Piglet vitality: determinants and consequences for survival

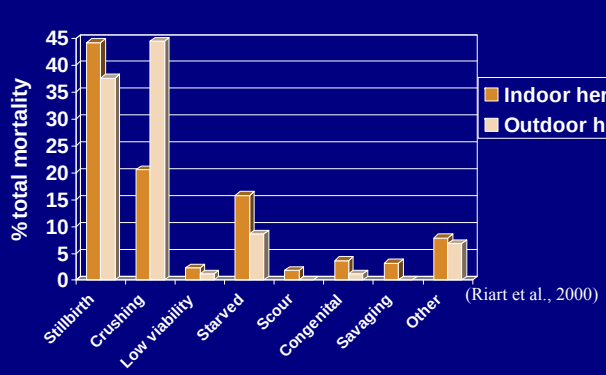
Sandra Edwards & Emma Baxter

Do piglets in loose farrowing systems require different characteristics?

- Aids to survival are not as readily available:
  - Targeted heat
  - Protection from crushing
  - Human intervention

- Causes of death are different

Causes of mortality



(Riart et al., 2000)

BUT BEWARE: Misdiagnosis is common

42% incorrectly attributed to stillbirths *(Edwards et al. 1994)*

32% incorrectly attributed to crushing *(Vaillicourt et al. 1990)*

How do we make neonates more viable?

- What characteristics do viable and non-viable piglets have?
- Generalised Linear Mixed Models
  - Allowing a binomial structure (piglet either dead (1) or alive (0))
  - Sow random factor
  - Adjusted for litter and sex effects
    - **Stillborn** mortality vs. Surviving piglets
    - **Live-born** mortality vs. Surviving piglets

(Baxter et al., 2006)

Prenatal survival results
(Baxter et al.)

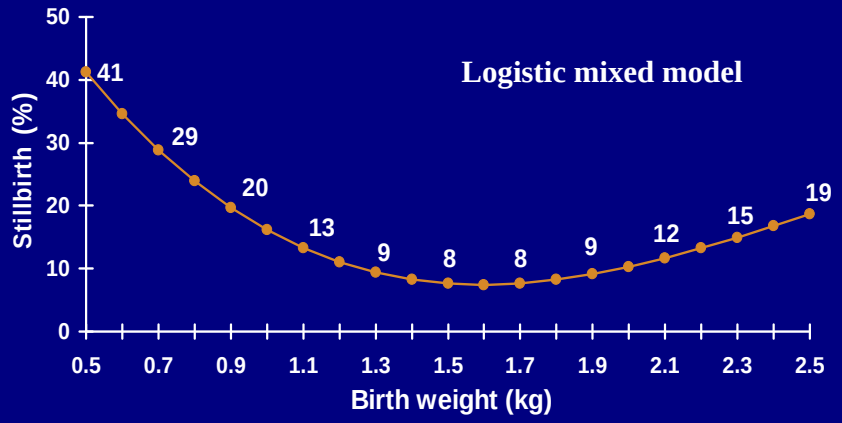
Survives

Body conformation
- Higher Birth Weight (1520g)

Stillborn

Body conformation
- Lower Birth Weight (1330g) *

Risk of stillbirth associated with birth weight



(Roehe, 2003)

What are the most important prenatal survival indicators?

- Birth weight (BW)
  Stillborn piglets were lighter (~200g lighter). Known indicator.
- Ponderal index (PI)- birth weight/crown-rump^3
  In human literature considered a better predictor of morbidity and mortality than birth weight (Fay et al., 1991). Measure of soft tissue growth
- Body Mass Index (BMI) - birth weight/crown-rump^2
  A measure of fat covering

Stillborn piglets were disproportionately long and thin (low PI and BMI) – can be a sign of intra-uterine growth retardation (IUGR)

Prenatal survival results
(Baxter et al.)

Survives

Body conformation
- Higher Birth Weight (1520g)
- Shorter Crown-rump length (27cm)
- Higher Ponderal Index (76)
- Higher Body Mass Index (20)
- Larger Abdominal circumference (27cm)

Prenatal environment
- Higher Placental Efficiency (6.48)

Stillborn

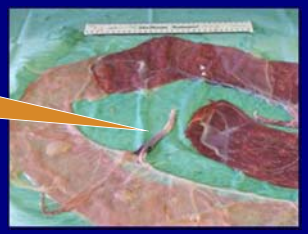
Body conformation
- Lower Birth Weight (1330g) *
- Longer Crown-rump length (28cm) *
- Lower Ponderal Index (58) ***
- Lower Body Mass Index (16) ***
- Smaller Abdominal circumference (24cm) ***

Prenatal environment
- Lower Placental Efficiency (6.00) *

What are the most important prenatal survival indicators?

Stillborn piglets were disproportionately long and thin (low PI and BMI) – can be a sign of intra-uterine growth retardation (IUGR)

Stillborn piglets experienced low placental efficiency
→ could lead to IUGR



Prenatal survival results
(Baxter et al.)

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Prenatal environment
- Higher Placental Efficiency (6.48)

Farrowing kinetics
- Earlier in Birth Order (7)

Stillborn

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- Lower Birth Weight (1330g) *
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- Lower Body Mass Index (16) ***
- Smaller Abdominal circumference (24cm) ***

Prenatal environment
- Lower Placental Efficiency (6.00) *

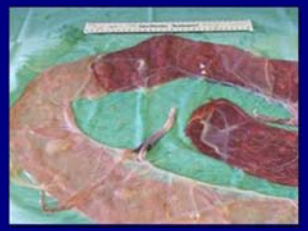
Farrowing kinetics
- Later in Birth Order (9) ***

What are the most important prenatal survival indicators?

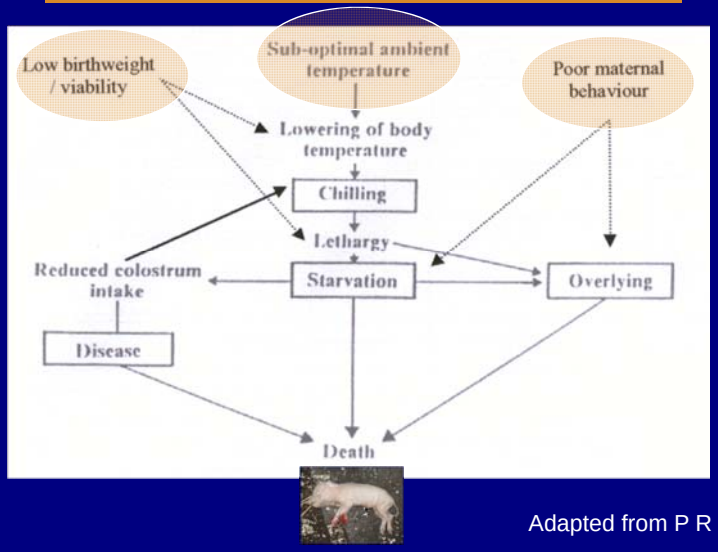
- Good uterine environment (placenta) is crucial
- **Farrowing progression is important**

  Stillborn piglets were born later in the birth order

Prenatal survival indicators are the same in farrowing crate and outdoor environments



Why do piglets die?



Adapted from P R English

Results – Piglet factors
(Baxter et al.)

Survives

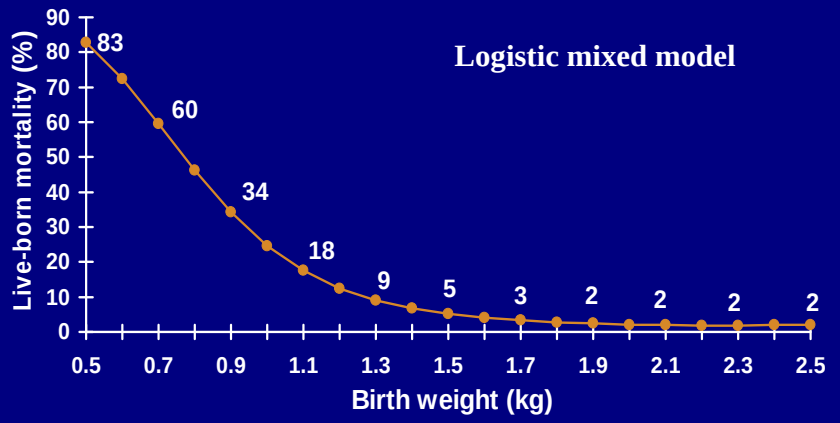
Vs.

Dies pre-weaning

Physiology
Higher Birth Weight (1520g)

Physiology
Lower Birth Weight (1289g) ***

Risk of live-born mortality of piglets associated with birth weight



(Roehe & Kalm 2000)

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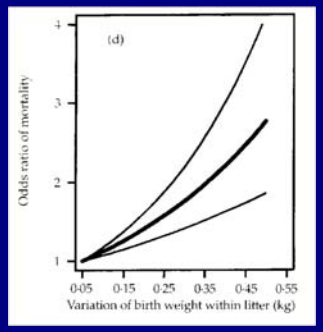
Piglet birthweight

- Increased risk of mortality with increased within litter birth weight variation (Roehe & Kalm 2000)



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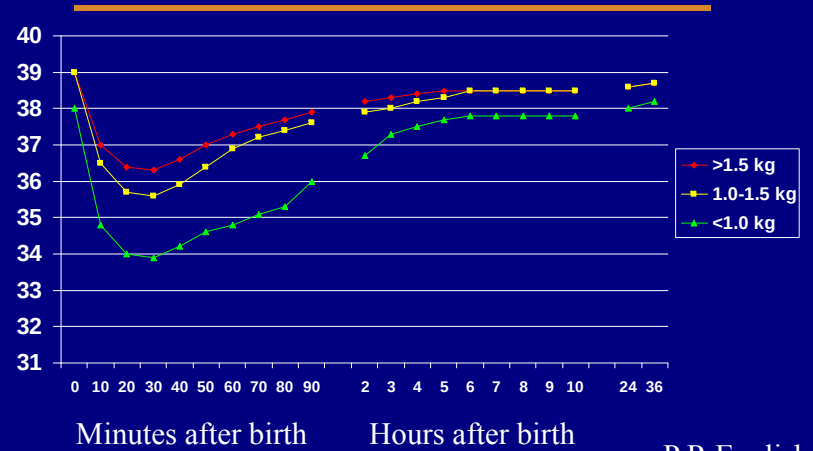
THE IMPORTANCE OF PIGLET BIRTHWEIGHT



P R English

Results – Piglet factors

(Baxter et al.)

Survives

Vs.

Dies pre-weaning

Physiology

Higher Birth Weight (1520g)
Higher Birth Temp (37.74ºC)
Higher 2h Temp (38.00ºC)
Higher 24h Temp (38.55ºC)

Physiology

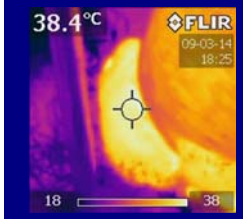
Lower Birth Weight (1289g)	***
Lower Birth Temp (37.13 ºC)	***
Lower 2h Temp (37.57 ºC)	**
Lower 24h Temp (37.56 ºC)	***

Vitality determinants

- **Blood lactate at birth** (indicative of hypoxia)
  - Positively correlated with cumulative farrowing duration (**)
  - Positively correlated with blood glucose (***)
  - Negatively correlated with Birth rectal temperature (*)

(Adeleye 2012)

Thermoregulation



Newborn = 0

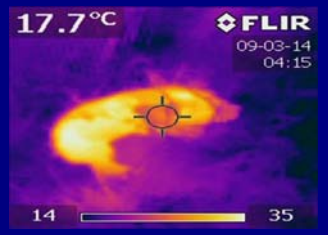
+1 minute

+30 minutes

+45 minutes

Thermoregulation

Newborn 30-60 minutes



At risk – no suckling

Newborn 30-60 minutes

Suckling improves thermoregulation

Results – Piglet factors

(Baxter et al.)

Survives

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Physiology

Higher Birth Weight (1520g)
Higher 24h Weight (1628g)
Higher Birth Temp (37.74ºC)
Higher 2h Temp (38.00ºC)
Higher 24h Temp (38.55ºC)

Behaviour

Quicker to udder (17mins)
Quicker to teat (24mins)
Quicker to suckle (33mins)

Physiology

Lower Birth Weight (1289g) ***
Lower 24h Weight (1326g) ***
Lower Birth Temp (37.13 ºC) ***
Lower 2h Temp (37.57 ºC) **
Lower 24h Temp (37.56 ºC) ***

Behaviour

Slower to udder (25mins) *
Slower to teat (38mins) ***
Slower to suckle (51mins) ***

VIABILITY SCORING

(Okere et al., 1997)

SCORE	0	1	2
Heart rate	absent	<120/m	>120/m
Respiration onset	absent	>15s	<15s
Muscle tone	flaccid	poor	good
Colour	pale	cyanotic	pink
Standing attempt	>5m	1-5m	<5m

ASPHYXIA AND MORTALITY

(Herpin et al., 1996)

	% high viability score	Time to udder (m)	% mortality to 10d
Asphyxiated	36	63	43
Control	79	32	19
		P<0.05	P=0.06

Results – Piglet factors

(Baxter et al.)

Survives

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Slower to udder (25mins) *
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Slower to suckle (51mins) ***

Vigour

Higher vitality score (2.28)
Higher rooting response (1.42m)

Vigour

Lower vitality score (1.77) *
Lower rooting response (0.47m) ***

Vitality Score (in first 15 secs pp)

0- Stillborn or resuscitated

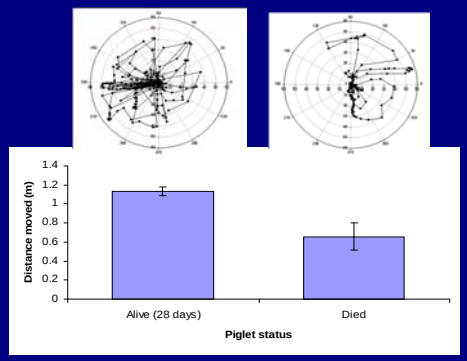
1- Remains in the same position after expulsion, does not move, breathes or attempts to breathe

2- Moves onto sternum and can move its head, but the rest of the body does not move

3- Moves a lot and attempts to stand

(Sacy & Le Treut, 2011; modified from Baxter et al., 2008)

Piglet rooting test shows "vitality"



Difference is not explained just by birthweight

(Baxter et al., 2006)

Do we need different piglets for different farrowing systems ?

Probably not

- **EU Welfare Quality Project**

Determinants of survival not significantly different

– **Outdoor v indoor pen** (Baxter et al., 2011)

– **Indoor pen v crate** (Pedersen et al., 2011

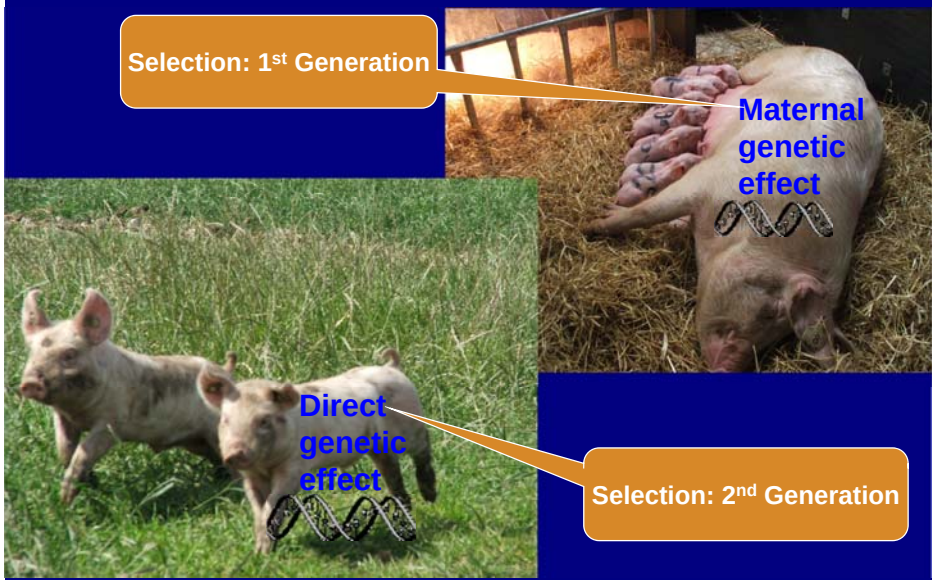
How can we improve viability ?

- **Genetic approaches**
  – selection for survival, weight, vitality
- **Nutritional approaches**
  – improving birthweight, vitality
- **Management approaches**
  – reducing hypoxia, hypothermia

Genetic Improvement of Viability

- Large genetic study – "GENOMUM"
  - unique (<22k records) **cross-over selection experiment** for piglet survival (High vs. Average) on a Scottish outdoor unit

Selection experiment for direct and maternal genetic effects of liveborn piglet survival



Direct heritabilities and correlations of survival traits and individual birth weight

Trait	(SVB)	(SVNP)	(IBW)
Survival at birth (SVB)	0.21 (0.14 to 0.28)	0.08 (-0.18 to 0.35)	0.17 (0.02 to 0.32)
Survival during the nursing period (SVNP)		0.24 (0.14 to 0.35)	0.16 (0.01 to 0.31)
Birth weight (IBW)			0.36 (0.31 to 0.41)

No indication of G x E interaction

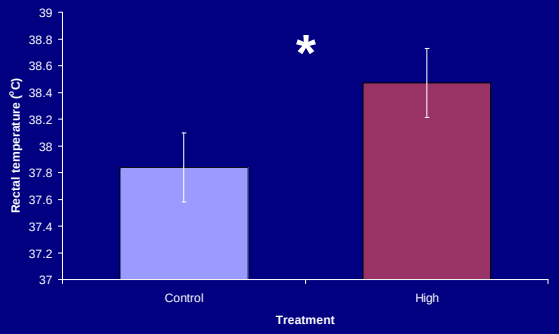
(Roehe et al., 2008)

Genetic Improvement of Viability

- Large genetic study – "GENOMUM"
  - unique (<22k records) **cross-over selection experiment** for piglet survival (High vs. Average) on a Scottish outdoor unit
  - results indicate that **genetic selection** could be an effective route to improving piglet survival in outdoor conditions
    - possibly also other non-crate farrowing systems

genetic improvement in survival: 3% better in HS lines (over 2 generations)

Genetic effects on vitality



(Baxter et al., 2007)

Nutrition to improve oocyte quality

Diets with fermentable substrates fed through lactation & pre-service (157 litters)

	Control	Dextrose + Lactose	
Litter size	14.09	14.40	ns
Birthweight (g)	1.46	1.55	P=0.05
Cv birthweight (%)	23.7	20.5	P=0.04
Total mortality (%)	20.4	17.2	P=0.09

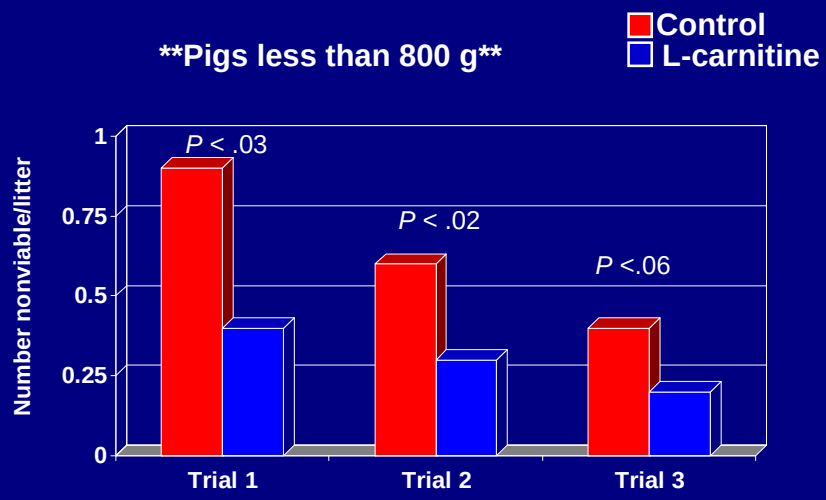
(van den Brand et al., 2009)

Nutrition to improve placental quality (1)

	Control	+Arginine
Embryo survival (%)†	68%	77%
Placenta vascularisation score†	2.6	2.9
Birth weight (kg)‡	1.36	1.41

†25g L-arginine/d (Hazeleger et al, 2007) ‡1% L-arginine (Matteo et al, 2006)

Nutrition to improve placental quality (2)



Eder et al., 2001 &2002

Nutrition to improve neonatal vitality

100 sows per treatment
Trial diets with DHA supplement fed from after breeding until weaning

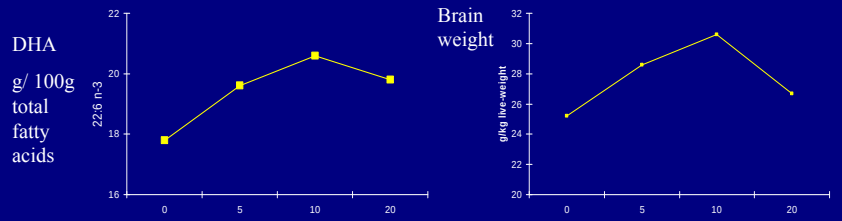
% mortality of piglets

P<0.05

(Rooke et al. 2001)

Piglet birthweight:
Vegetable oil (control) = 1.54 kg
Salmon oil (16.5g/kg) = 1.47 kg

Piglet Brain DHA and Brain Weight with increasing Maternal Fish Oil Intake



g Salmon oil/kg diet - day 60+

5 g/kg equivalent to ~ 3 g 20:5 n-3 + 22:6 n-3 / day
0.3% Digestible Energy

(Rooke et al 2001)

Improved piglet vitality by maternal n-3 fatty acids

Diet	Basal	Tuna –1	Tuna-2	Sig
Time to suckle (min)	25	26	21	*
At 28 days of age				
Weight (kg)	8.2	8.7	8.9	*
Plasma IgG (mg/ml)	7.8	9.0	9.6	*

1- 17.5 g oil/kg day 63-91
2- 17.5 g oil/kg day 92-term

(Rooke et al 2001)

Conclusions and Implications

- Stillborn mortality
  - Regardless of environment, body conformation, placental efficiency and birth order are the most important prenatal survival indicators
- Live-born mortality
  - Regardless of environment, birth weight, thermoregulation, vitality and landmark behaviours are important postnatal survival indicators
- Genetic selection for all environments possible
  - selection for survival influenced thermoregulation
- Nutritional and management interventions are also possible