Reproduction in extensive production systems

Dr Stuart Barber

Importance of reproduction

Maintain flock/herd/group size

- Replace animals that die
- Replace animals that are beyond effective breeding age (cast for age (CFA)
- Allow for genetic selection in both male and female

Impacts on production

- Must give birth to produce milk (for a mammal) e.g. dairy cow

Image: University of Wisconsin

Impacts of reproduction on management

Impacts on other management procedures

- Reduce handling in last third of gestation or post parturition
- Increased feed & attention required in pregnant or lactating animals

Impacts on animal health

- Diseases spread via sexual transmission
- Increased risk of many diseases during pregnancy or lactation
- Different ages of animals in self-replacing flock/herd/group

http://www.beefproducer.com/sites/beefproducer.com/files/10-002-beef-grazing-pasture-cow-60.jpg

Key events in a reproduction system

https://www.videoblocks.com/

Joining

Gestation

Parturition

Lactation

Return to oestrous

http://www.boergoats.com/clean/articles/breeding/givingbirth/S_nubiankidding0.jpg

https://www.dairyaustralia.com.au/animal-management-and-milk-quality/mastitis-and-milk-quality

Events in female reproduction

- Age at first mating (joining) – how old/big does she need to be?
- Oestrus cycle length and pattern - when to mate?
- Mating method – how to mate?
- Joining (mating) period – how long to allow for her to become pregnant
- Pregnancy testing – is she pregnant?
- Gestation length – how long will she be pregnant?
- Parturition – will it be easy for her to give birth? How many offspring is she likely to have?
- Lactation – how long should the offspring be left with the dam?
- Return to oestrus – how long until she can be pregnant again?

Female age at first mating

When can a female be mated for the first time?

In general, the larger the animal, the longer before it will be mature enough to successfully mate e.g.

- elephant in captivity – approximately 12 years of age
- mouse – approximately 3 months of age

Key points:

A female needs to be mature enough to have started her reproductive cycle

An animal must be mature enough to cope with the weight of the male (depending on mating technique – not relevant for AI)

As a rule of thumb, female ruminants need to be in the order of **60-70%** of adult bodyweight at first mating to get good pregnancy rates

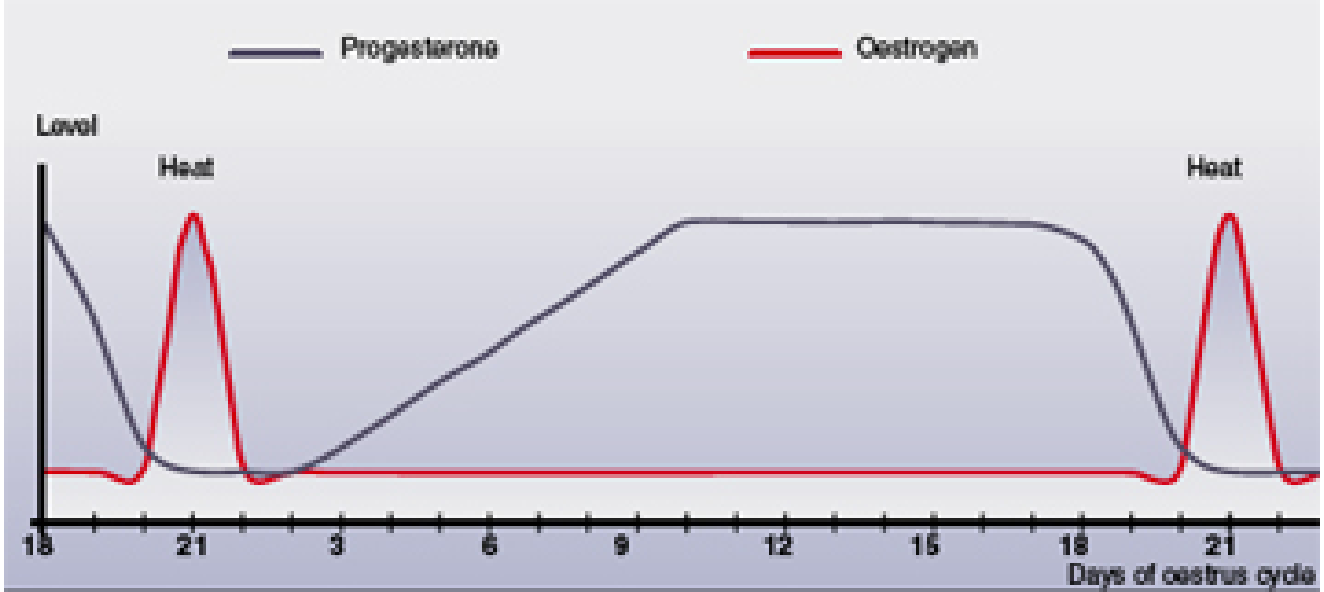
Image: http://agritech.tnau.ac.in

Oestrus cycle

What is the oestrous cycle?

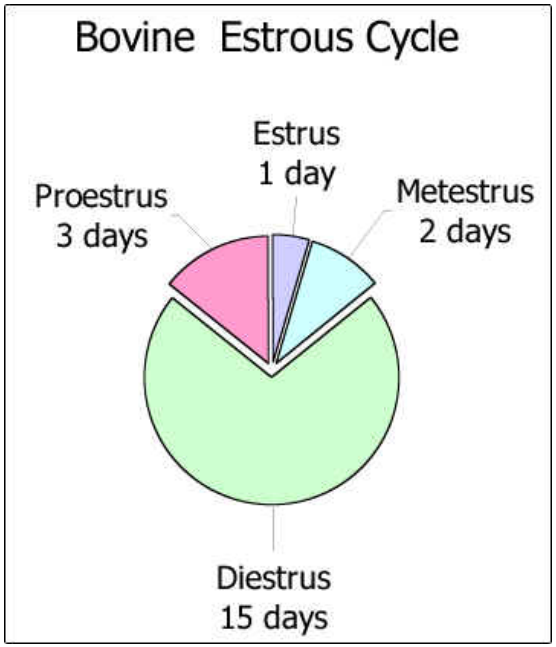
The recurring physiological changes induced by reproductive hormones (in many ways similar to the human menstrual cycle) once reach puberty

Females are usually only receptive to males during the oestrus stage of the cycle (also known as being “on heat”). This is commonly a fairly short period of time (up to a few days) of each oestrus cycle.



Oestrus cycle

If not successfully mated, many species continue to have oestrus cycles, either throughout the year (e.g. beef cattle) or for a particular time each year (e.g. horses). Others may only have 1-2 oestrus cycles per year e.g. most dogs cycle approximately every 6 months



Total cycle length 21 days

https://instruction.cvhs.okstate.edu/histology/fr/HiFRp14.htm

Seasonal breeders

Many animals are seasonal breeders

Temperate deer, goats and long wool British Breed sheep (e.g. Border Leicester) are typically seasonal breeders. They come into oestrus so that young will be born in favourable time of year (spring) – advantage as get higher survival of young, hence more likely to contribute genes to next generation. They are known as 'seasonally polyoestrus' – they cycle continuously during their reproductive season until they get pregnant.

www.wattlefarm.com.au

https://en.wikipedia.org/wiki/Red_deer

Seasonal breeders

It is not always ideal from a human perspective to have animals give birth at their natural time.

If a dairy goat enterprise wants to have multiple kidding rounds per year to get yearly milk production this will generally require use of lights or hormones to get goats cycling out of season

Regulin (melatonin) can be used in sheep production to aid cyclicity
https://www.ceva.com.au/Products/Products-list/REGULIN-R

Oestrus cycle and on heat times

Species	Oestrus cycle length	Time on heat (in oestrus)	Seasonal breeders?
Cows (dairy and beef)	21 days	2-28 hours	No
Sheep – long wool British breeds	17 days	24-28 hours	Short day
Sheep other than long wool British breeds	17 days	24-28 hours	A little bit (will cycle but lower numbers)
Alpacas	No regular cycle	Depends on ovarian activity	No
Deer	17-22 days	24 hours (approx.)	Short day

In the next session we will begin looking at the joining period

Joining (mating) period

The joining or mating period is the period of time the males are in the paddock with the females or the period over which artificial insemination (AI) will be conducted. It determines the time over which the offspring will be born.

It is often based on the number of oestrous cycles the males will be with the females. It can be expressed as the **number of cycles or the number of weeks**.

https://www.farmanddairy.com/

Joining (mating) period

Two or three cycles is a common joining period for livestock.

e.g. a joining period of 2 cycles for beef cattle will be 6 weeks as each cycle is 21 days
e.g. a joining period of 3 cycles for sheep will be 7-8 weeks as each cycle is 17 days

In industries where AI is used, an animal may undergo AI for 2 cycles
e.g. for a cow 2 consecutive periods of oestrus, which will be approximately 21 days apart.

Heat detection

For industries where there is natural mating without human supervision (e.g. beef cattle, sheep) the males identify on-heat females (those at the oestrogen peak of their cycle) through pheromones and behaviour.

In industries where supervised mating or AI is common (e.g. dairy cattle), we need to be able to identify when females are on heat so that they are mated at the time that gives the greatest chance of getting pregnant.

Heat detection

Heat detection is done by observing physical signs such as a swollen vulva, behavioural changes such as ‘winking’ in horses or behaviour in the presence of a male (often called a ’teaser’) e.g. showing interest or not rejecting in the male.

Heat detection aids can also be used e.g. Kamars in dairy cattle

In some industries, ultrasound of follicles is also used to provide a higher level of detail about the timing of mating.

http://www.bairnsley.com/Breeding%20-%20Heat%20Detection.htm

Heat detection

Species	Common method/s of heat detection
Beef cattle	Bull in paddock, cows riding cow on heat
Dairy cattle	Visual observation of mounting or detection aids (e.g. Kamars) during AI period; bull in paddock after AI period
Small ruminants	Ram/buck in paddock, mating crayon
Alpaca	Bring male and female together and assess female acceptance of male
Deer	Stag/buck in paddock

Mating method

Three common methods are:

1. Paddock mating – e.g. beef cattle, sheep, deer, goats
2. Supervised natural mating – e.g. Alpaca
3. AI – e.g. dairy cattle, stud animals

https://www.arkive.org

http://www.sundaynews.co.zw/artificial-insemination-lessons-for-smallholder-communal-beef-farmers/

Pregnancy testing

Not done in all industries or on all properties.

Advantages of pregnancy testing are:
- to identify which females are not pregnant so they can either be rejoined or sold
- to estimate time of parturition
- to check for multiple foetuses to allow for appropriate management e.g. in horses twins are not viable so one foetus is often crushed, in sheep ewes with twins or triplets may be separated so that they receive adequate nutrition

Most commonly done by ultrasound or rectal palpation.

http://www.allstateag.com.au/eventschedule/cattle-combined-artificial-insemination-pregnancy-testing-course/

http://www.eimedical.com/blog/bid/48257/Using-Portable-Ultrasound-for-Early-Pregnancy-Detection-in-Sheep

Gestation period

What is gestation?

Time from mating to parturition (birth) for mammal

Varies for each species (and within species)

Important determinant in generation interval

Why is it important?

Number of age groups on property/area

Ability to match natural feed supply

Prolificacy

Number of progeny per pregnancy (or laying season) varies e.g. pig v cow

Species	Gestation period (days)
Bovine	283
Ovine	147 (145-150)
Caprine	150
Cervine (Red)	234
Alpaca	345

Parturition

Ease of parturition varies between species based on several factors:

- Relative size of offspring to dam
  e.g. average weight piglet 1.44kg vs sow 250kg (0.5% of dam's bodyweight)
  average weight beef calf 40kg vs beef cow 400kg (10% of dam's bodyweight)

- Anatomical factors e.g. brachycephalic dogs have large heads and a narrow pelvis which results in many caesarians

- Litter size – larger litters will usually have smaller offspring

- Normal duration of parturition varies significantly between species

From https://www.wool.com/sheep/reproduction/national-lambing-density-project/

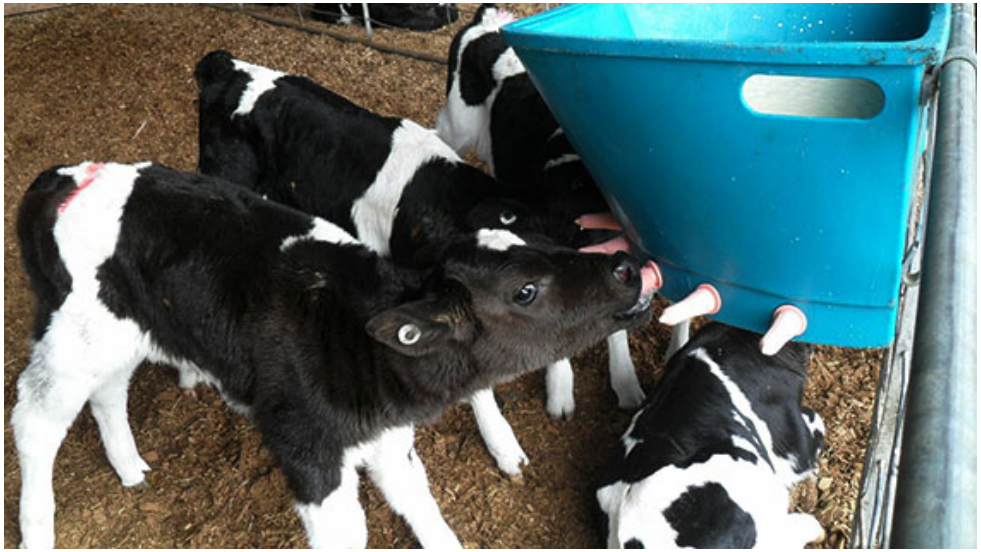
From https://www.warrawindi.com/east-friesians/

Lactation (suckling)

The lactation period (also known as the pre-weaning period) is the time the offspring are suckling milk from the dam.

Lactation length varies significantly between species based on the needs of the offspring, the needs of the dam and production requirements.

Where milk is a key product, the offspring are usually weaned within the first days of life and fed milk replacer e.g. dairy calves



http://biostart.co.nz/products/animal-probiotics/calf/calf-trial/

Weaning

All domestic animals must be weaned from their mother's milk. The age at which weaning occurs can depend on several factors:

- Feed availability for mother – if poor may limit milk supply
- Need for mother to have a break before the next pregnancy or birth
- Age at which offspring are able to digest solid feed
- Need for milk as product e.g. dairy cow

Weaning time on the same property can vary from year to year based on feed availability.

•In most cases offspring gradually begin to eat solid feed while still drinking from their mother.

From https://www.dairynz.co.nz/media/4113422/weaning-og.jpg?anchor=center&mode=crop&width=1200&height=630&rnd=131050996410000000

Return to oestrous

After giving birth, most species will have a period of not cycling while in peak lactation. The dam cannot become pregnant again until she returns to oestrus.

In species with longer lactation periods the dam will usually return to oestrus while still lactating

There is also some variation within species. Females in ideal body condition score will usually start cycling more quickly that those in a lower body condition score, similarly those with access to optimal feed will cycle more rapidly than those on lower quantity/quality.

Events in male reproduction

- Age at first mating (joining) – how old/big does he need to be?
- Fitness for mating – what needs to be checked?
- Other aspects covered under female section

http://www.karori.com.au/index83cb.html?sitemenu=31

The impact of age structure

Why is age structure of a group of animals important?

- In some enterprises all animals are the same age – “all in, all out” production systems such as Merino wethers, finishing beef steers etc
- In any self replacement enterprise there are multiple age groups – consisting of males and females
- Reproductive age of females and males varies with each species
- In any one year it is impossible to replace the entire breeding female population unless the progeny per female is a minimum of 2, presuming sex ratio is 1:1

Ruminant reproduction

Cattle, sheep & goats

•Ruminants share similarities in their reproduction, though there are also considerable differences between them

• Goats and long wool British breed sheep are highly seasonal breeders, giving birth in spring (cycle in Autumn)

• Cattle, Merino & most short wool British breed sheep less seasonal or not seasonal (relatively)

• Oestrous (cyclicity) reduced post partum (after birth)

• Oestrous reduced if in low condition score and low feed consumption eg. If cow gives birth and in CS2 and low feed may take 60-70 days to cycle (compared to 30 days for CS4 and good feed)

• Presence of male may increase number of females coming into oestrous eg. Rams and ewes

Events in male reproduction

Age at first mating (joining)

- As with females, the larger the species the longer it generally takes to become sexually mature
- Obviously must have reached puberty and be producing sperm
- For species where mating takes place in the paddock, or which use supervised natural mating, need to be able to successfully mount females

http://www.worldwidewaftage.com/2016/02/alpacas-matingvideotime-consuming.html

Events in male reproduction

Fitness for mating

Always examine several weeks before joining date.

Exam should include:

- Condition score
- Teeth
- Musculoskeletal soundness
- Scrotal size, palpation of testes for symmetry and firmness
- Penis and prepuce for swelling and wounds, ability to protrude
- Semen exam if necessary

http://agriculture.vic.gov.au/agriculture/livestock/sheep/sheep-notes-newsletters/sheep-notes-spring-2015/pre-joining-ram-checks

Reproductive loss

Stages

1. Conception – embryo, foetus
2. Parturition
3. Pre weaning
4. Post weaning
5. Adult

Loss rates for each one of the stages above vary for each industry.

Measuring reproductive rate

How to measure?

- Ovulation rate
- Fertilisation rate
  - Relatively high loss rate possible here (good number of ova produced but poor embryo survival/production)
- Birth survival, Neonatal & weaning.
  - One study by Hatcher *etal* in Australian Merino sheep (1975-1983, over 14,000 lambs)
    - Survival to weaning – 72.4% (lost 23% singles, 32 % twins, 45% multiple)
    - 6% dead within 24 hours of birth, further 14% by day 7, further 3% between 7-30 & 8% between 30 and 110d
  - Once born, it is relatively easy to measure survival rate at different time points (but MUST be physically measured as opposed to, "I reckon we lose about……..)

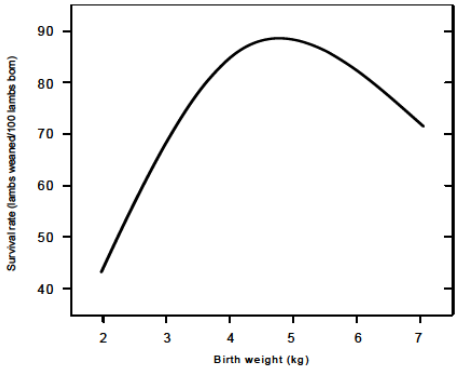


Figure 2: Relationship between lamb birth weight (kg) and survival (number of lambs weaned per 100 lambs born).(Source: Atkins 1980)

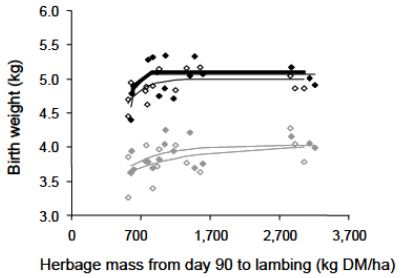


Figure 3: Progeny birth weight responds positively to ewe nutrition. The black lines represent single born lambs and the grey lines twins. (Source: Dr Chris Oldham)

Survival to weaning, from weaning to adult

Lamb survival

"For single and twin-born lambs, the percentage of lamb deaths between flocks ranged from 6.0 to 19.9% (mean = 11.0%) and 19.1 to 63.2% (mean = 33.1%) respectively." Kelly, AJAR 43 (6)

Weaner survival

Data from Angus Campbell

Survival of weaner sheep

bodyweight at weaning

growth weight

Bodyweight of dam at lambing

Nutrition post parturition

Nutrition post weaning

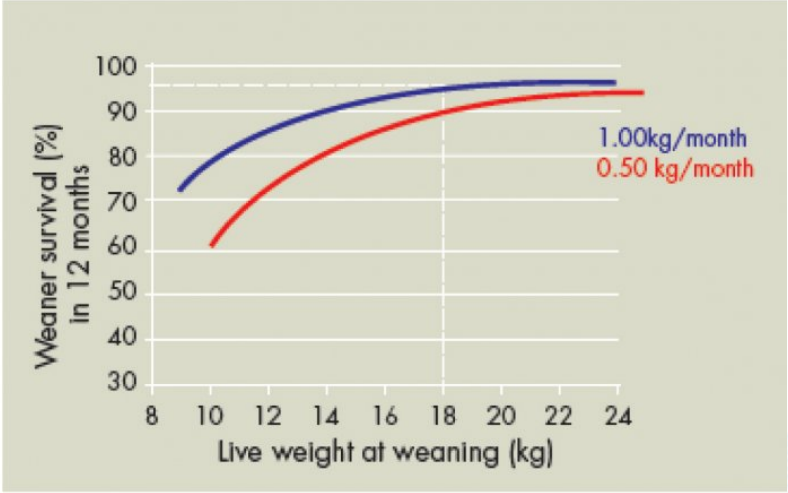


Figure 1: Survival of small frame Merino weaners over summer

Other species

Estimating loss

•It can be difficult to estimate reproductive "wastage" or loss in some industries due to a lack of data

• Good point to start = number of females bred, multiplied by industry standard for progeny per female

• What is the difference between this number and the actual number of animals that are produced each year – reasonable "guestimation" of post birth deaths (doesn't account for loss during conception/gestation)

•

• There will always be some loss – this is unavoidable

• What loss is acceptable (a lower weaning rate in some situations may be more likely to be profitable – why?)?

What causes the loss?

Causes:

1. Genetics (size, shape etc)
2. Nutrition
3. Infectious disease
4. Predation
5. Environment

Genetics

How can genetic information be used to reduce complications at birth?

www.sheepgenetics.org.au

Animal ID	BWT	WWT	PWT	PFAT	PEMD	PWEC	LE_DIR	C+	Trade$	Lamb 2020	SRC
	0.13	8.2	12.5	-0.8	**2.6**	**-35**	3%	**196**	**114**	**114**	**141**
POLLAMBI-080608 **CRC**	93%	95%	95%	95%	**95%**	**87%**	69%	**95%**	**91%**	**91%**	**65%**
PEPPERTON-050508 **CRC**	0.74	**10.4**	**16.4**	-1.4	-0.5	4	-9%	181	**113**	111	134
	93%	**94%**	**94%**	93%	94%	82%	75%	94%	**88%**	88%	68%

Birth weight

Lambing ease direct

Lambing ease daughters

Similar figures available from Breedplan (see reproduction case study)

Physical shape – ease of parturition

Genetic defects

Various genetic defects can reduce reproductive rate

Curly calf syndrome (arthrogryposis multiplex)

Breeds with large heads or high muscling (dystocia – caesarean section)

Identification of breeders with condition

Toxins

What causes the loss? Nutrition

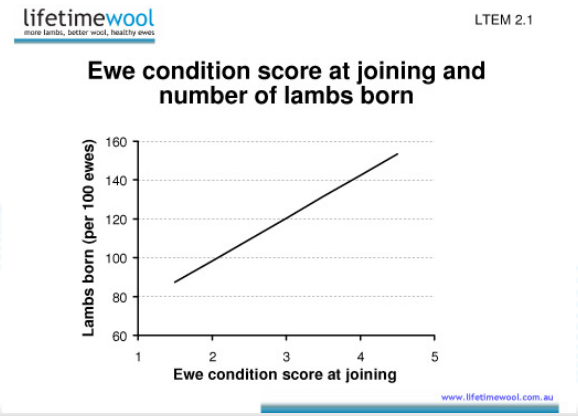
Recall notes from FAH1

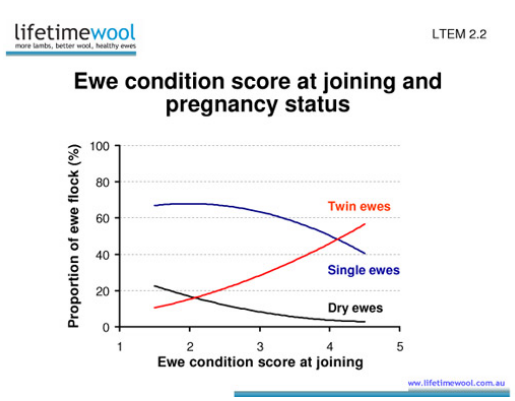
- Majority of fetal growth occurs during last third of gestation
- Multiple progeny need plenty of feed to get adequate weight, not too much for singles (how can you feed these animals with different requirements?)
- Lactation – high energy and protein demand (increased if more progeny than average)
- Any interference in lactation ➔ progeny death (can transfer some progeny to other dams)
- Once weaned – nutrition critical to survival
    - weaner must adapt to adult type diet in most situations – easily controlled in intensive production systems (pig, chicken, feedlot etc), not as easy in extensive production systems
    - diet should be balanced (consider giant dog breed diet)
    - Important that not too much nutrition is spent feeding internal parasites
- Adequate trace element nutrition

What causes the loss? Infectious disease

Male + Female in adequate condition = progeny

- The equation above holds true as long as the male and female are reproductively “fit”
- Infectious disease can significantly reduce ability to successfully rear progeny – either in dam or sire (female or male)
- May be transferred from male to female
  - Eg. EHV 3 - vesicles, pustules and ulcers on external genitalia: EHV1 - abortion
  - Eg Ovine brucellosis – male infertility
- Poor condition score of male or female can also dramatically reduce reproduction rate



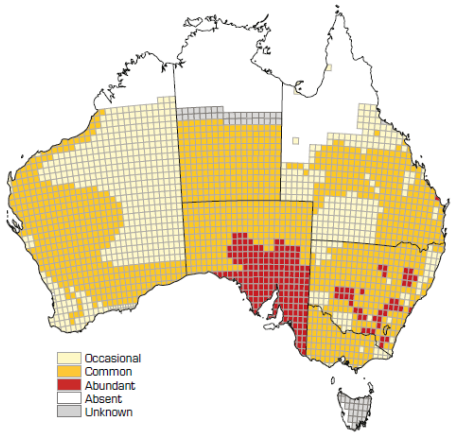


What causes the loss? Predation

Predation:

- In Australia = primarily wild dogs, foxes, pigs and less commonly birds of prey & crows
- Control methods
  - guard animals (dogs or camelids mostly)
  - shooting/baiting (co-ordinated)
  - "safe" containment areas
  - dog proof fences

Figure 3.36 Fox abundance throughout Australia



From Peter West, 2008

Controlling foxes prior to lambing can reduce predation of newborn lambs (photo by NSW Department of Primary Industries)

What causes the loss? Environment

Environment

- Extreme environmental conditions are one of the largest killers of newborn extensive livestock
- Heat, cold, rain, wind etc
- The worst of these is cold for terrestrial mammals

"Following a reasonably benign winter, the Southland region of New Zealand (NZ) has in the past week been hit by "the worst spring storm in living memory" according to the *NZ Herald*. Six days of blizzards have caused deaths among new lambs numbering in the hundreds of thousands, and raised concern over the welfare of ewes yet to lamb." source www.mla.com.au (Sept 2010).

Fig. 2. Lambs and ewes sheltering in the lee of the hedge on 21 August 2009 (left) and 24 August 2009 (right). These dates were characterised by low temperatures, high winds and periods of rain.

From:Evergraze – McCaskill *et.al.*

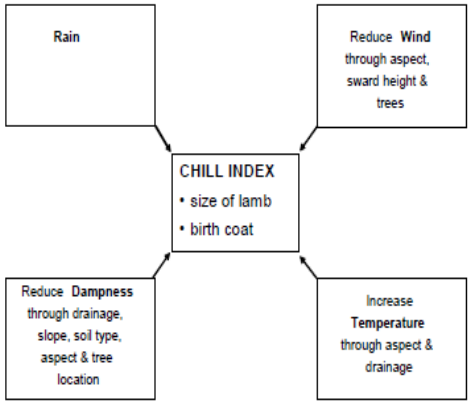


Figure 5: Factors impacting on the chill index during lambing. (Source Holst and Marchant 2002)

Measures to improve success?

Measures to improve success

- Remove those causes reducing optimisation of success (mentioned on previous slides)
- It may not be financially viable to maximise reproductive success as this would mean all animals were in maximum condition score
- There will however be an optimal condition score for any given year, given nutritional and seasonal constraints
- Matching breeding with season where this is a limiting factor, match lactation to maximum grass production for milk supply (or supplementary feed)
- Be able to investigate and find causes of loss
    - suggest direction to reduce this loss