Neonatal Mortality in Small Ruminants: What are the important phenotypes?

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Causes of lamb/kid losses

- Abortion
- Stillbirth
- Congenital malformation
- Functional disorders
- Starvation
- Hypothermia
- Mismothering
- Infectious disease
- Accident
- Predation

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- **Stillbirth**

Infectious agents

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- Functional disorders
- Starvation
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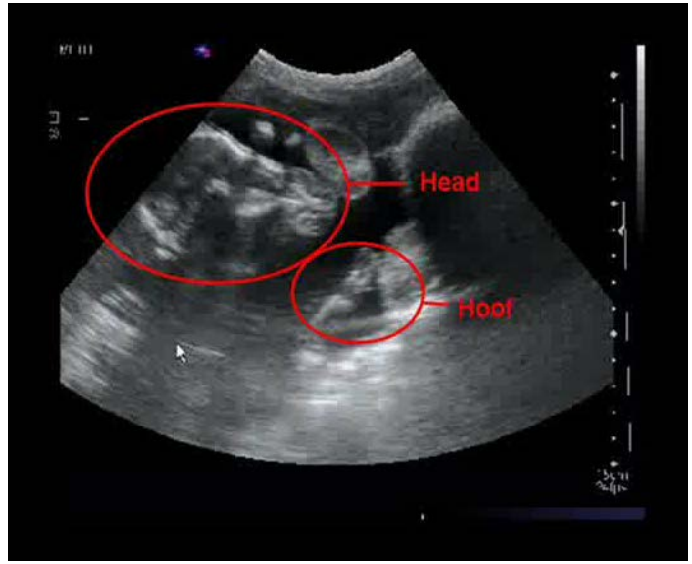

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- **Stillbirth** Birth Trauma
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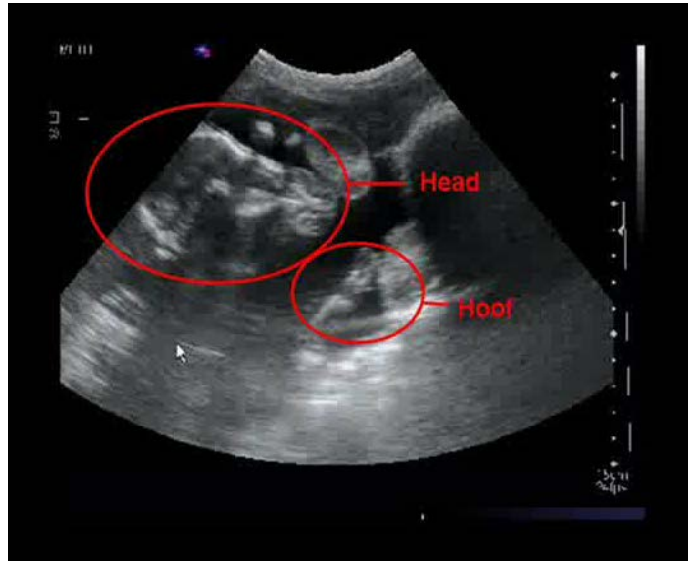

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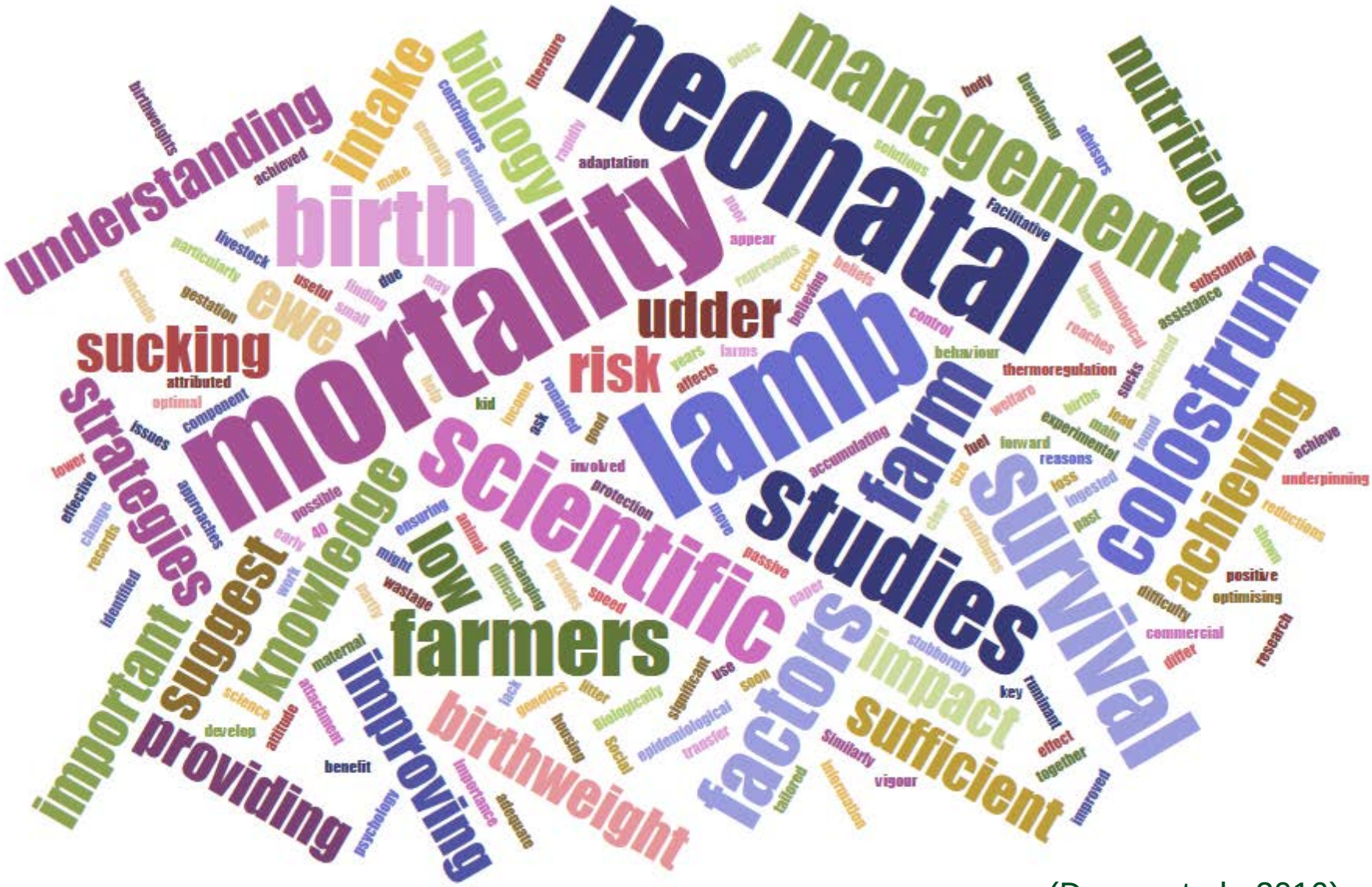
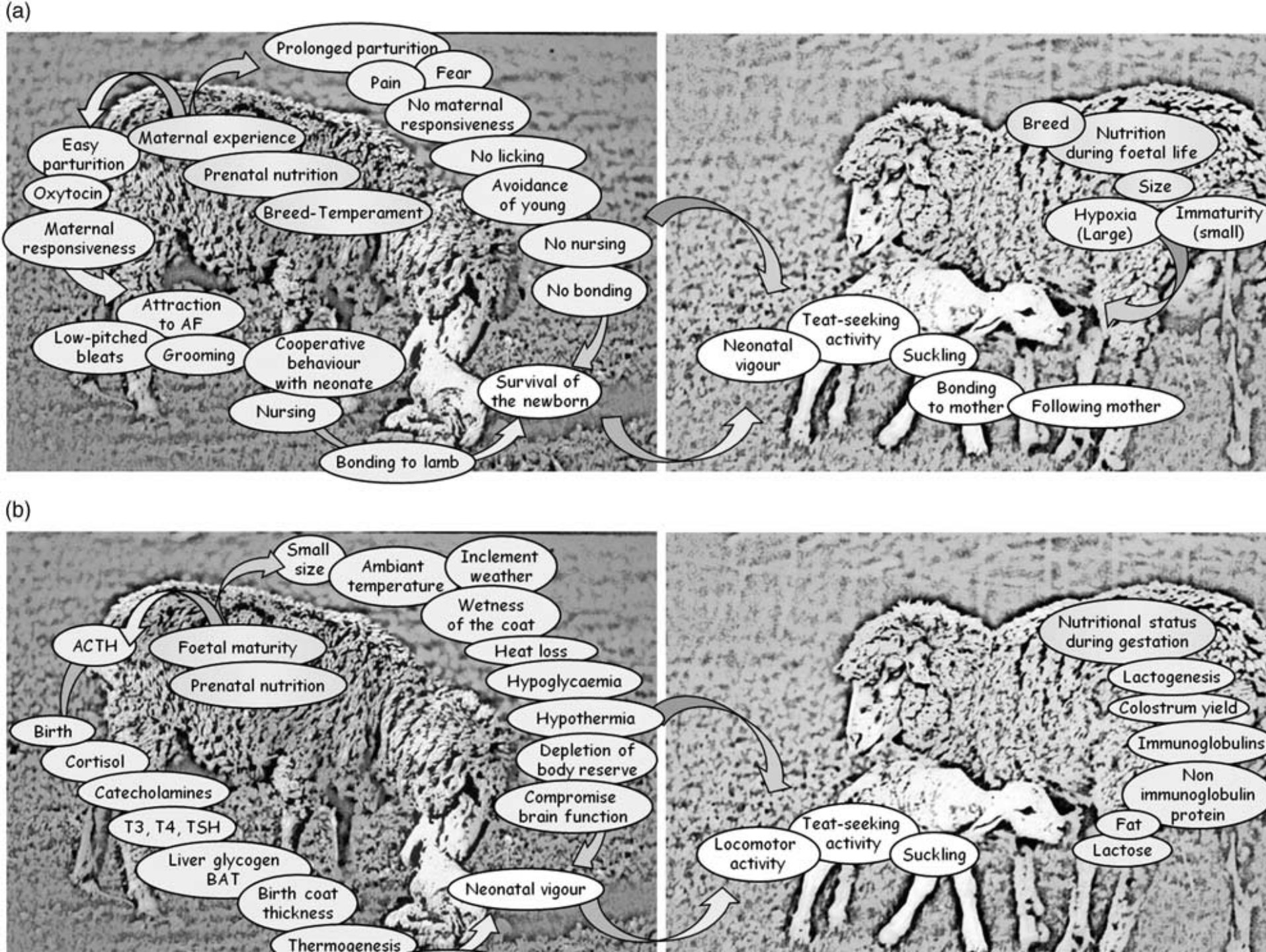
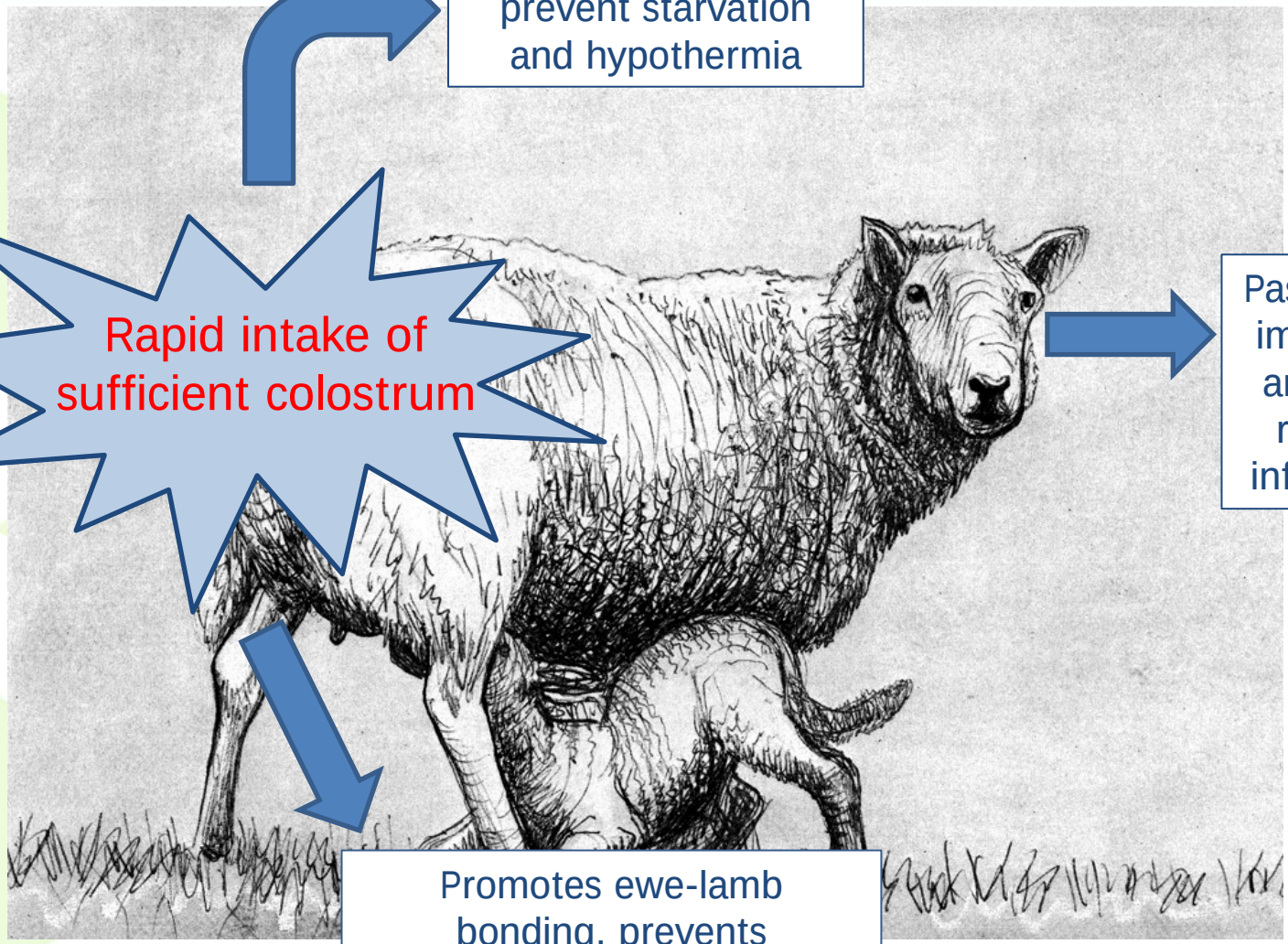


(Dwyer et al., 2016)


(a)
Prolonged parturition
Pain
Fear
No maternal responsiveness
Maternal experience
Easy parturition
Oxytocin
Prenatal nutrition
Breed-Temperament
Maternal responsiveness
No licking
Avoidance of young
No nursing
No bonding
Attraction to AF
Low-pitched bleats
Grooming
Cooperative behaviour with neonate
Nursing
Survival of the newborn
Bonding to lamb
Breed
Nutrition during foetal life
Size
Hypoxia (Large)
Immaturity (small)
Teat-seeking activity
Neonatal vigour
Suckling
Bonding to mother
Following mother
(b)
Small size
Ambiant temperature
Inclement weather
Wetness of the coat
Heat loss
Hypoglycaemia
Hypothermia
Depletion of body reserve
Compromise brain function
Neonatal vigour
Thermogenesis
Birth coat thickness
Liver glycogen BAT
T3, T4, TSH
Catecholamines
Cortisol
Birth
ACTH
Foetal maturity
Prenatal nutrition
Nutritional status during gestation
Lactogenesis
Colostrum yield
Immunoglobulins
Non immunoglobulin protein
Fat
Lactose
Teat-seeking activity
Locomotor activity
Suckling

Sufficient nutrition to prevent starvation and hypothermia

Rapid intake of sufficient colostrum



Passive transfer of immunoglobulins and gut closure, reduces risk of infectious disease

Promotes ewe-lamb bonding, prevents mismothering, reduces risk of accident and predation

Can we measure intake of sufficient colostrum?

- Dependent on ewe production, quality and IgG content of colostrum, sucking ability of the lamb
  - Lamb ingestion abilities probably the most important determinant
    - This is dependent on ewe cooperation with sucking attempts and lamb ability to find the udder and suck
- What can be measured:
  - Ewe production/yield
  - Ewe maternal behaviour
  - Lamb behaviour
  - Lamb circulating IgG content

Ewe production of colostrum IgG

- IgG availability declines rapidly after birth
- Concentration is affected by litter size, by ewe age (*Gilbert et al., 1988*), ewe nutrition (*Banchero et al., 2009*), mineral supplementation (*Boland et al., 2005*) etc.
- Some evidence for sire and breed influences and heritability estimated at 0.19 ± 0.12 (*Gilbert et al., 1988* – but small sample size)
- But relationships between ewe colostrum IgG concentrations and lamb serum IgG are low
- Not easy to measure in large numbers and poor association with important phenotype

Ewe maternal behaviour and intake

- Ewes with low maternal behaviour score have higher lamb mortality *(O'Connor et al., 1985; Lambe et al., 2001)*
- Some evidence for differences in maternal behaviour and temperament influencing lamb survival *(Murphy et al., 1998; Bickell et al., 2010; Plush et al., 2011)*
- Several studies have shown breed differences in maternal behaviour and lamb survival *(reviewed by Dwyer & Lawrence, 2005)*
- Ewe maternal behaviour did not affect lamb behaviour and time to stand/suck with embryo transfer *(Dwyer & Lawrence, 1999)*
- Selection for maternal behaviour directly is difficult and heritability estimates are based on proxy measures

Lamb behaviour and intake

- Higher mortality in lambs that were slow to stand and suck *(Dwyer et al., 2003; Madani et al., 2013)*
- Sucking assistance predicts lamb future survival *(Dwyer & Nath, in prep)*
- Lambs of 'high-loss' sires were quicker to stand, reach the udder and suck than from 'no loss' sires *(Hergenhan et al., 2014)*
- Lambs from lines selected for higher survival were quicker to suck than low line lambs *(Cloete & Scholtz, 1998)*
- Better survival in lambs that could distinguish their mother from other ewes at 12h old *(Nowak et al., 1992)*
- Good heritability of lamb sucking traits (*Matheson et al., 2012*) but require knowledge of time of birth – poorer estimates with other lamb behaviour traits

Lamb circulating IgG

- Can be measured in lamb blood samples
- But timing after birth an issue
- Not feasible to measure in large numbers of animals
- Heritability of 0.18 ± 0.06 at 36 h old (*Gilbert et al., 1988* – but small sample)
- Other measures of colostrum intake (more than just IgG) e.g. ^{3}GT?

Other indirect phenotypes?

- Ease of delivery – birth trauma delays sucking
- Lamb birth weight – low birth weight lambs are slow to stand and suck, heavy lambs have more birth difficulty, but poor genetic correlation with survival *(Brien et al., 2014)*
- Lamb rectal temperature – evidence of adequate intake as able to thermoregulate successfully, phenotypic and genetic correlation with survival
- Proxies for maternal behaviour e.g. physiological indicators
- Ewe-lamb attachment – bleating, behavioural responses, average ewe-lamb distance
- Ewe rearing ability – weight/number of lambs weaned, stress susceptibility

Conclusions

- Rapid intake of colostrum key factor in postnatal lamb/kid survival
- Measuring this directly is challenging and relies on the genetics of two animals
- Measuring this indirectly is challenging and may only be possible in some systems
- Number of potential other indicators that might be relevant and more readily measured on farm, but many are time consuming and time dependent
- What next?
  - Use imperfect but measureable tools
  - PLF options to improve what can be measured (e.g. proximity sensors?)
  - Continue to look for better proxy measures

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