgency, severity, uncertainty of consequences, temporal and spatial dimensions



The Concept of Sustainable Livestock Production

- **Sustainability is defined by a multitude of elusive descriptions**

literally: "the capability of maintaining something in existence"

"sustainability"
Is meeting the needs of the present generation without compromising the ability of future generations to meet their own needs (1987, WCED)

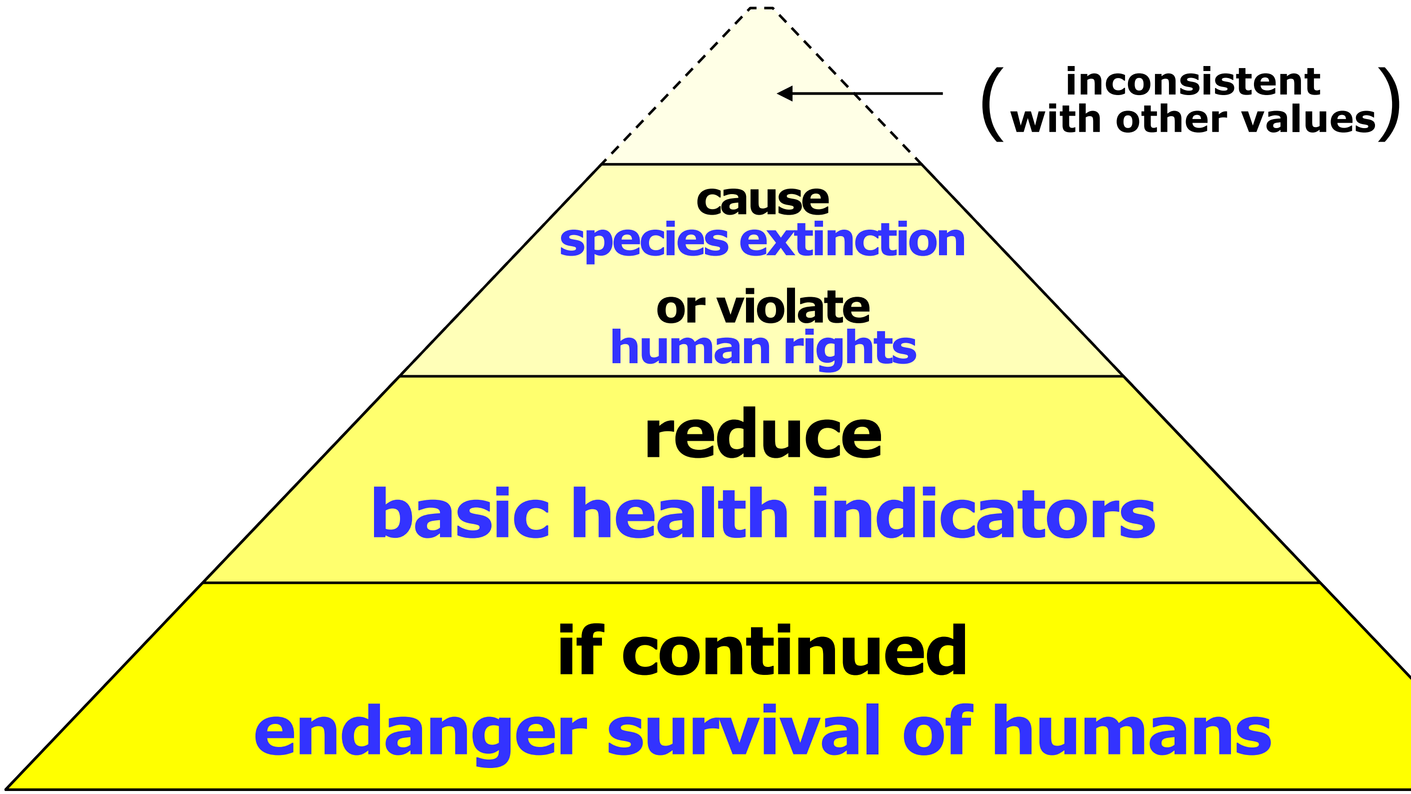
> 100 definitions by the mid-1990's (definitional chaos)

something that improves the quality of human life within the carrying capacity of the supporting eco-systems (Milne et al., 2006)

"unsustainable" implies a direct or indirect potential to impede the ecosystem functions that support human life, human health and species viability (after Marshall and Toffel, 2005)

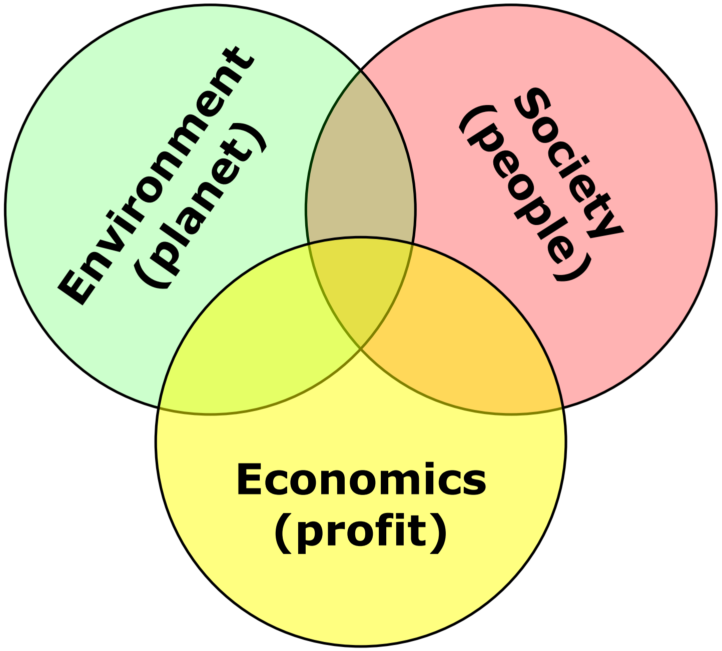
Hierarchy of unsustainable actions

The 4 or 3 levels of issues that are considered in the understainding of the term sustainability



(after Marshall and Toffel, 2005)

Sustainable Production One Health Concept



Strives to a balance in

- economic goals
- social goals
- ecologic goals

➡ on the long run

Inextricable Link

- animal health
- animal welfare
- public health
- environmental health

Actipro animal proteins

Feed-related variables of sustainable livestock production

INPUT | **UTILISATION** | **OUTPUT**

FEED

GHG-emission
Deforestation
Depletion
…

Productivity
Welfare

N-emission
P-emission

Min Up-stream Eco footprint

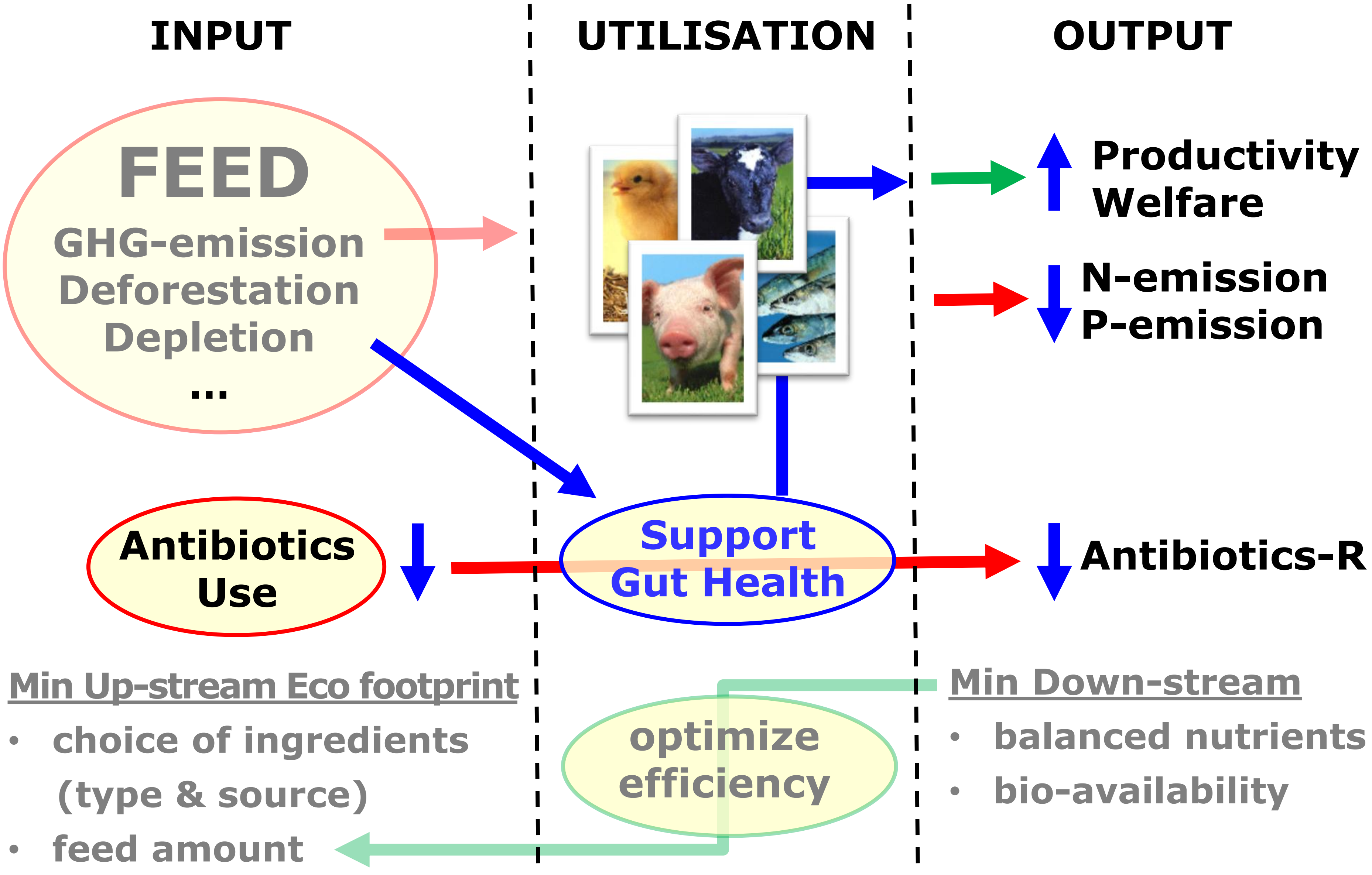
- choice of ingredients (type & source)
- feed amount

optimize efficiency

Min Down-stream

- balanced nutrients
- bio-availability

Feed-related variables of sustainable livestock production



Sustainaibility of Livestock Nutrition

1. **Sourcing & Production of ingredients**
   - ⇨ **Sustainability of Up-stream actions**

2. **Used as feed ingredients**
   - ⇨ **Nutrient Utilisation** (productivity)
   - ⇨ **Gut Health** (animal health/welfare, antibiotics use, productivity)

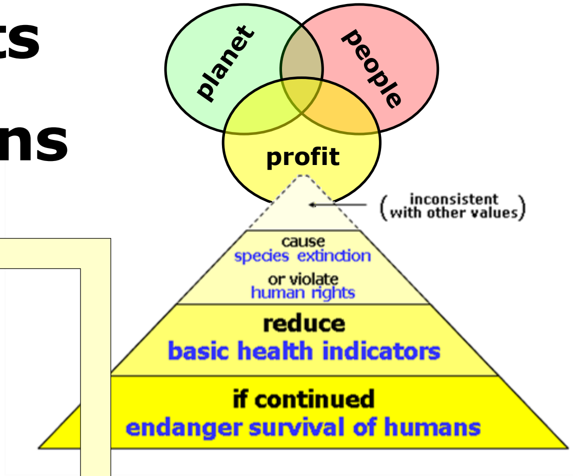
3. **Sustainability of down-stream effects**
   - ⇨ **N-emission**
   - ⇨ **P-emission**
   - ⇨ **Antibiotics resistence**

Min Input - Max Productivity & Welfare - Min Emission (P, N, AB-R)

Sustainability of blood products

1. Sourcing & Production of ingredients

⇨ Sustainability of Up-stream actions



1. Blood collected at slaughterhouses (anti-coagulant added, refrigerated)
2. Transported
3. Centrifuged → Hb / Plasma
4. Dried

Type: Not purpose-grown
Not purpose-bred

Source : EU animal by-products

EU labor laws

→ guarantees on human rights aspects

EU animal welfare and production laws

→ guarantees on animal welfare aspects (production and slaughter practices)

→ guarantees on environmental issues

Sustainability of ingredients - Type & Source

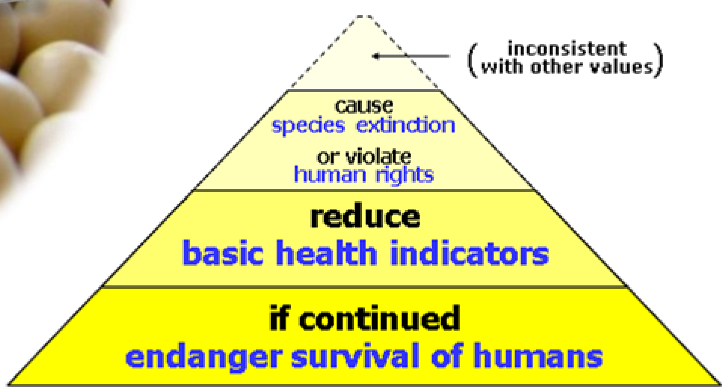
Soybean meal used to be a by-product

in the production of soy oil for human consumption

Ingredient
Soybean meal

Type
not purpose-grown
until demands outgrew availability

Source
varies in sustainability



Sustainability of ingredients - Type & Source

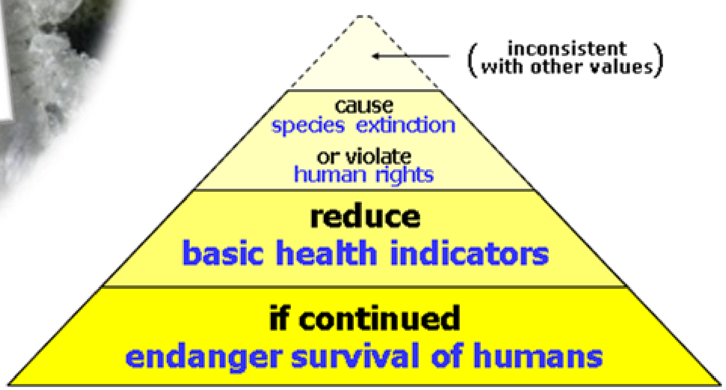
Fish meal used to be a by-product

but demand rose above availability ⇨ sustainability ↓

Ingredient
Soybean meal

Type
not purpose-grown
until demands outgrew availability

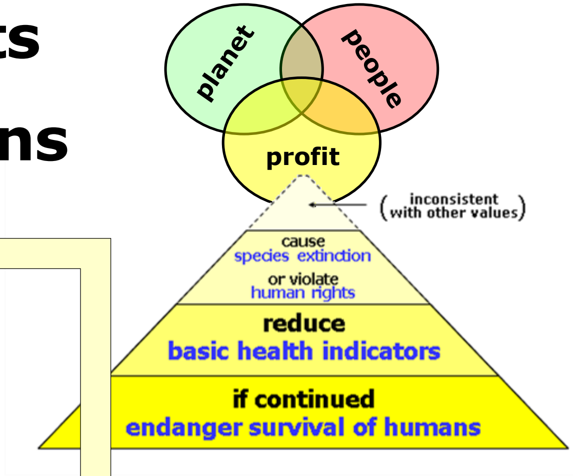
Source
varies in sustainability



Sustainability of blood products

1. Sourcing & Production of ingredients

⇨ Sustainability of Up-stream actions



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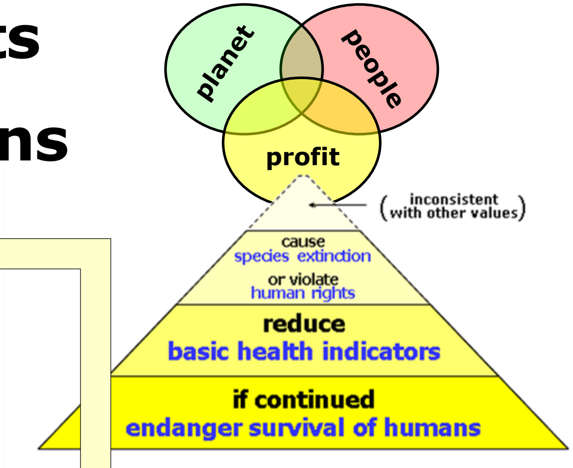
Exception
“Designer-pigs”
(cfr Hyper-immune eggs)

⇔ Cat-3 EGG products

Sustainability of blood products

1. Sourcing & Production of ingredients

⇨ Sustainability of Up-stream actions



1. Blood collected at slaughterhouses (anti-coagulant added, refrigerated)
2. Transported
3. Centrifuged → Hb / Plasma
4. Dried

Type: Not purpose-grown
Not purpose-bred

Source & Processing : C-Footprint

Up-stream

→ Allocation based on economic value
1. Animal husbandry
2. Slaughtering process

Down-stream

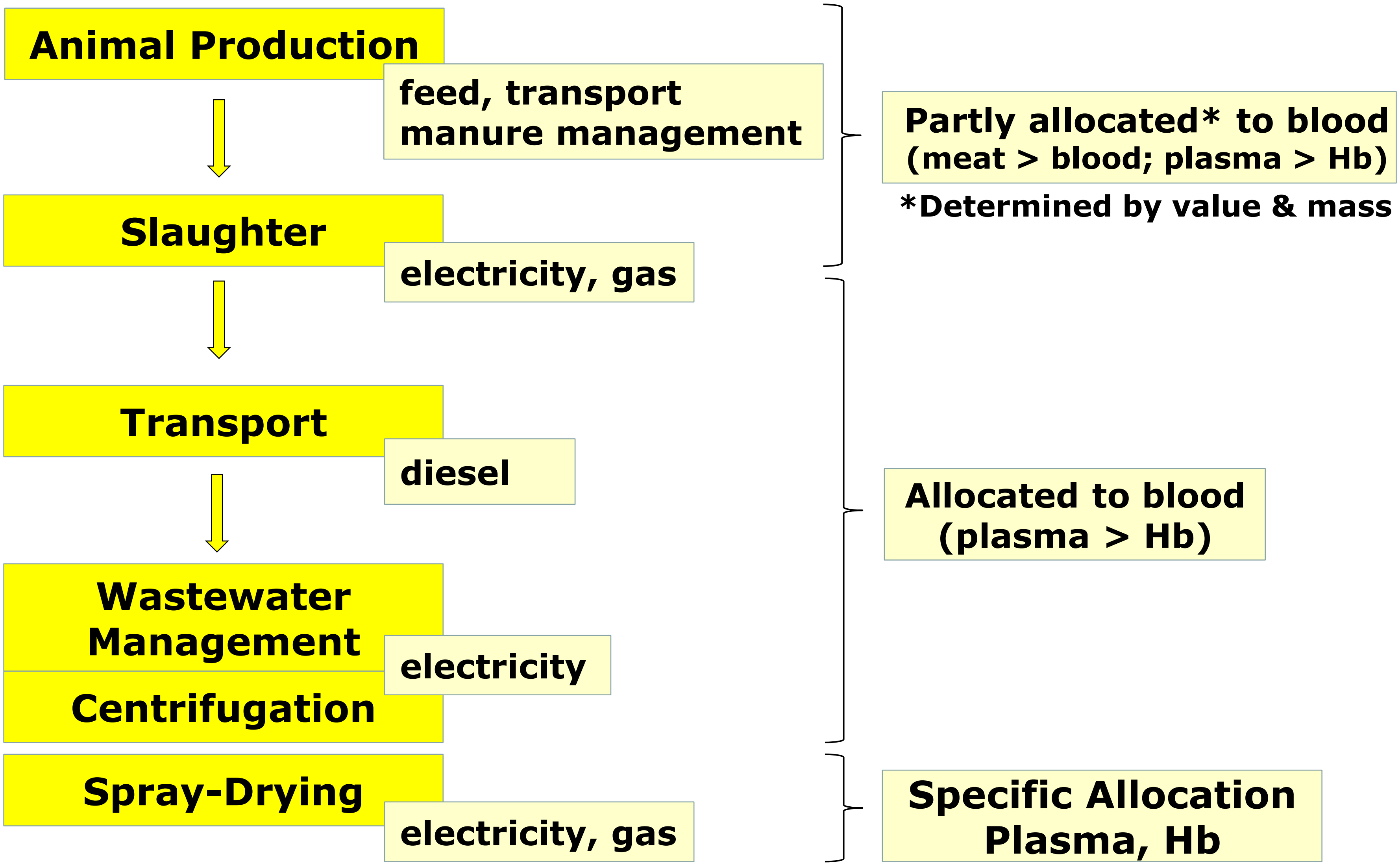
→ Transport of blood (diesel)
→ Processing

Exception
"Designer-pigs"
(cfr Hyper-immune eggs)

⇔ Cat-3 EGG products

Carbon footprint

➪ **The sum of all greenhouse gas emissions in the production chain**

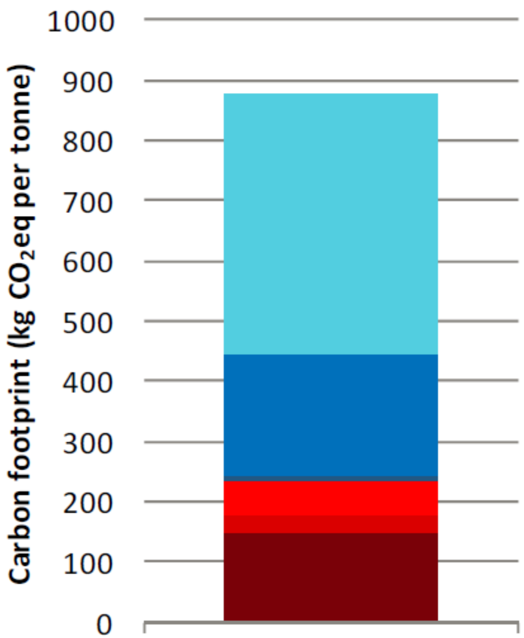


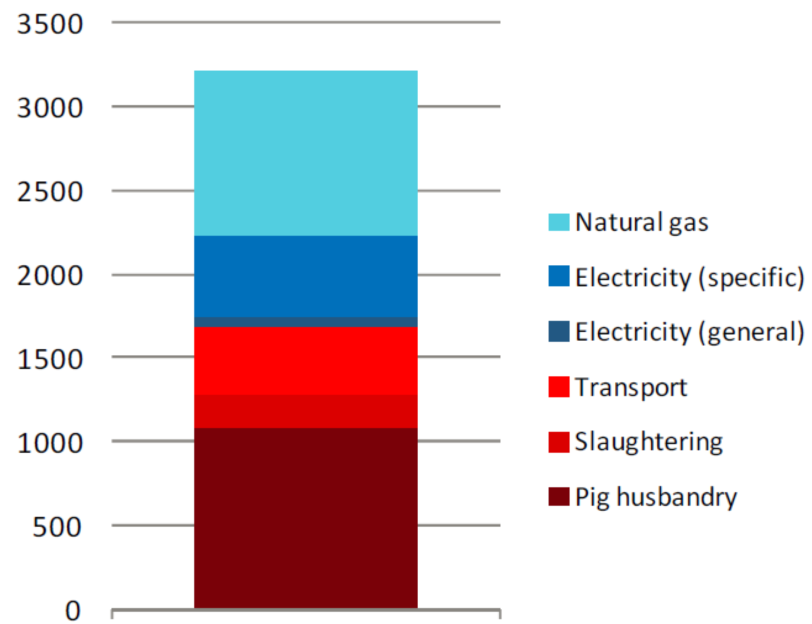
Carbon footprint

➯ **The sum of all greenhouse gas emissions in the production chain**

<u>Spray-dried Hb</u> (porcine)
870 kg CO_2 eq. / ton

<u>Spray-dried plasma</u> (porcine)
3200 kg CO_2 eq. / ton





Carbon footprint of spray-dried Hb (left) and plasma (right)
(Ponsioen and Blonk, 2011)

Carbon footprint

➪ **The sum of all greenhouse gas emissions in the production chain**

Spray-dried Hb (porcine)	→	**Protein source in aqua/mink feed**
870 kg CO_2 eq. / ton		**Alternative for fish meal**

Ingredient	**C-footprint** (kg CO_2/kg)	**C-footprint** (kg CO_2/kg CP)	**landuse change** (kg CO_2/kg CP)
Hb powder (92% CP)	**0.87**	**0.95**	**0.13**
Fish meal (64% CP)	**1.1 – 2.3**	**1.7 – 3.6**	**0**

(Ponsioen and Blonk, 2011)

Carbon footprint per kg protein
is 44% to 74% lower in dried Hb compared to fish meal

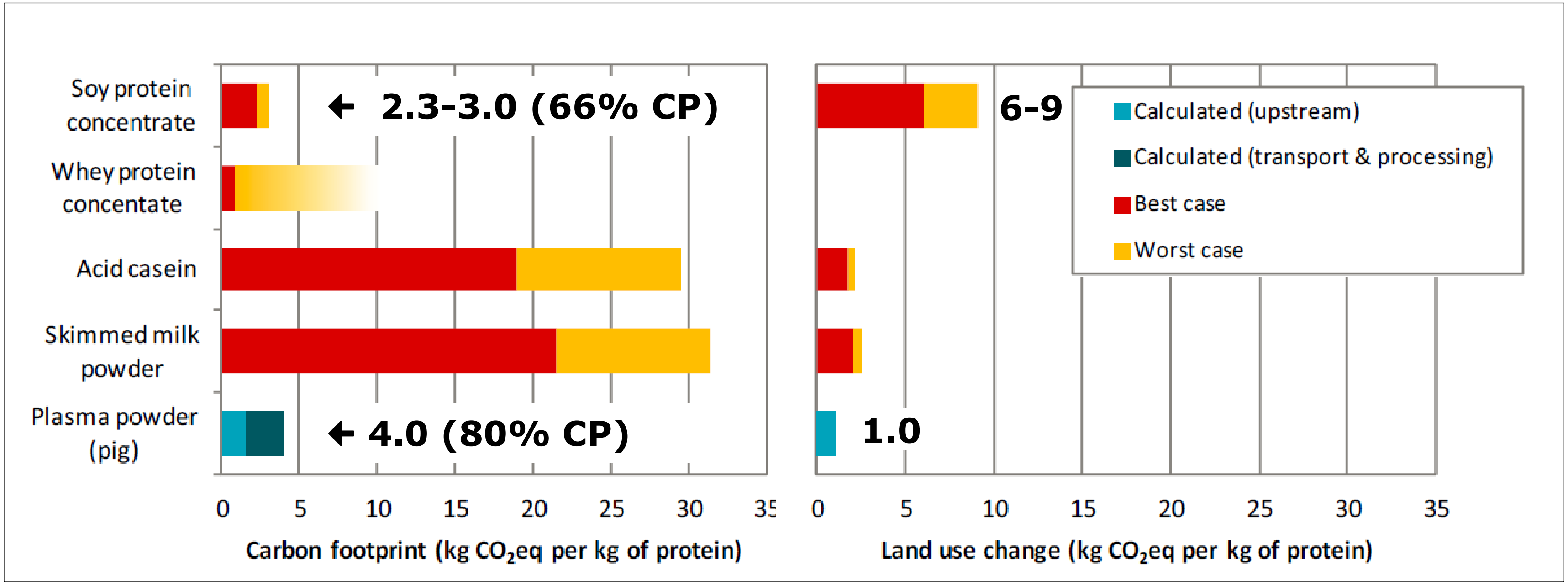
Carbon footprint

➩ **The sum of all greenhouse gas emissions in the production chain**

<u>Spray-dried plasma</u> (porcine)
3200 kg CO_2 eq. / ton

→

<u>Piglet feed</u> (poultry feed)
- Protein source
- Gut health (bio-active ingredient)



(Ponsioen and Blonk, 2011)

Sustainability of blood products

1. Sourcing & Production of ingredients
   - ⇨ Sustainability of Up-stream actions

2. **Used as feed ingredients**
   - ⇨ **Nutrient Utilisation** **(productivity)**
   - ⇨ **Gut Health** **(animal health/welfare, antibiotics use, productivity)**

3. **Sustainability of down-stream effects**
   - ⇨ **N-emission**
   - ⇨ **P-emission**
   - ⇨ **Antibiotics resistence**

Min Input - Max Productivity & Welfare - Min Emission (P, N, AB-R)

Sustainability of blood products

Protein Source	Utilisation	Emission
ingredient	bioavailability anab/katab	N-emission P-emission

Vegetal - Animal protein sources

- Amino acid profile : diet ⇔ requirements
- Bioavailable AA-profile
- Factors that "come-along" with the protein
  - ❑ ANF's — processing
  - ❑ Phosphorous (phytate-P) — additives
  - ❑ Bio-security issues — processing

2. Nutrient Utilisation

Balancing amino acid profile = combining complementary ingredients

NRC requirements (ad libitum fed, 90% DM)

%CP	Pig 3-5 kg	Pig 5-10 kg	wheat	corn	Hb	SDPP	whole egg
Arg	2,3	2,3	5,0	4,9	3,8	5,7	6,6
His	1,8	1,8	2,4	3,0	6,8	2,9	2,4
Ilo	3,2	3,1	3,8	3,7	0,6	3,4	5,2
Leu	5,8	5,6	7,2	13,0	13,3	9,6	9,1
Lys	5,8	5,7	3,0	3,2	9,2	8,1	7,6
Met	1,5	1,5	1,8	2,2	0,7	1,0	4,0
Met + cys	3,3	3,2			1,6	4,4	6,6
Phe	3,5	3,4	5,0	5,1	7,0	5,7	5,2
Phe + tyr	5,4	5,3			9,4	10,7	9,9
Thr	3,8	3,6	3,2	3,7	4,0	6,0	5,5
Try	1,0	1,0	1,4	0,8	1,5	1,6	1,6
Val	4,0	3,9	4,7	4,9	9,1	6,0	6,3
1st limiting AA			Lys	Lys	Ile	Met	
2nd limiting AA			Thr	Try	Met		

Actipro animal proteins

Sustainability of blood products - AA profile

2. Nutrient Utilisation

Balancing amino acid profile = Balancing bio-available amino acids
Minimizing N and P emission

National Swine Nutrition guide (US Pork COE, 2010)

	$CP_{\%}$	$\%_{Lys}$	$\%_{SID}$	$\%_{Met}$	$\%_{SID}$	Lys_{SID} (%)	P% (P_{aD}%)
SDPP	78.0	6.84	**91**	0.75	92	**6.2**	1.48 (80)
Egg (dried)	47.0	3.09	81	1.48	90	2.5	0.67 (<50)
Fish meal	62.9	4.81	95	1.77	94	4.6	3.04 (77)
(MBM)	(52.8)	(2.76)	(80)	(0.72)	(83)	(2.2)	(4.63; (75))
SBM	44.0	2.83	**89**	0.61	91	**2.5**	0.65 (20)
SBPC	64.0	4.20	**95**	0.90	94	**4.0**	0.81 (<33)
Wheat bran	15.7	0.64	71	0.25	79	< 0.5	1.20 (50*)

CVB, 2004
- **P = 0.65; P_{aD} = 39**
- **P = 2.56; P_{aD} = 77**

Actipro® animal proteins

Sustainability of blood products - AA profile

2. Nutrient Utilisation

Balancing amino acid profile = Balancing bio-available amino acids
Minimizing N and P emission

National Swine Nutrition guide (US Pork COE, 2010)

	$CP_{\%}$	$\%_{Lys}$	$\%_{SID}$	$\%_{Met}$	$\%_{SID}$	Lys_{SID} (%)	P-em. (g/kg)
SDPP	78.0	6.84	**91**	0.75	92	**6.2**	3.4
Egg	47.0	3.09	81	1.48	90	2.5	> 3.3
Fish meal	62.9	4.81	95	1.77	94	4.6	7.0
(MBM)	(52.8)	(2.76)	(80)	(0.72)	(83)	(2.2)	(11.6)
SBM	44.0	2.83	**89**	0.61	91	**2.5**	5.2
SBPC	64.0	4.20	**95**	0.90	94	**4.0**	> 5.4
Wheat bran	15.7	0.64	71	0.25	79	< 0.5	6.0*

CVB, 2004
P-emission = 4.0
P-emission = 5.9

Sustainability of blood products - AA profile

2. Nutrient Utilisation

Balancing amino acid profile = Balancing bio-available amino acids
Minimizing N and P emission

National Swine Nutrition guide (US Pork COE, 2010)

	$CP_{\%}$	$\%_{Lys}$	$\%_{SID}$	$\%_{Met}$	$\%_{SID}$	Lys_{SID} (%)	aD P / P-em. (mg/g Lys_{SID})
SDPP	78.0	6.84	**91**	0.75	92	**6.2**	**190 / 48**
Egg	47.0	3.09	81	1.48	90	2.5	< 136 / > 132
Fish meal	62.9	4.81	95	1.77	94	4.5	518 / 158
(MBM)	(52.8)	(2.76)	(80)	(0.72)	(83)	(2.2)	(1577 / 527)
SBM	44.0	2.83	**89**	0.61	91	**2.5**	**52 / 208**
SBPC	64.0	4.20	**95**	0.90	94	**4.0**	**< 67 / > 135**
Wheat bran	15.7	0.64	71	0.25	79	< 0.5	1200 / 1200

2. Nutrient Utilisation

Balancing amino acid profile = Balancing bio-available amino acids
Minimizing N and P emission

National Swine Nutrition guide (US Pork COE, 2010)

	$CP_{\%}$	$\%_{Lys}$	$\%_{SID}$	$\%_{Met}$	$\%_{SID}$	Dig Lys (g/100g)	P-emission (mg/g Dig_{Lys})
SDPP	78.0	6.84	**91**	0.75	92	**6.2**	**48**

Depends on the source: e.g. US vs EU

- **Different anti-coagulants used** (US phosphate-based; EU e.g. Na-citrate)
- **EU regulations for waste water management**
  (e.g. 2 ppm P, 15 ppm N)
- **US Pork COE: 1.48% P_{tot} / EU-SDPP: < 0.2% P_{tot} (if citrate is used)**
- **↓ Bioavailable P and ↓ Unavailable P in SDPP if citrate is used**

Sustainability of blood products

1. Sourcing & Production of ingredients
   - ⇨ Sustainability of Up-stream actions

2. Used as feed ingredients
   - ⇨ Nutrient Utilisation (productivity)
   - ⇨ **Gut Health** **(animal health/welfare, antibiotics use, productivity)**

3. Sustainability of down-stream effects
   - ⇨ N-emission
   - ⇨ P-emission
   - ⇨ **Antibiotics resistence**

Min Input - Max Productivity & Welfare - Min Emission (P, N, AB-R)

Sustainability of blood products

3. Improving Gut Health

⇨ ↑ productivity and animal welfare

⇨ ↓ need for antibiotics and antibiotics-resistance

AB are over-used → Regulations on AB-reduction are needed

But: deprivation of AB compromises productivity and welfare

Clinical disease	→	↓ Animal Welfare; ↓ productivity
Sub-clinical disease	→	↓ productivity

Therapeutic AB: Yes	Prophylactic AB : No
	Growth-promoting AB : No

Need for sustainable alternatives

e.g. Reducing infection pressure (on-farm biosecurity)

e.g. Improving gut health (bio-active ingredients)

Sustainability of blood products

3. Improving Gut Health

➯ ↑ productivity and animal welfare

➯ ↓ need for antibiotics and antibiotics-resistance

Plasma

- animal-based, sustainable protein source (dig Lys ↑)
- low content of ANF (e.g. no phytate)
- bio-active glycoproteins
  - IgG (substitute for sIgA from sow milk)
    → offers passive mucosal immunity to the gut
  - Growth factors (substitute for milk-borne GF)
    → promotes maturation and integrity of the intestinal lining
  - Non-Ig "binders" (e.g. lectins)

Use: Piglet feed (milk replacers, creep feed, post-weaning diets)

[Poultry feed (productivity ↑; necrotic enteritis ↓)]

3. Improving Gut Health : plasma

In Literature

- Improves (early) post-weaning performance of piglets
- Reduces clinical disease / diarrhea in challenge trials
- Effects on ADFI, ADG, G:F are more pronounced in challenge trials
- IgG and other glycoproteins diminish pathogen adhesion
- Improves intestinal barrier (e.g. tight junctions)
- Can increase brush-border enzyme activity / villus height
- Reduces immune activation (influx immune cells,…)

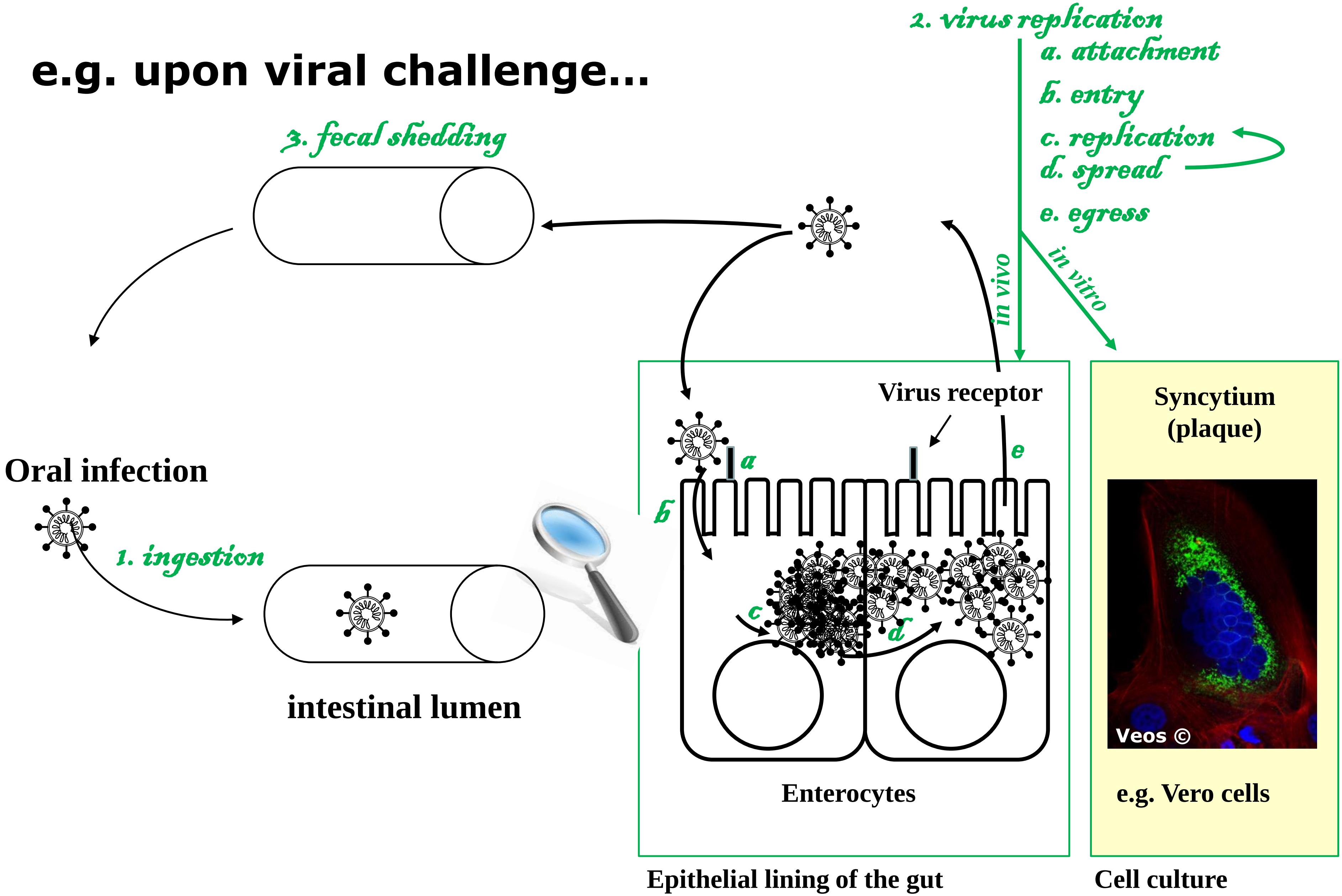
In Practice

- ↑ ADFI
- Beneficial amino acid profile
- Highly digestible protein source

most importantly,
feed intake ↑

Dietary IgG improves gut health

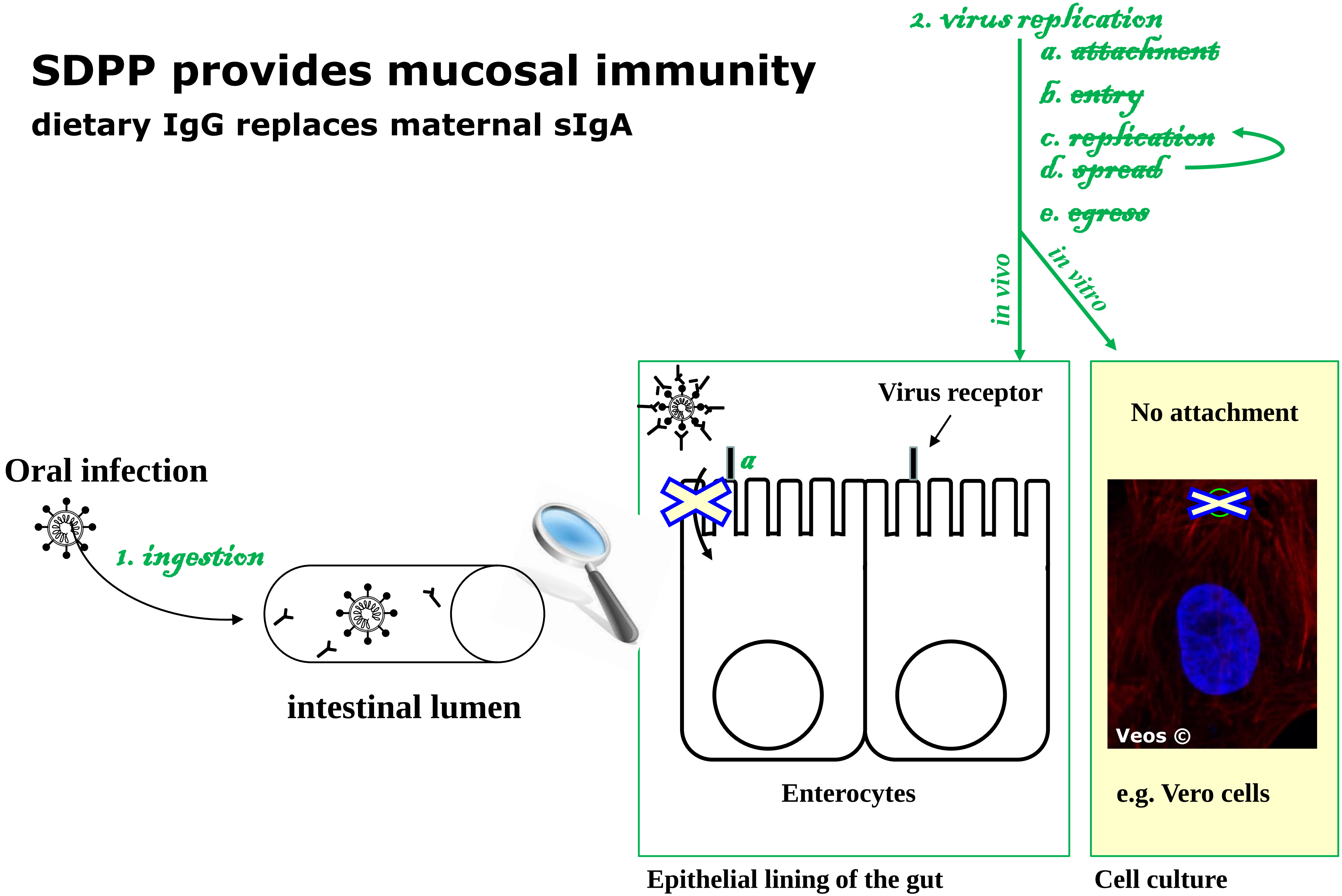
e.g. upon viral challenge…



Dietary IgG improves gut health

SDPP provides mucosal immunity

dietary IgG replaces maternal sIgA



e.g. use of SDPP in post-weaning diets

PIGLET

- separation from the sow
- moving
- mixing litters
- new environment
- dry feed

PIGLET's INTESTINE

- withdrawal milk-borne GF
- withdrawal maternal sIgA (gut mucosal immunity)
- not adapted to the feed

(new) pathogens

ANOREXIA

Changes in Intestinal Mucosa

Impaired Functionality (absorptive and digestive capacity ↓)

Impaired Integrity (vulnerability ↑)

e.g. use of SDPP in post-weaning diets

Concerns

- **Weight dip**
- **Diarrhea**
- **Mortality**

Multi-factorial etiology

- **Post-weaning anorexia**
- **Impaired digestion & absorption**
- **Increased vulnerability to pathogens**
  - loss of intestinal integrity
  - withdrawal of maternal sIgA
  - availability of undigested food
- **Infection pressure**

Solutions (targets : environment, piglets, feed or drinking water)

- Hygiene
- Cleaning & Disinfection
- All-in All-out
- ↑ Weaning age
- Antibiotics
- ↑ Palatability pre-starter
- "Acceptance"
- Organic Acids
- SDPP
- Zinc Oxide

Conclusion : Blood products as sustainable ingredients

1. **Sourcing & Production of ingredients**
   - ↑ **Sustainability of Up-stream actions**

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