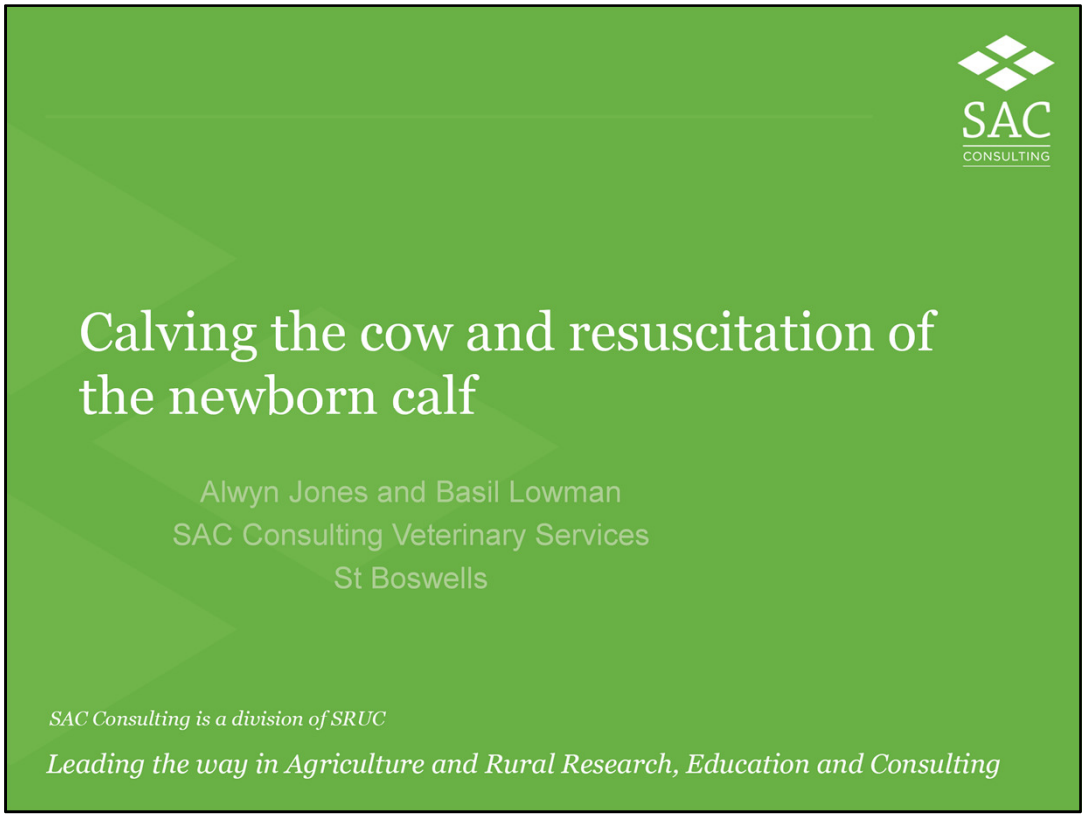


Calving the cow and resuscitation of the newborn calf

This course is aimed at farmers and it teaches the best practices in calving cows and resuscitation of newborn calves.

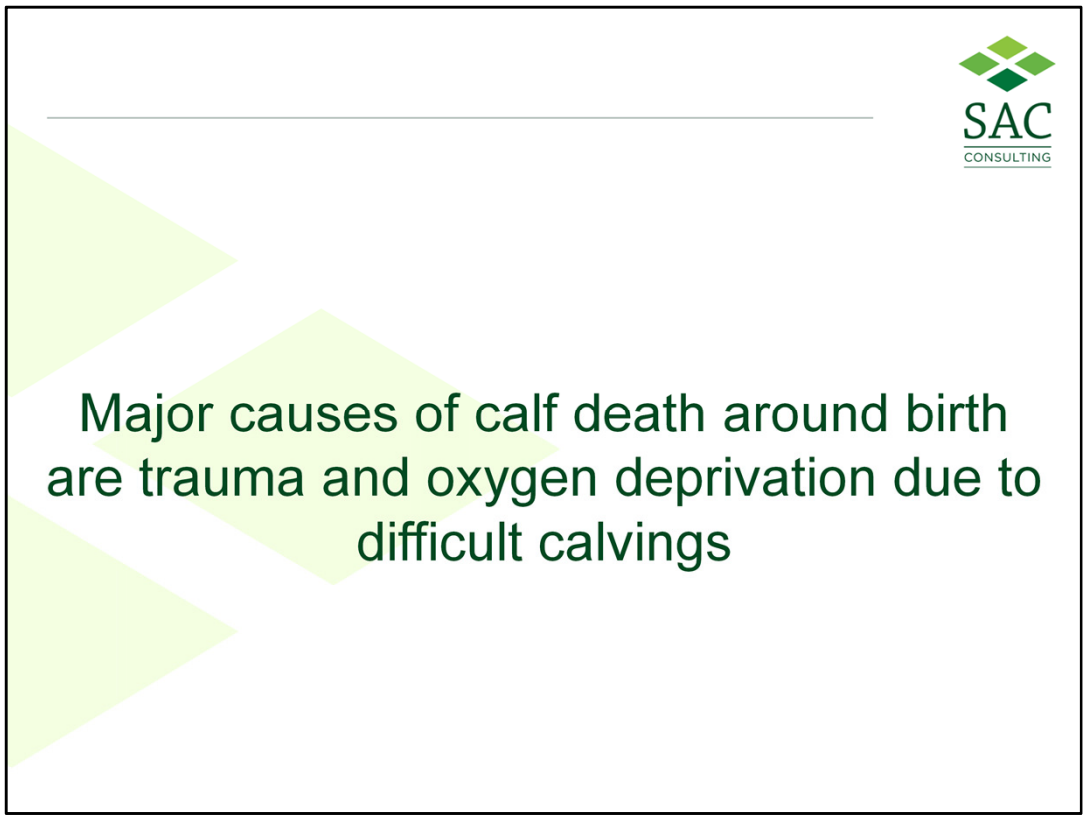
The aim of the course is:

•To increase the survival rate and thriftiness of newborn calves

•To reduce the incidence of hypoxia and acidosis in newborn calves

•To improve welfare in the calving cow and newborn calf

•To transfer current knowledge and skills on calving cows and resuscitating calves to farmers.

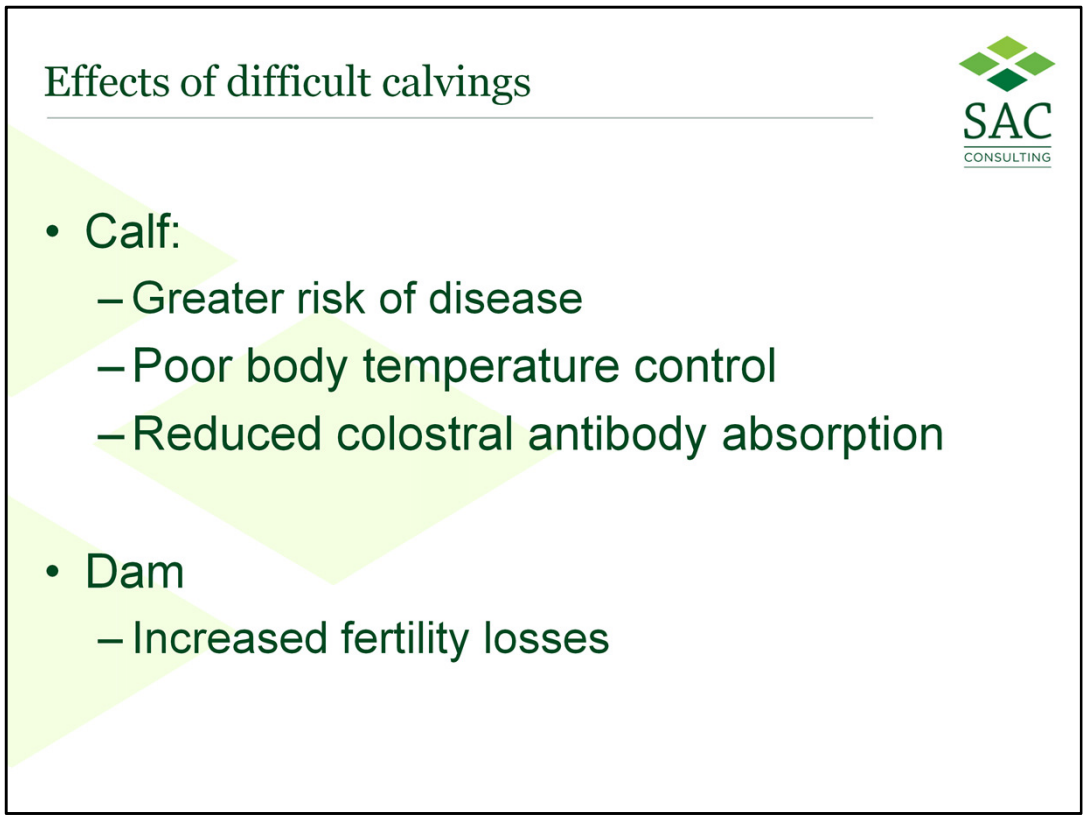


Introduction

The period around birth is the most hazardous in the life of all animals

Studies show that approximately 90% of calves which die around birth were alive at the start of calving.

This suggests that much of this loss is due to difficult calvings, hypoxia and acidosis and as such, much of this loss is preventable.



Difficult calvings

There are four main consequences of a difficult calving

Calf effects:

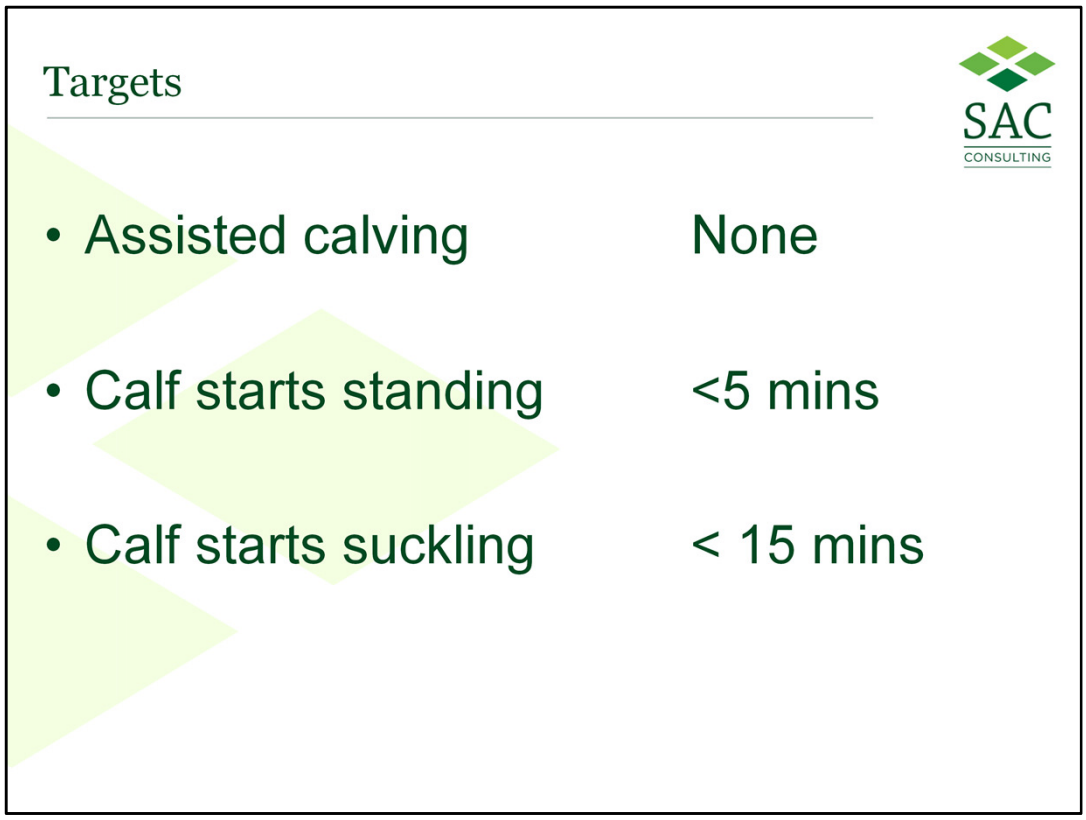
1. There is a greater risk of infectious disease primarily diarrhoea and respiratory disease.

2. It is harder for the calf to maintain it's body temperature following calving.

3. There is a decrease in absorption of protective antibodies due to metabolic acidosis. This will be discussed later on in the presentation.

Dam effects:

4. There are increased fertility losses in the dam.



Targets

Our target should be:

- for every calf to be born without assistance, i.e. no assisted calvings.

- for every calf to be standing within five minutes of calving.

- for every calf to be sucking its mother within 15 minutes of calving.

Selection of parents

- Genetic improvement is mainly achieved through the bull

CALVING EASE EBVs
(Estimated Breeding Values)

<u>Preventative measures</u>

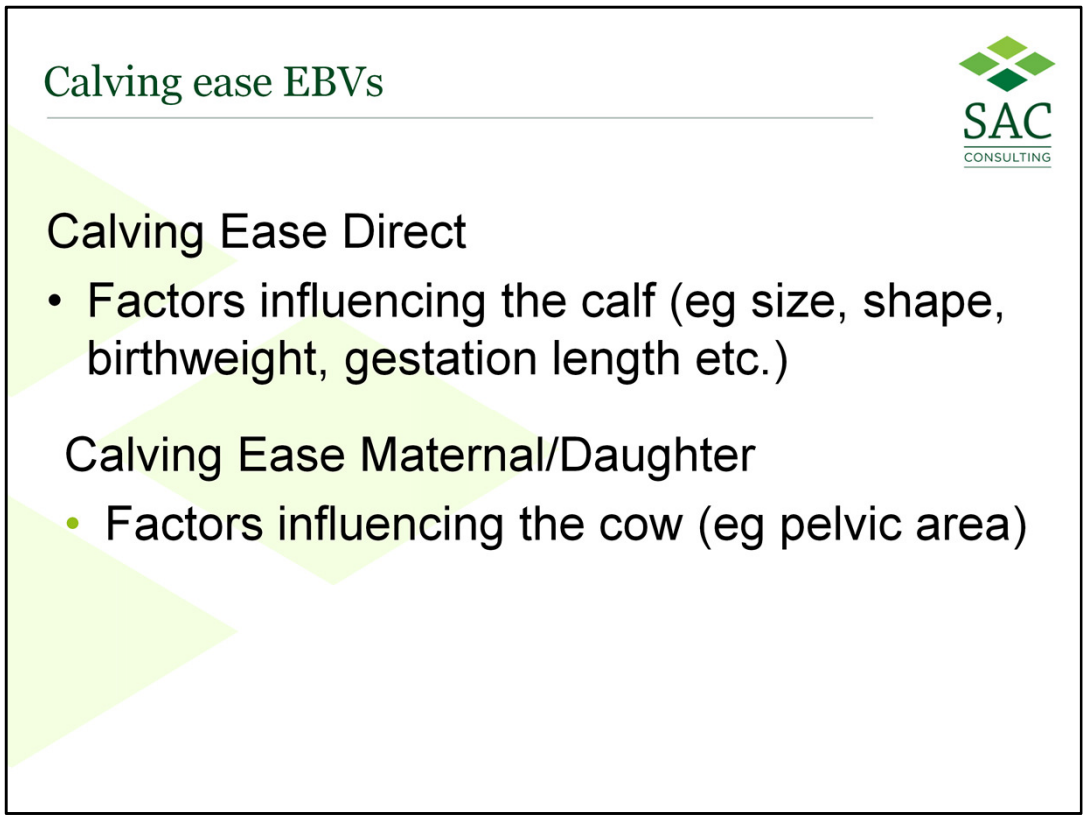
This presentation does not go into detail on preventing difficult calvings however three areas which can make a significant contribution to calving success are worthy of mention in the next ten slides.

Selection of parents

Genetic improvement is largely through the selection of breeding bulls, both terminal sires, where all the progeny are destined for slaughter and dual purpose/maternal bulls, whose daughters may be kept/sold as replacements.

Apart from a few very minority breeds EBVs are available for the vast majority of pedigree bulls sold in the UK.

To ensure an unassisted easy calving the critical EBVs are the two Calving Ease figures.



To increase the percentage of unassisted calvings, select sires and dams based on calving ease estimated breeding values (EBVs).
There are two calving ease EBVs.

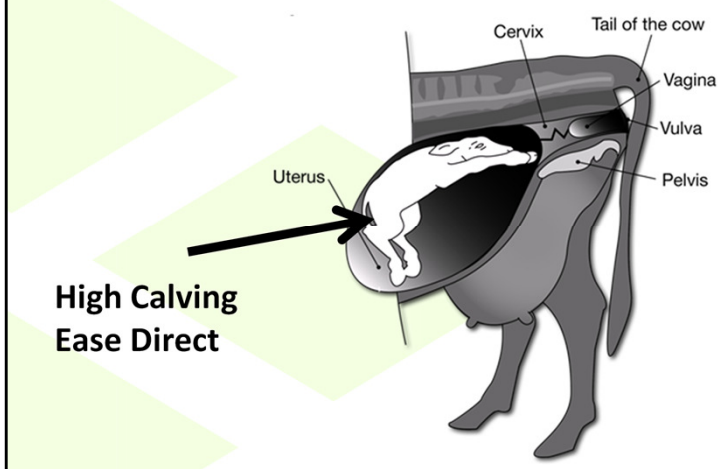
Calving Ease Direct relates to factors influencing the calf and how easily it will be born. The main factors are its size (birth weight), shape, sex, gestation length, etc.

The genetics of the calf come equally from its sire and dam ie a 50:50 split. Ideally the Calving Ease Direct of both the sire and the cow need to be known to predict the effect the calf will have on how easily it is born.

The second EBV is **Maternal Calving Ease Maternal/Calving Ease Daughter*** This relates to factors influencing the cow herself which affect how easily she will give birth e.g. her pelvic area. This is only of interest for bulls whose daughters will be kept as heifer replacements. It is of no value and can be ignored when selecting terminal sire bulls where all of their progeny will be slaughtered.

* Unfortunately there are 2 organisations producing EBVs for different breeds in the UK. While both organisations use the term Calving Ease Direct, for breeds in the UK system the second EBV is called Maternal Calving Ease whereas the Australian system uses the term Calving Ease Daughter.

Sire of the calf

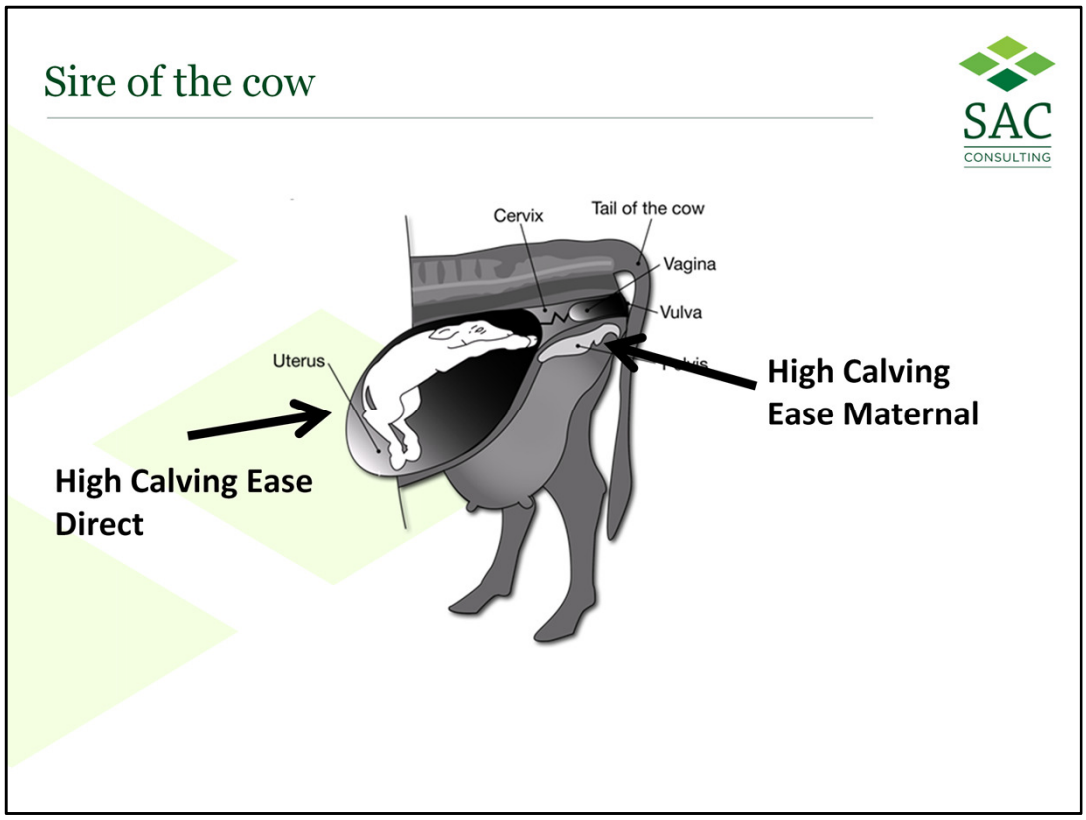


High Calving Ease Direct

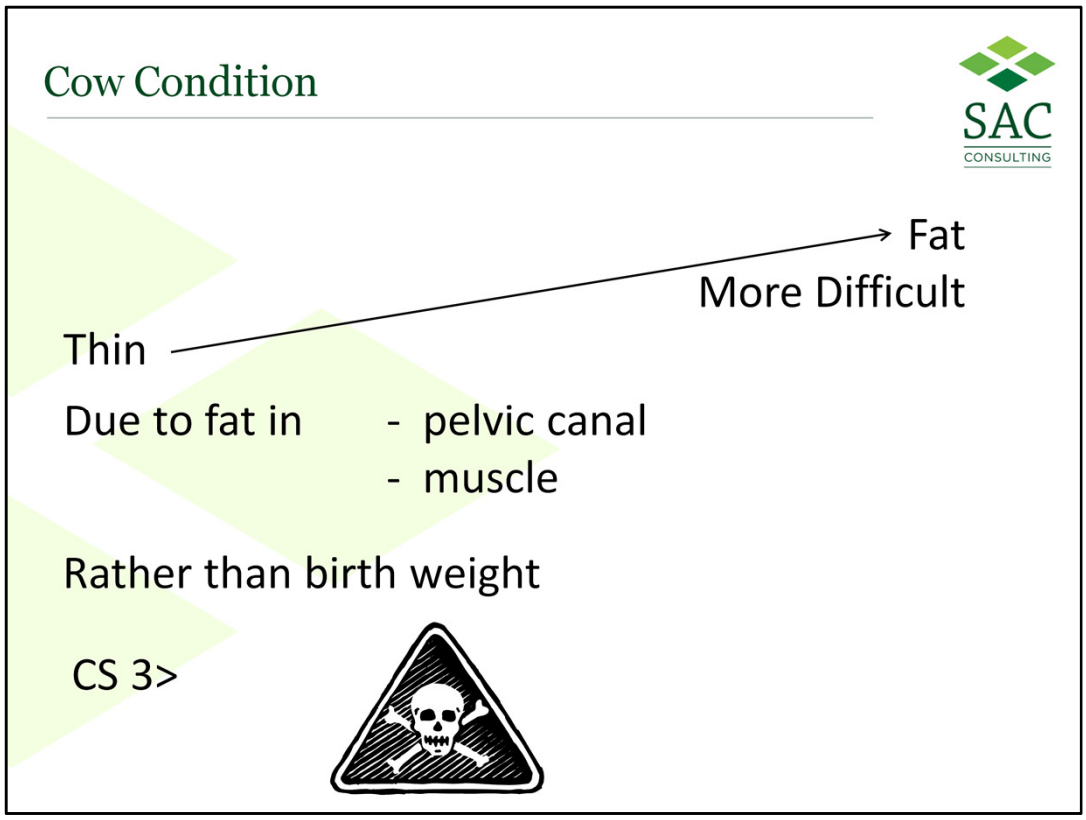
For an unassisted calving the bull used to serve the cow must have a high positive EBV for **Calving Ease Direct**. In simple terms, this avoids using bulls that will give difficult calvings.

If all the calves which are born are to be slaughtered, the Calving Ease Maternal EBV can be ignored.

However if his heifers were to be kept as replacements, then Calving Ease Maternal must be taken into account as shown in the next slide.

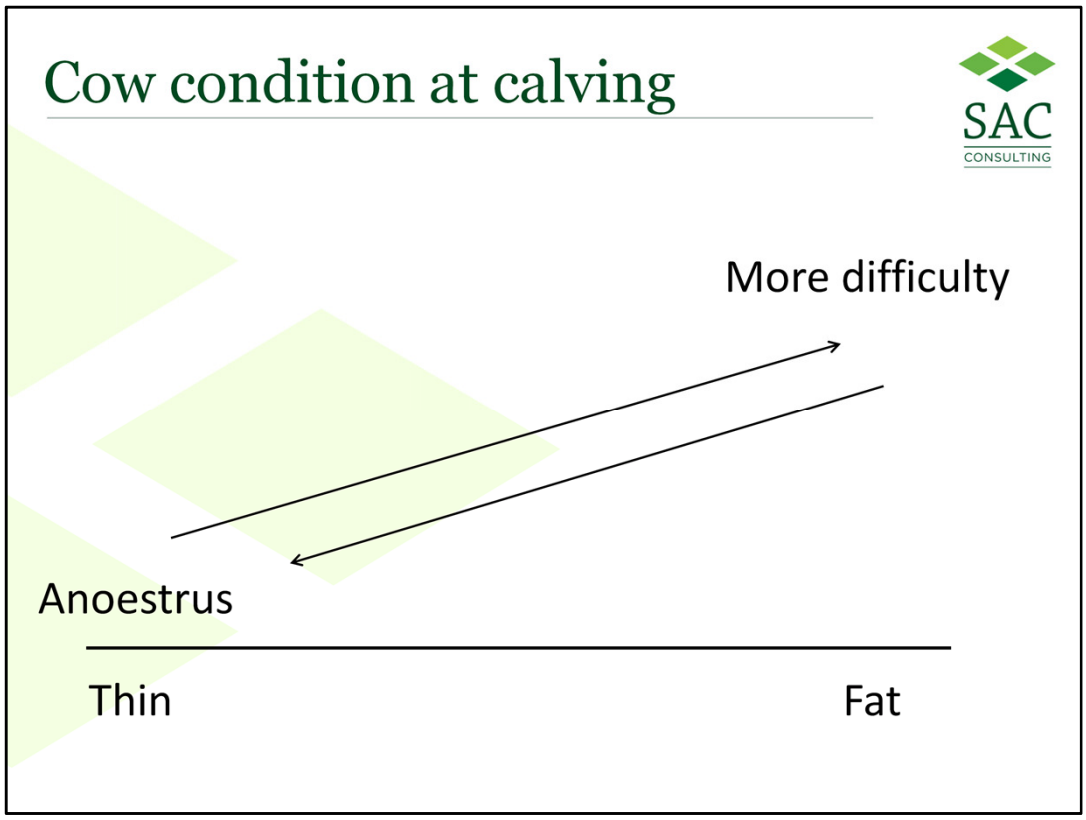


For a bull's daughters, who could be used as replacements, bulls with the highest possible EBVs for **Calving Ease Direct** and for **Calving Ease Maternal** should be selected.



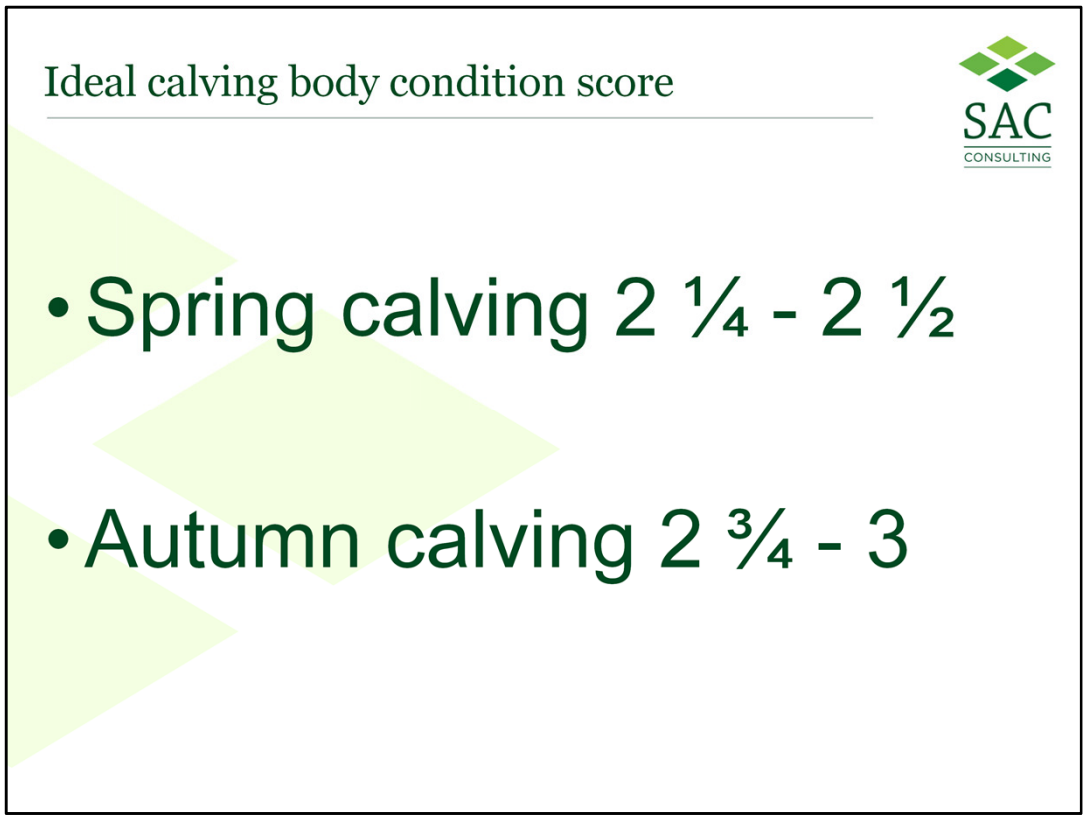
Body condition score

The risk of difficult calving increases rapidly when body condition exceeds 3. Fat in muscle also makes cows tire more quickly.



Body condition

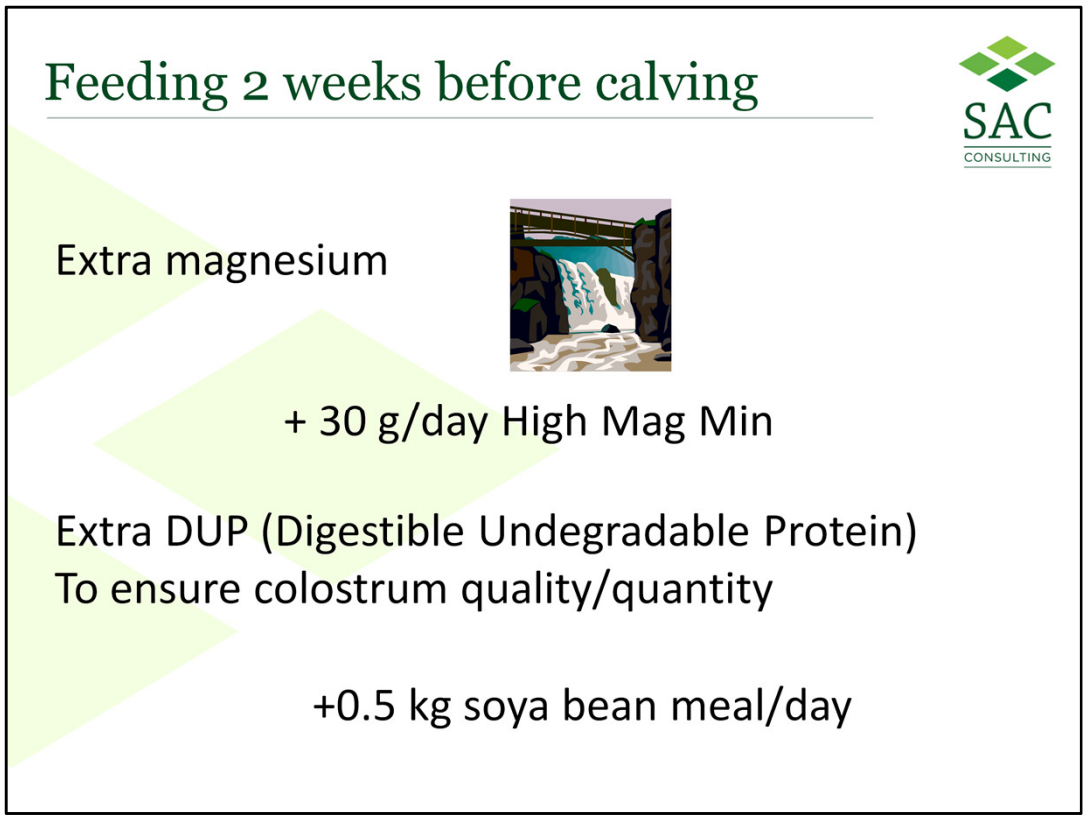
Cows that are too thin undergo a longer post partum anoestrus period and require a higher liveweight gain to get back in calf again.



Body condition score

In spring calving herds, cows should calve at a body condition score (BCS) of 2 ¼-2 ½. Cows will gain condition at grass and should be at BCS 3 at weaning. If fed correctly, they will lose 0.5 a condition score over the winter to calve at the correct score the following spring.

In autumn calving herds, cows should calve at body condition score of 2 ¾ - 3. Cows will lose condition over the winter and should be at BCS 2 at turn-out in spring. BCS will be regained again at grass during the summer.



<u>Nutritional supplements two weeks pre calving</u>

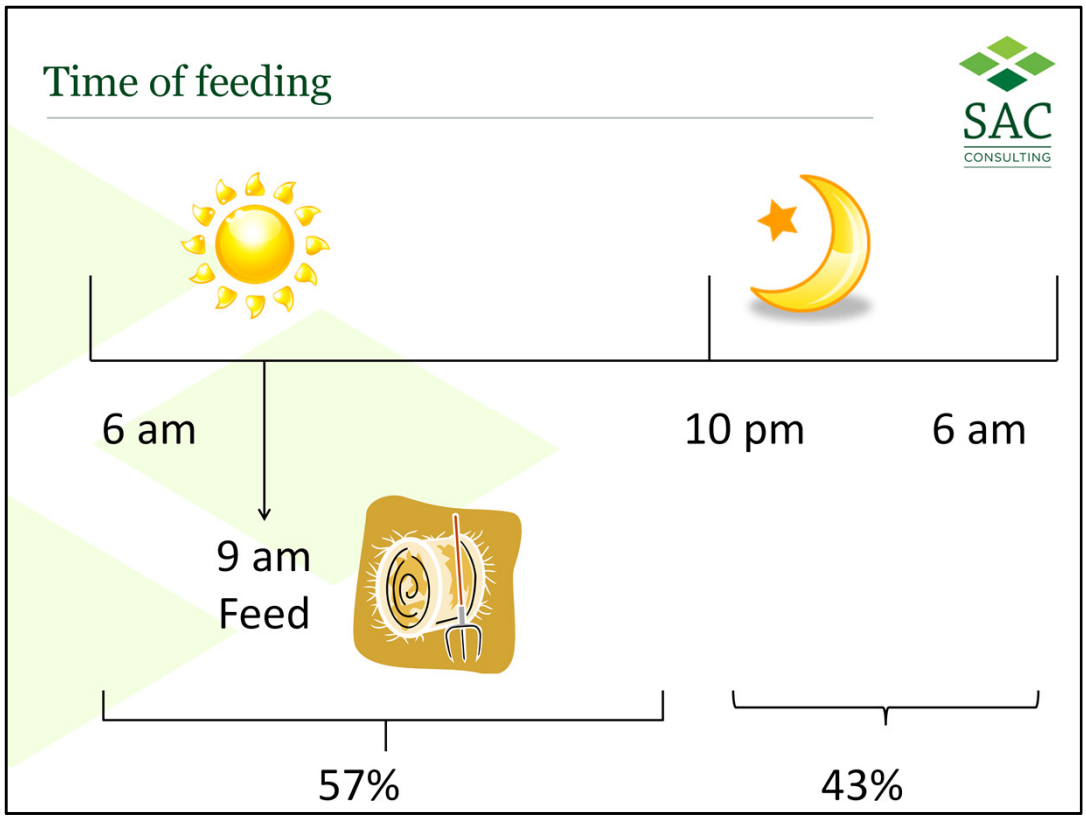
Magnesium

Supplementation with extra magnesium in the last two weeks before calving improves muscle tone and reduces the occurrence of slow calving.
Recommended supplementation level is 30 g/day of a High Magnesium mineral per animal.

Digestible Undegradable Protein (DUP)

Supplementation with a source of DUP such as soya bean meal will improve colostrum quality and quantity.
Recommended supplementation level is 0.5 kg soya bean meal/day.

To target these supplements the cows need to be split on expected calving dates (an early calving group and the remainder) 4 weeks before the expected date of calving.



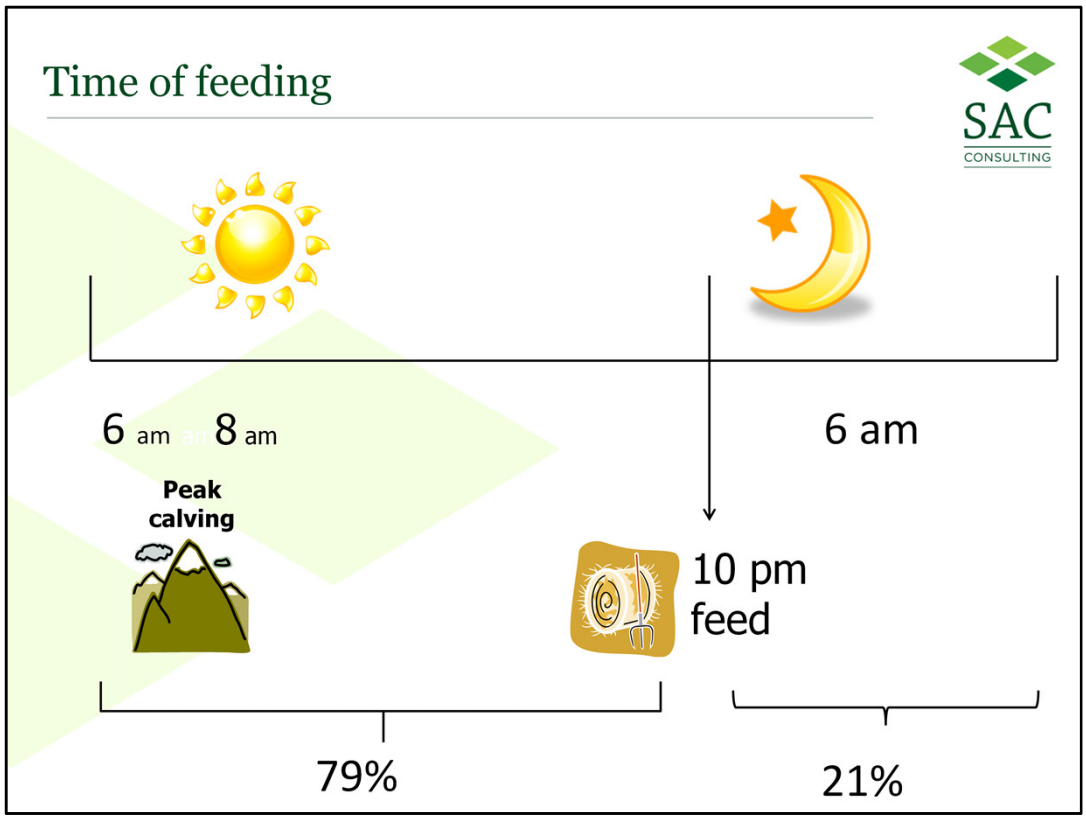
Timing of feeding

Changing the time of feeding has been shown to have an effect on the time of day cows will calve

In a trial on four commercial spring calving farms:

- feeding the daily roughage allowance as normal in the morning resulted in 43% of cows calving at night.

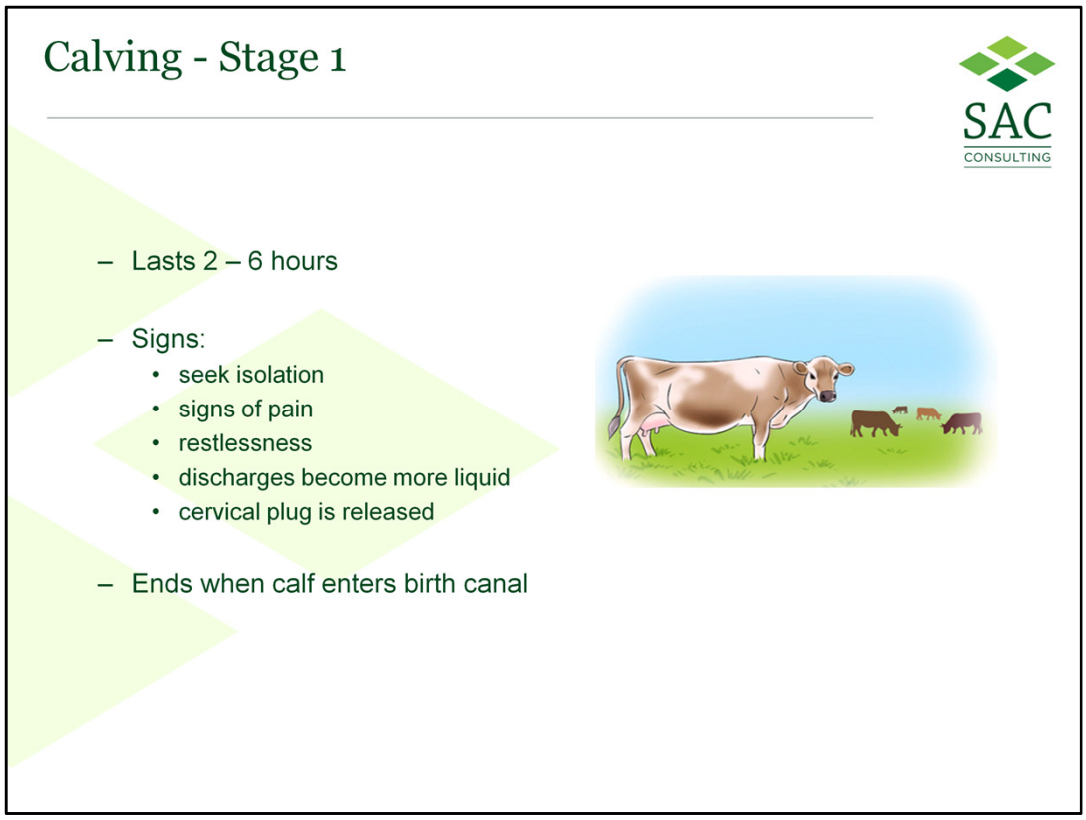
…….move to next slide



- Moving to late evening feeding, around 10 pm, reduced the number of cows calving at night to only 21% with the peak time of calving occurring between 6 and 8 am.

On a practical level, this may be achieved by laying out the food during 'normal' working hours, e.g. 5pm but keeping the cows away from the food with a gate. When the stockperson goes out to check the cows before bed, e.g. at 10 pm, the gate is opened and the cows are allowed to feed.

After eating, cows will lie down to ruminate and digest for several hours . This may act to delay calving and increase the likelihood of calving occurring during 'normal' working hours. Less night calvings means a more rested stockperson to attend calvings during the day. Extra staff to assist is generally available during the daytime.



First let's review the normal calving process.
Calving is crudely divided into three stages.

Stage 1

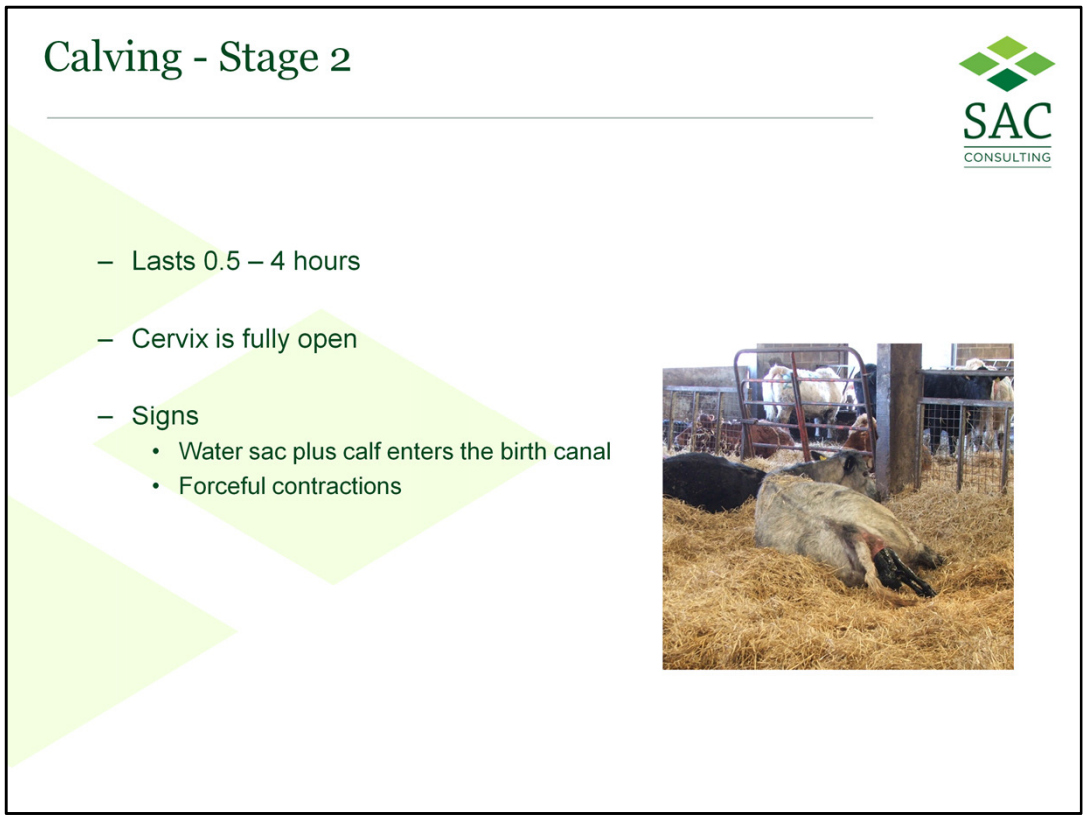
This marks the beginning of delivery and is characterised by progressive relaxation and opening of the cervix. This stage normally lasts 2 – 6 hours but can take up to 24 hours in heifers. On the other hand, signs may be scant or absent in mature cows.

Typical signs of stage 1:
- Seeking isolation
- Vaginal discharges become more liquid and the cervical plug is expelled.
- May show signs of uneasiness, restlessness and pain.
- Lie down and get back up repeatedly.
- Kicking at the belly, swishing the tail
- The contractions may force some cows to arch the back and strain slightly.
- Weight may be shifted from one leg to the other.
- The tail may be extended

Rupture of the first water sac (chorioallantois) and release of allantoic fluid usually marks the end of stage 1.

At the start of stage 1, the uterus contracts every 15 minutes, however by the end of stage 1 contractions occur every 3 minutes. These contractions may not be noticeable to

the observer.



Stage 2

During stage 2, the cervix is fully dilated and the second water sac (amniotic sac) plus foetus enters the birth canal.

The presence of foetal parts in the cervical canal causes stretching of the cervix and release of oxytocin which in turn stimulates strong uterine contractions. The greatest frequency and force of contraction occurs when the foetal head passes through the cervical canal, vagina and vulva.

The force of contractions force most cows to lie down.

A series of short abdominal presses followed by a short period of rest is normal

Following delivery of the head, a short period of rest may occur.

Another big effort is required to get the shoulders and chest out before another rest period. Please note that during this rest period, there will be compression on the umbilical cord between the abdomen of the calf and the pelvic floor of the cow. It is not unusual in normal calvings to see a calf establishing its own breathing at this point.

Stage 2 lasts 0.5 – 4 hours but may take longer in heifers because more effort is required to dilate the tissues of the birth canal.

Calving - Stage 3

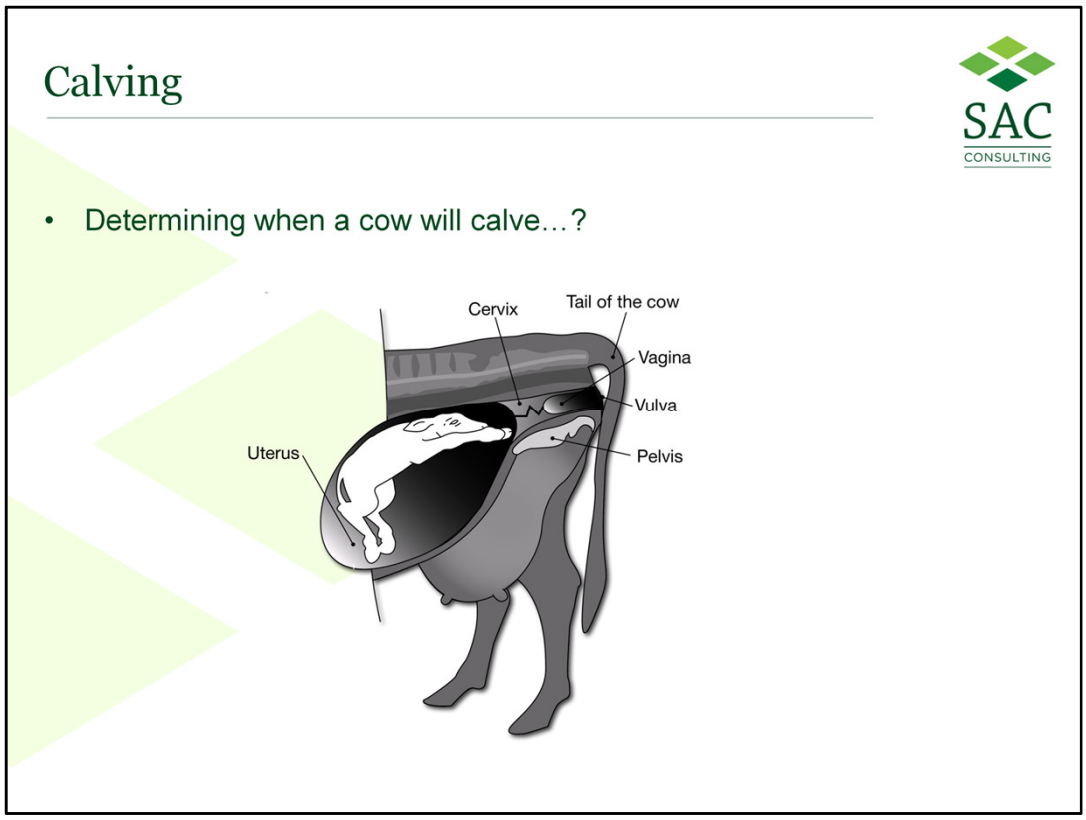
SAC CONSULTING

- Expulsion of the afterbirth
- Occurs within 12 hours

Stage 3

During stage 3, the afterbirth is expelled.

This should occur within 12 hours of calving.



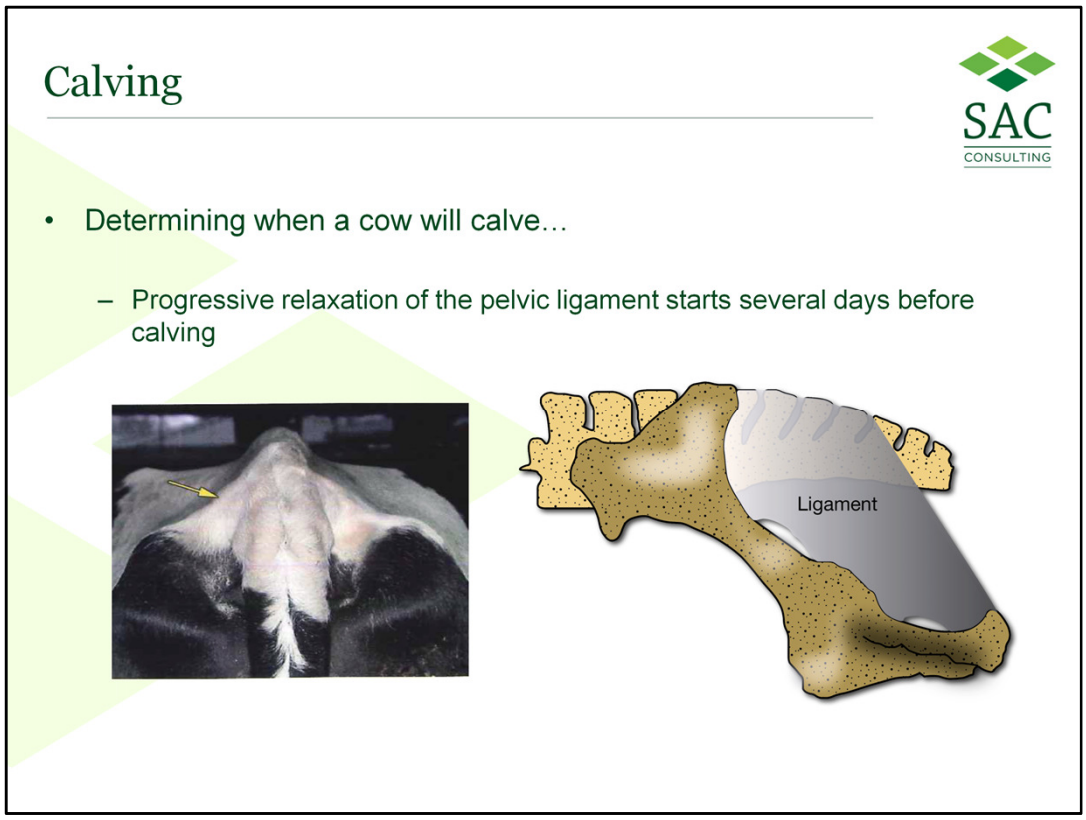
When will she calve?

It would be great if we could tell exactly when a cow will calve. This would avoid us intervening too early or too late and would reduce the risk of calf death and injury to the cow.

For participants engagement, at this point we recommend that you ask the audience…..

How do you estimate when a cow will calve?

What cow signals have you found that are good at estimating the timing of calving?



Unfortunately, the timing of calving remains difficult to predict.

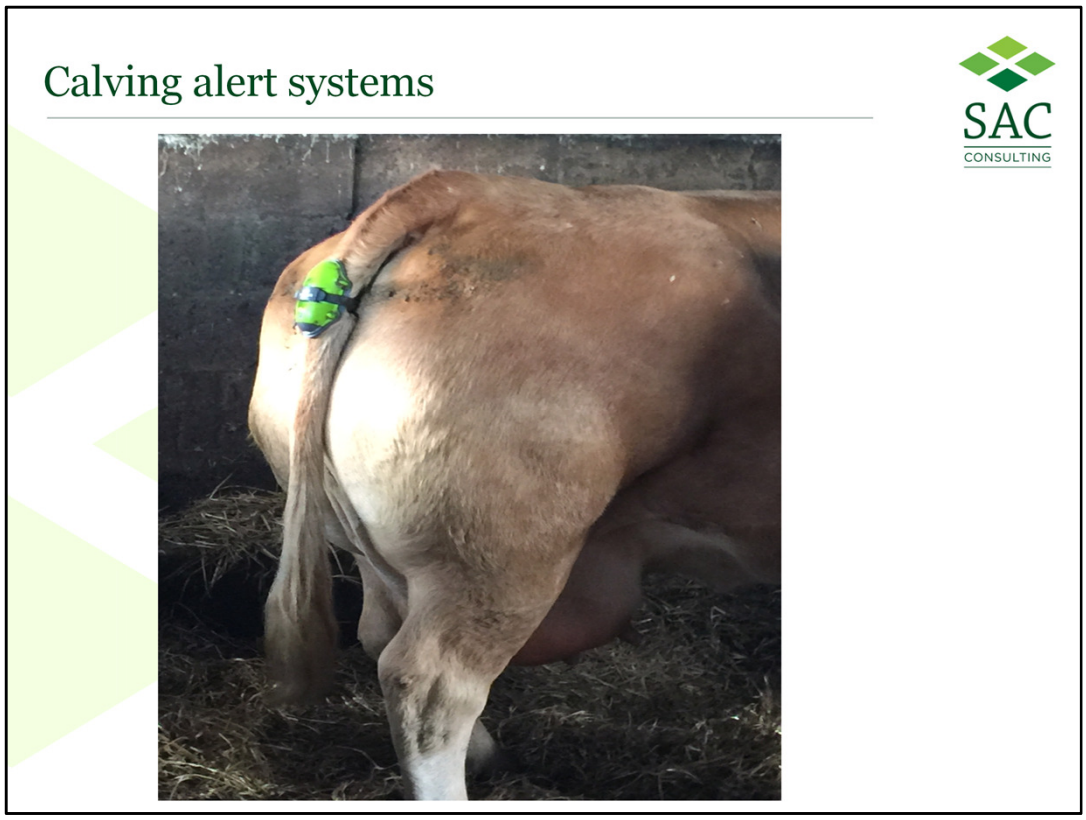
Progressive relaxation of the pelvic ligaments is commonly used and the most useful hands-on method. The pelvic ligaments relax up to 2.5 cm over several days before calving. However, just before calving, a further relaxation occurs which allows displacement of the ligament by 5 cm (2 inches) or more. This usually indicates that calving will occur in the next 24 hours. Shah (2006) measured the daily drop in ligaments over a few weeks before calving. When the pelvic ligament dropped by 5 mm or more from the preceding days drop it was possible to predict with 93.9% accuracy that the cow would calve within 24 hours. Successive palpation is needed to use this.

Other changes that are used but tend to vary a lot between cows include:

- Cervical dilation – once started, calving occurs within 24 hours, may be as little as 6 hours in mature cows.
- Relaxation and enlargement of the vulva
- Tenseness and filling of the teats (may begin several months before calving in heifers but may not be obvious in cows until the last week).
- Changes in body temperature
- Changes in quantity and viscosity of vaginal secretions

Note that the above is not very practical in beef cows as the cow would have to be handled regularly. Handling of pregnant cows should be minimised in late pregnancy.

Environmental disturbances at calving caused by continuous presence of an observer, confinement, or overcrowded calving accommodation can lead to reduced uterine motility, reduced cervical dilatation and reduced abdominal contractions resulting in prolonged calving and dystocia. This is due to a premature reduction in systemic oestradiol concentration and a high cortisol to progesterone ratio pre-calving (Mee 2008).



Calving alert systems

There are different types of calving alert systems available to detect physiological changes that can predict when your cow is most likely to give birth.

One type measures tail movement patterns. When they reach a certain level of intensity over a period of time it sends an SMS text alert directly to a mobile phone on average one hour prior to calving.

Another device is placed in the vagina of the cow about a week before the expected date of calving. This measures the cow's temperature. Some 48 hours before calving the animal's temperature will peak and then start to fall again and this change is relayed to a mobile phone. At the start of calving, when the water bag expels the sensor, the temperature drops suddenly and the farmer is alerted immediately.

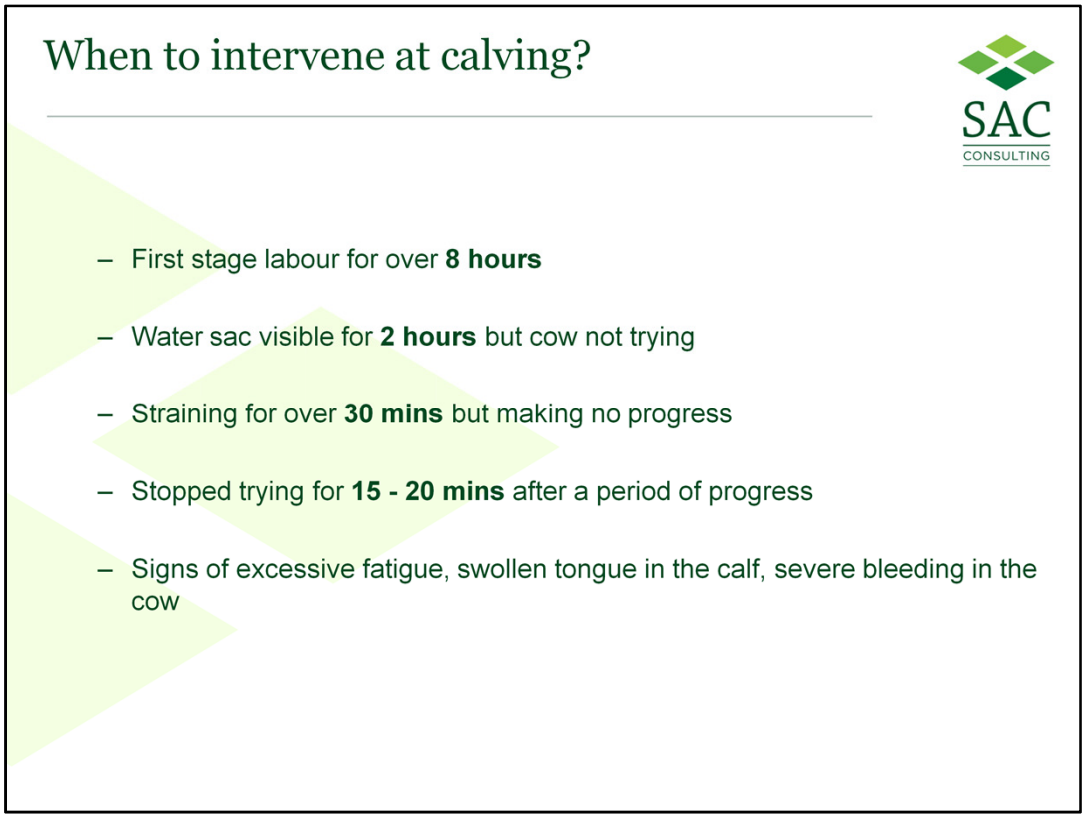
When should you intervene at calving?

We recommend that you ask the audience first:

When should you intervene at calving?

What signs do you look for that tell you that intervention may be necessary?

It may be useful to write a list on a flip chart for comparison with the next slide.



As a general rule of thumb, intervention is indicated:

- If the cow has been in first stage labour for over 8 hours.
- If the second water sac has been visible for two hours but there is no progress
- If the cow has been straining for over 30 mins but making no progress
- If foetal feet have been visible for two hours (particularly in heifers). The '2 feet 2 hours' rule.
- If the cow stopped trying for 15 to 20 minutes after a period of progress. Breaks between contractions in a normal calving should not exceed 5 to 10 minutes

Note:
It can be difficult to know when the cow entered stage 1 especially if the cows are not regularly observed. Therefore knowing when 8 hours of stage 1 has passed is going to be difficult. This should be made clear to the audience. Recommended frequency of observation is 1-2 hours.

In heifers, vocalisation during straining can indicate that the birth canal is still being stretched. In this situation, the heifer should be given a bit more time under close supervision as there is still a chance that the calf will be delivered normally.

Intervention

- To prevent uterine infections
  - Tie the tail to the side
  - Clean around the anus and vulva
  - Wash calf parts outside the vulva
  - Gloves or clean hands and arms
  - Clean and dry bedding

Intervention

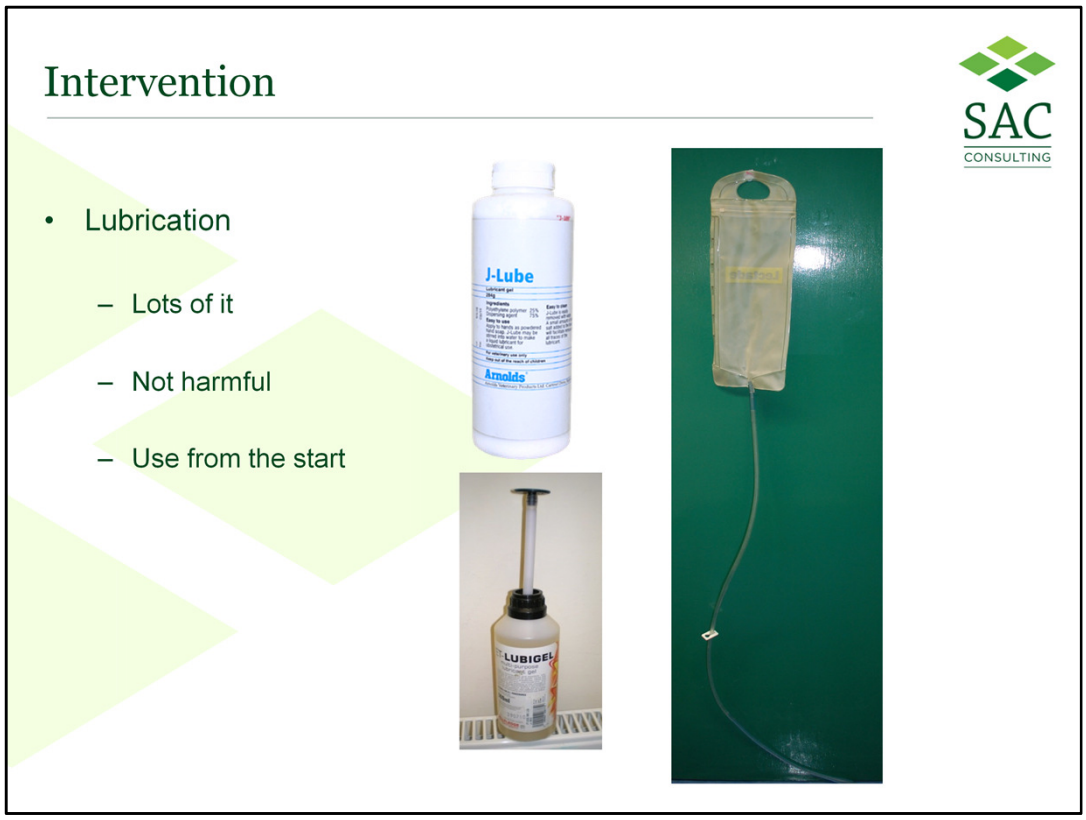
If intervening, hygiene should be a priority.

Cleanliness, asepsis and gentleness is vitally important in order to avoid introducing infection into the uterus that could result in uterine infection post calving.

Wash the vulva and anal area with water and disinfectant.

Wash hands and arms or use gloves.

Wash any protruding foetal parts to remove faeces. This will minimise the risk of taking faeces into the uterus with your hand and arm.

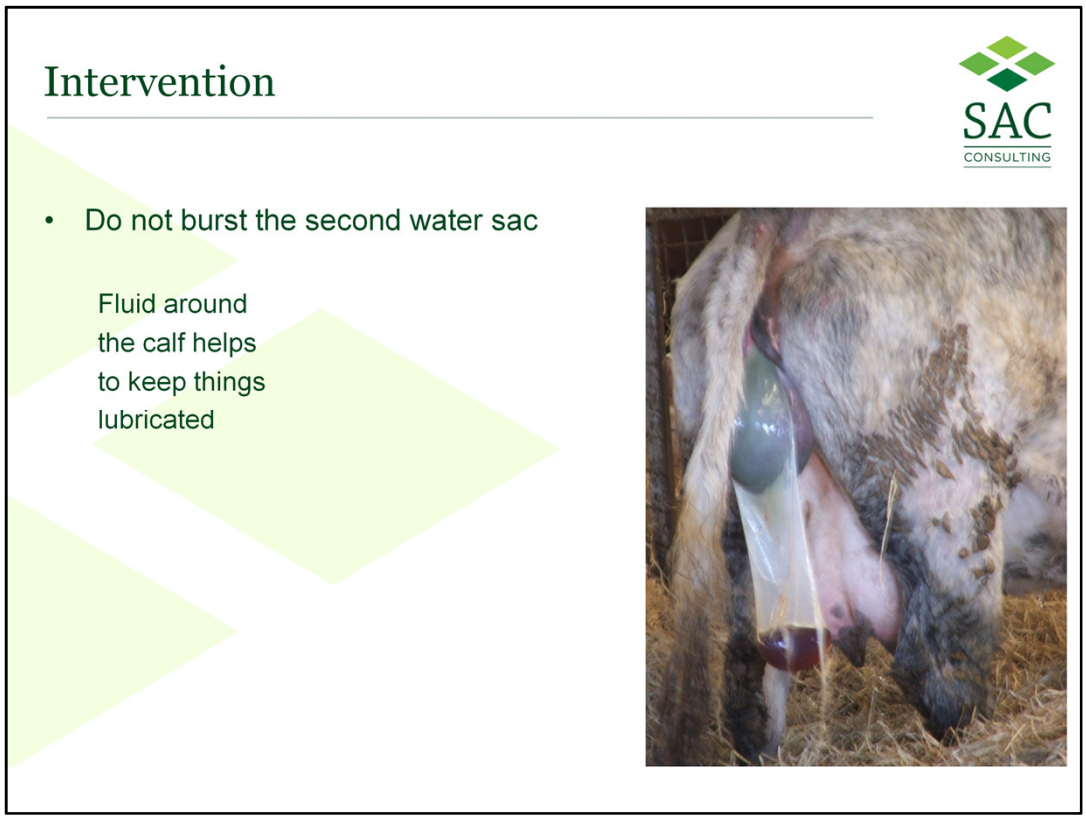


Intervention

Use lubrication on your hands and arms from the start. It is cheap and not harmful. It is better to ensure the birth canal is well lubricated before the calf becomes tightly lodged in the canal. It is often difficult to get lubrication into the right places when the calf is tight and a lot falls on the ground as a result.

A powdered form of lubrication is also available that turns into lubrication when mixed with water. It clings well to skin and you can make bucket loads of it. But it can be difficult to remove from your skin after! If using powdered lubrication, it is best to wear a rectal glove.

During labour, the uterus has contracted down around the calf from all directions. This has decreased the amount of room within the uterus for corrective purposes. On occasions it may be helpful to distend the uterus using several litres of warm water mixed with powdered lubrication. An old calf stomach tube, with a smooth end, may be used to deliver several litres of lubrication.

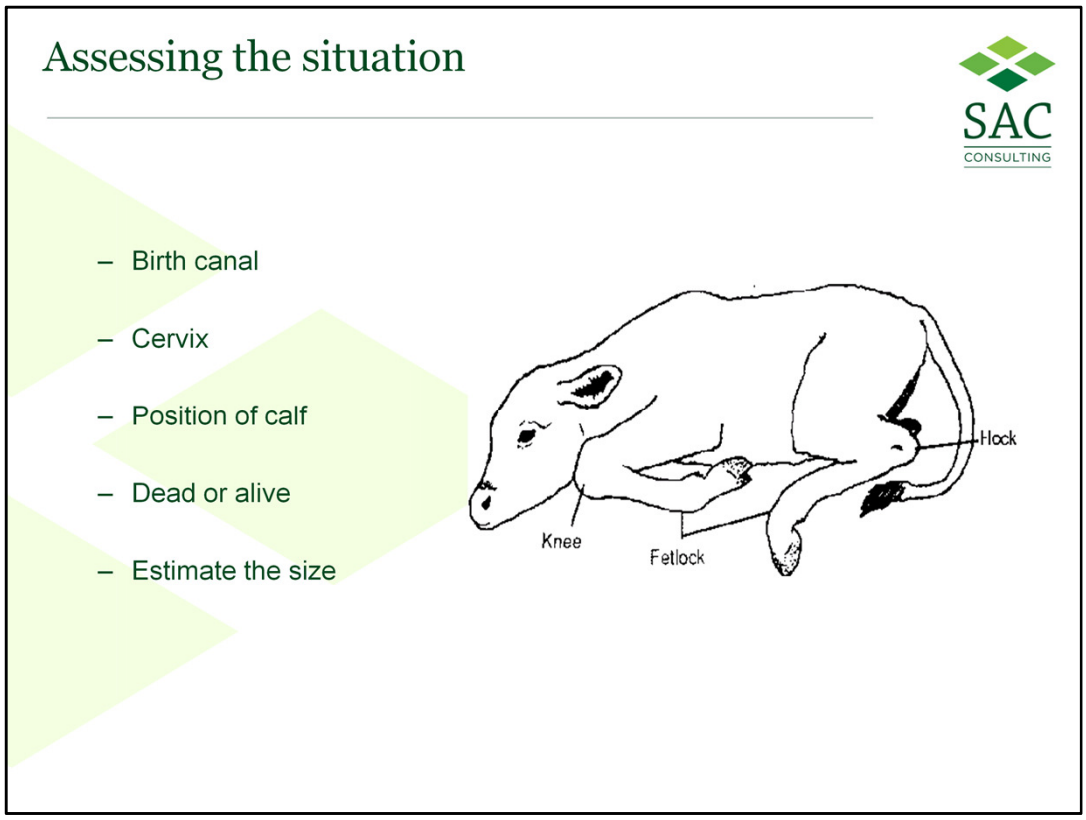


Intervention

It is a good idea to avoid manually rupturing the second water sac (allantois) until you are ready to apply traction and the cervix is fully dilated.

When putting your hand in to assess the position of the calf, try and keep the second water sac intact. The fluid within keeps the calf mobile and lubricated.

When it's time to apply calving ropes, it will be necessary to burst the second water sac.



Assessing the situation

First, put your hand in with the sole intention of assessing what is going on. This helps to decide on the best method to complete delivery (traction vs caesarean vs embryotomy), whether to get help and to determine how urgent the situation is.

Feel around the birth canal. Does it seem normal? Are there any protruding parts?
Is the cervix fully dilated? It should be wide enough to allow passage of the calf. If the cervix is narrow, re assess in half an hour. If no change, it may be due to cervical stenosis (narrow cervix). This is more common in cows and can be due to environmental stress pre calving, premature assistance, hormonal imbalance and pre term calving. It could also be confused with a uterine torsion.

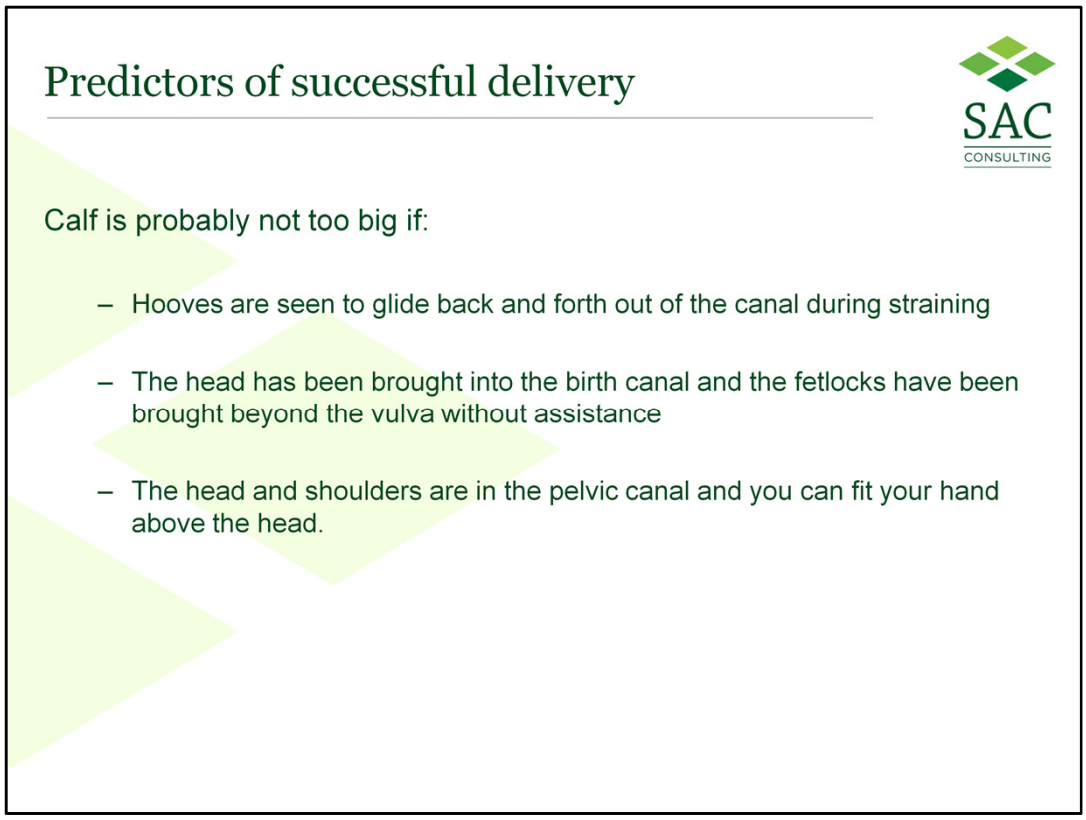
Next, assess the position of the calf and determine if it's
• coming frontward or backwards?
• the correct side up or upside down – Does it need corrected to be the right side up?
• in the correct position. Are the legs and head orientated correctly?

Then try to determine if the calf is dead or alive:
- Pinch between the hooves – a live calf will withdraw its foot.
- If the calf is presented backwards, you could Insert a finger into the calf anus. If alive, there should be contraction of the anus, known as the anal reflex .
- The suckle reflex or blink reflex may also be used if coming forwards

Frequent and/or violent spontaneous foetal movements are a sign of distress . This is often due to hypoxia and acidosis. This is a poor prognostic indicator and denotes the need for urgency.

Next, estimate the size to determine if it can be delivered by traction. Delivery by traction increases the risk of hypoxia and acidosis. Its important to decide if the risk of harm to the foetus and dam is justified.

How to deliver a calf in forward presentation

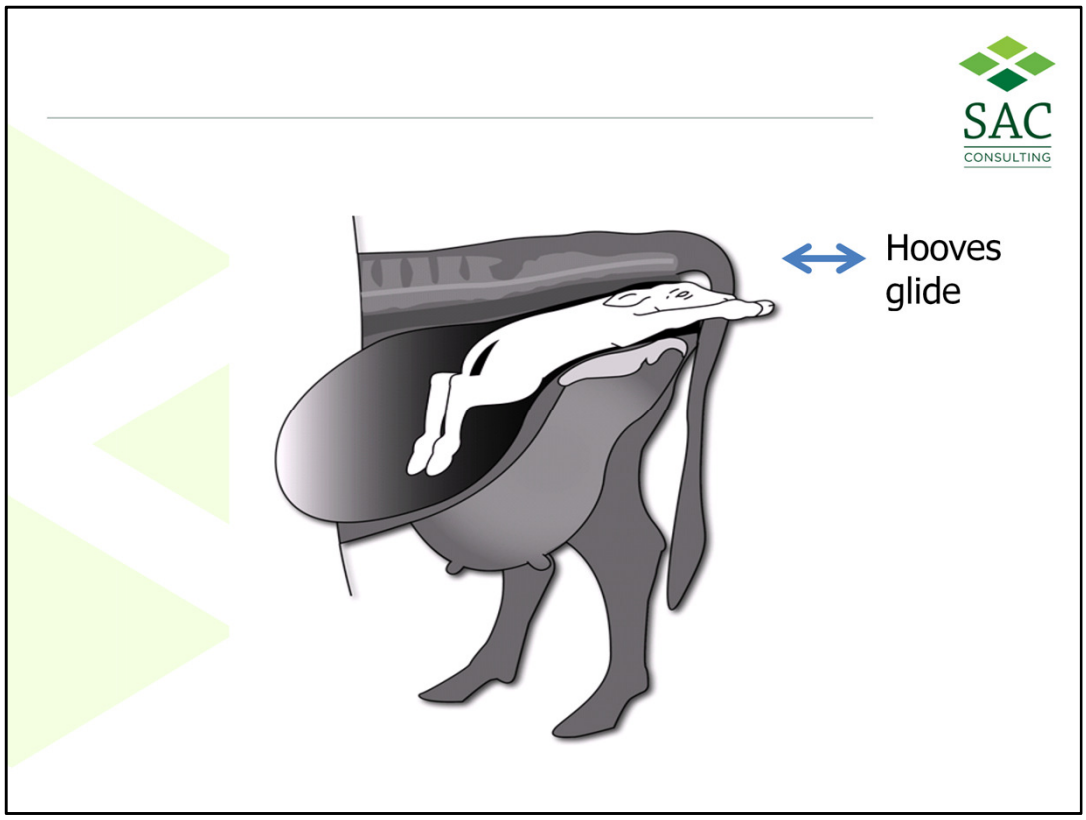


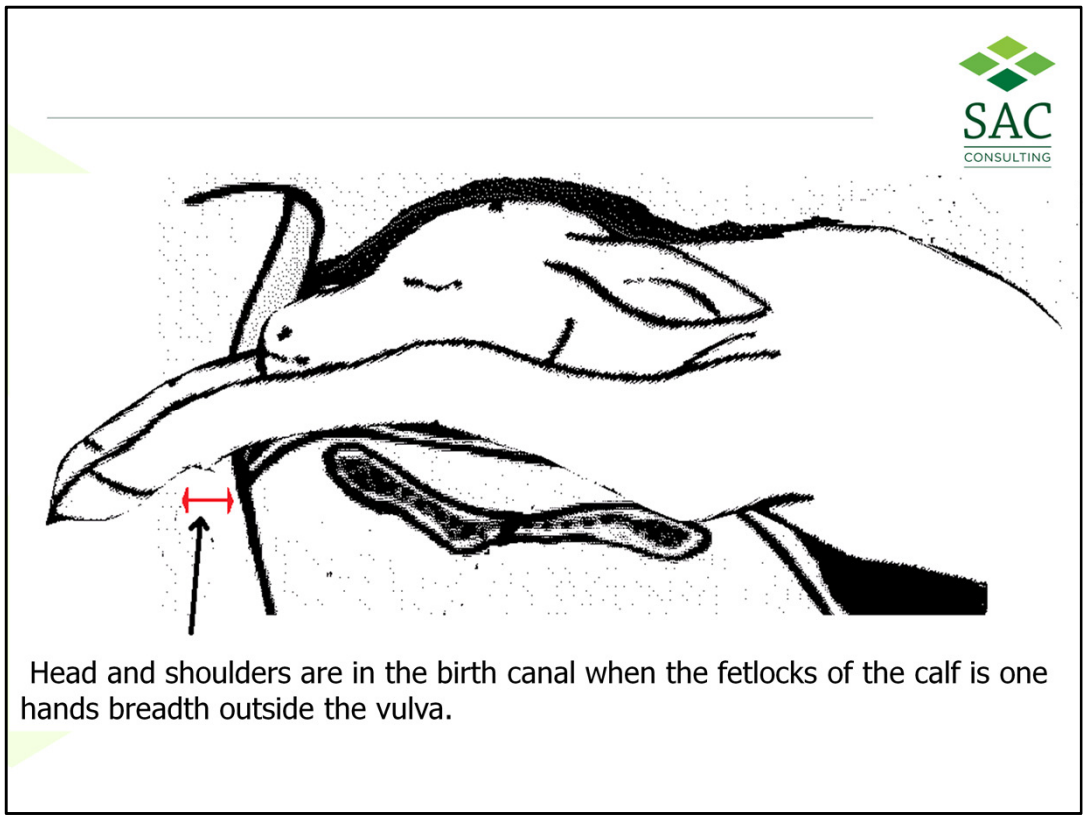
Good chance of successful delivery

These points are only to be used as a guide. They will not apply to every case.

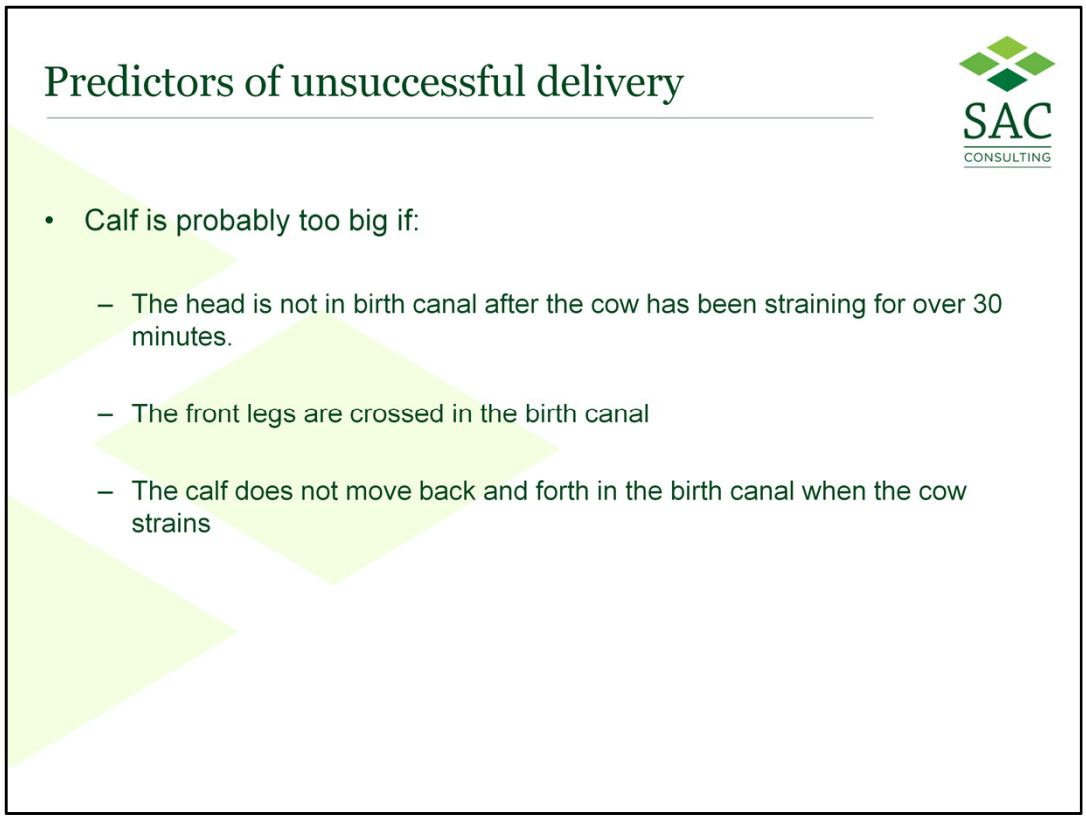
The calf is probably not too big and there is a good chance of successful delivery if:

- The hooves protrude from the vulva during an abdominal press and glides back into the birth canal when straining stops.
- The head has spontaneously been brought into the birth canal and the fetlock joints have been brought beyond the vulva spontaneously i.e. without any intervention.
- You can fit your hand above the head when the head and shoulders are in the pelvic canal.


SAC
CONSULTING
Hooves
glide

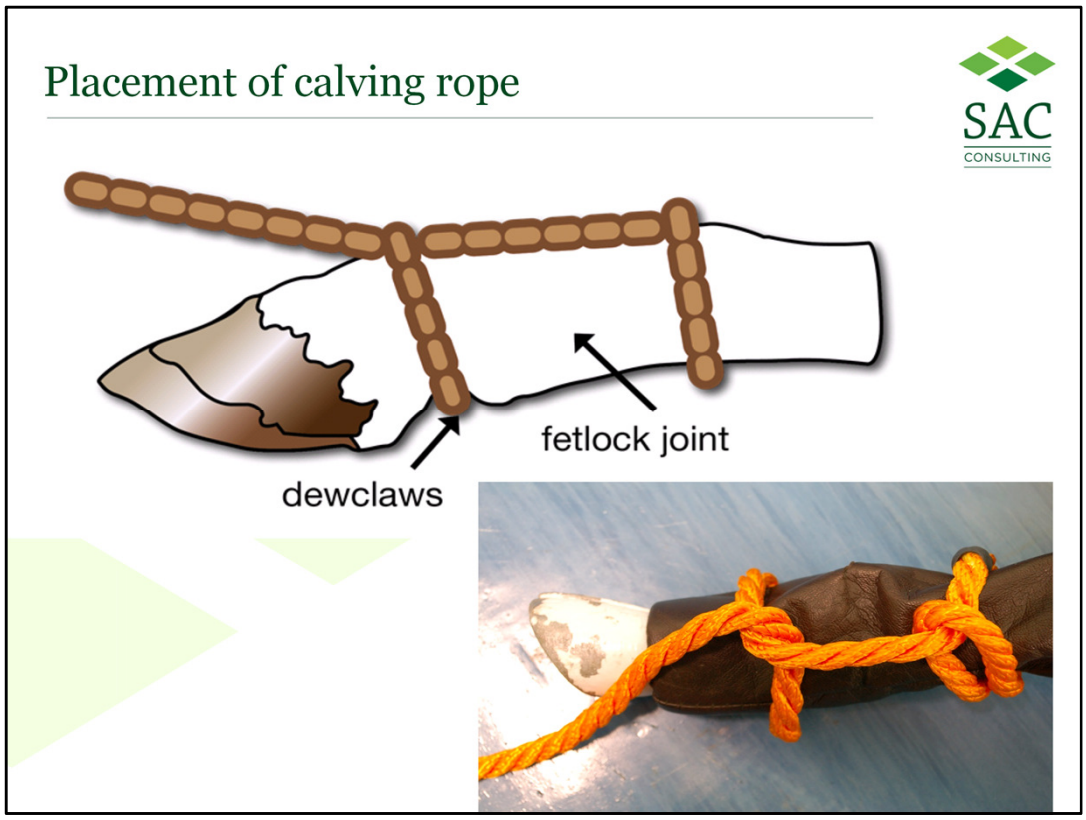


As a rough rule, the head and shoulders are in the birth canal when the fetlocks are one hands breadth outside the vulva.



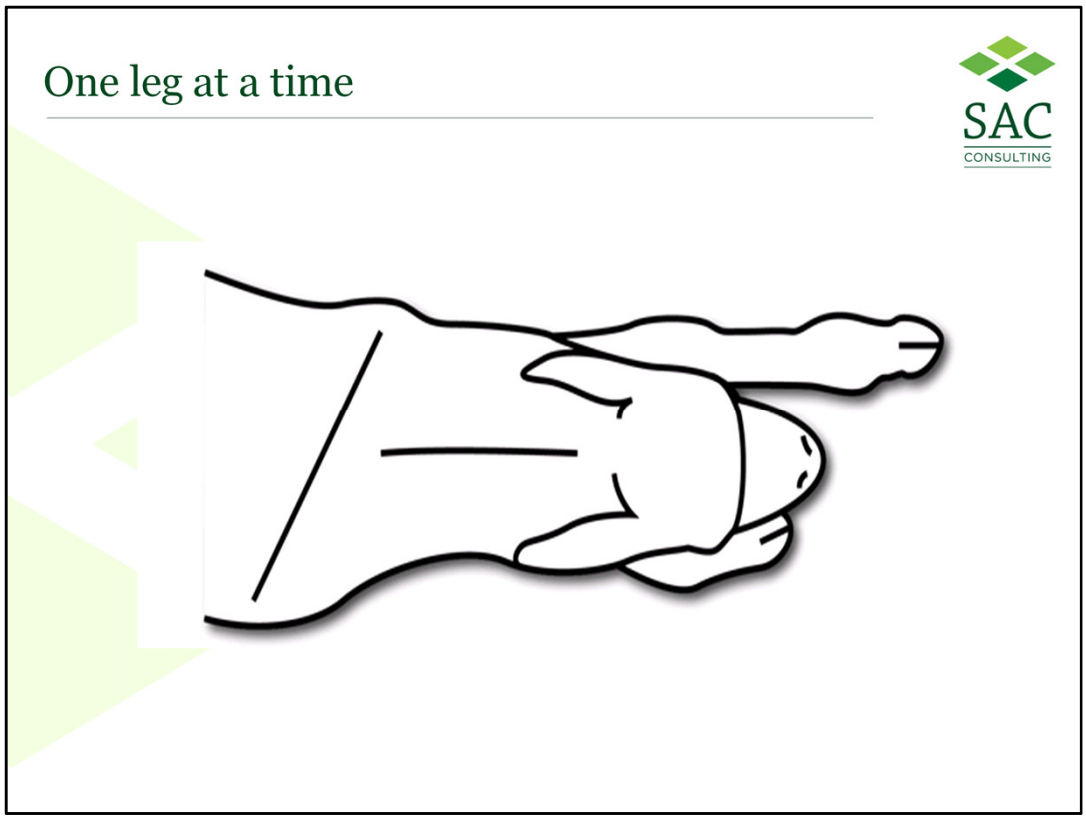
The calf is probably too big and there is a poor chance of a successful delivery if:

- The head of the calf is not in the birth canal after being in labour for over 30 minutes, despite the calf's head pointing in the correct direction.
- The forelimbs are crossed in the birth canal. This is an indication that the foetus has wide shoulders that may not pass into the birth canal.
- The foetus is in the birth canal but does not move when the cow strains. This may indicate that the calf is too tightly lodged in the birth canal. It also suggests that the birth canal is maximally dilated and that spontaneous delivery has not been possible.



Placement of the ropes

- Place the ropes above the fetlock and if possible take a half hitch below the fetlock as well.
- This spreads the extractive forces over a greater area.



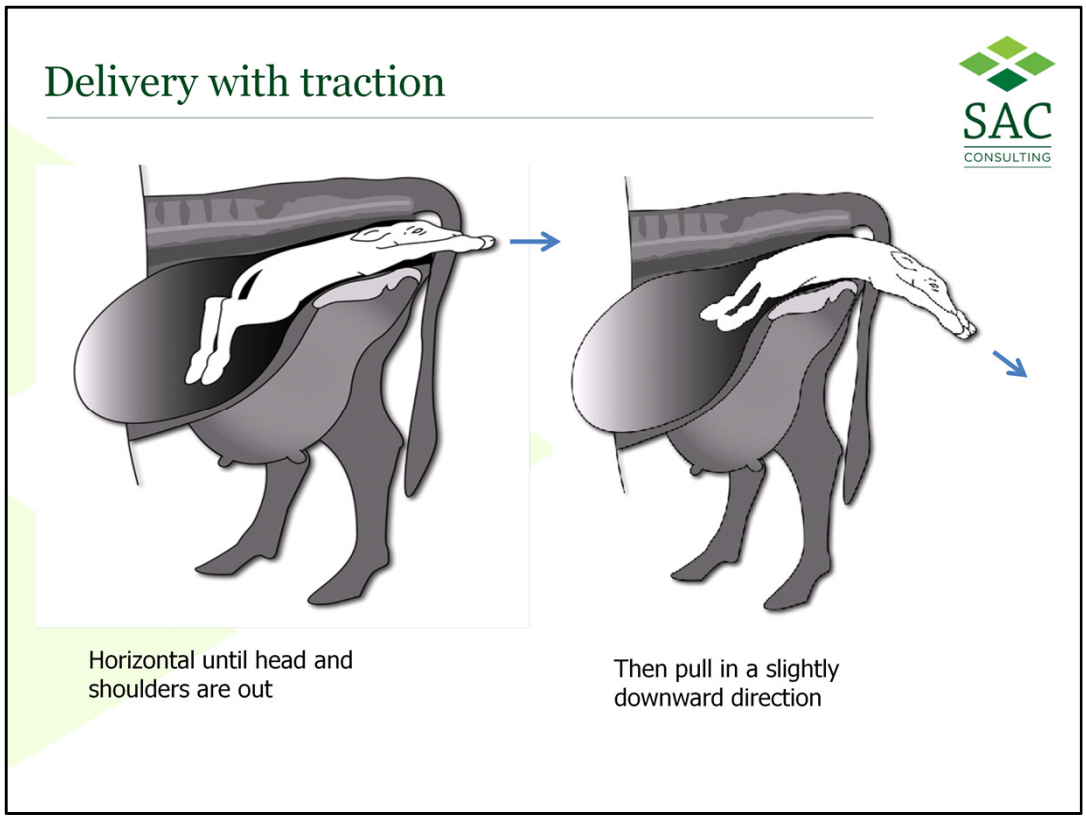
<u>One leg at a time</u>

Diagram showing a calf being 'walked through' the pelvic canal by applying traction to one limb at a time.

If possible, 'walk' the calf, one leg at a time, until both shoulders are in the pelvic canal.

This may be achieved by:
- Manually pulling at one leg at a time
- Using a calving jack that applies alternate traction
- Pulling one leg using the jack for a short distance, disconnecting and connecting the other leg. The above process is repeated until the shoulders are in the pelvic canal.

Thereafter, pull both limbs at the same time.



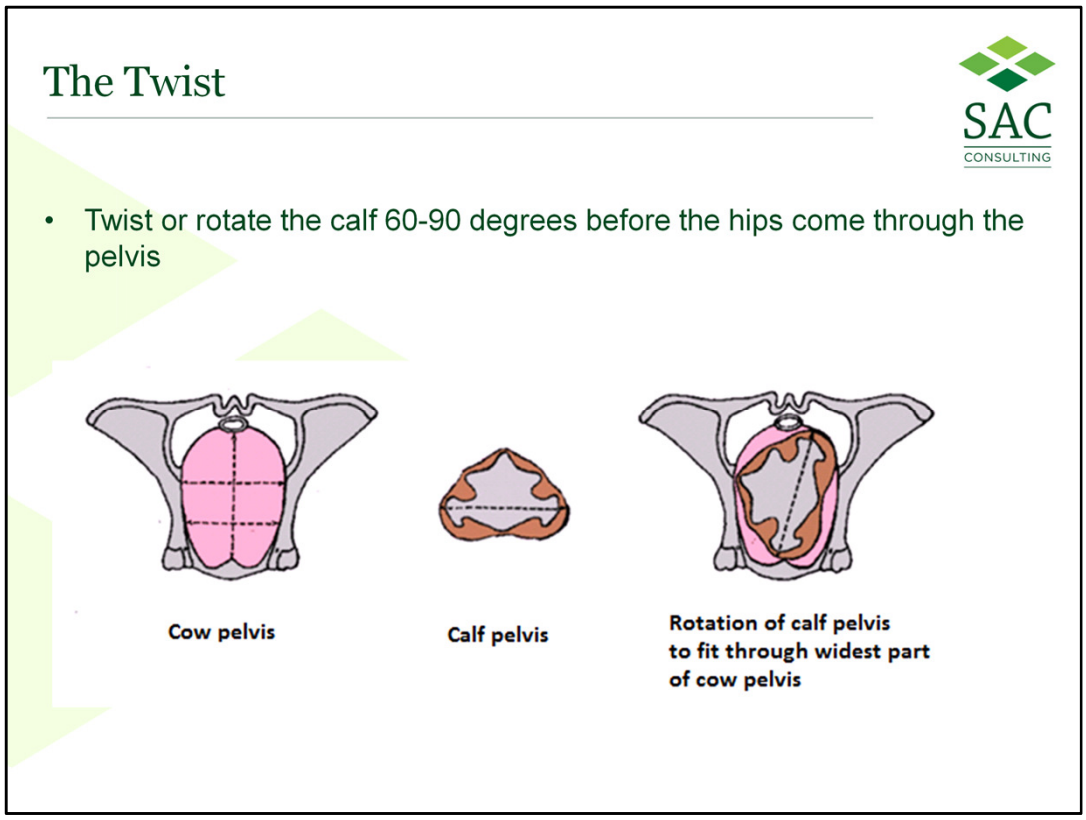
Delivery of calf frontward

• Apply traction when the cow is assisting with an abdominal press.

• Ideally a cow would calve down on her right. This is because the calf will be horizontal, aided by the rumen underneath. The cows abdominal press will also be more effective, and you don't have to lift the whole weight of the calf into the pelvic canal as occurs when the cow is standing. We do not recommend that the cow is cast for calving.

• Pull straight until the head and shoulders are out, and then pull in a slightly downward direction

A note on using a calving jack responsibly
When applying traction, the force of one person per leg should be sufficient. The pressure exerted by two people pulling is around 400 psi.
However on many farms, a calving jack is routinely used. Please remember that a calving jack can exert as much as 2000 psi and so if used incorrectly can cause damage to the cow and calf.



Twisting the calf

Rotation of the calf should occur before the calf pelvis enters the birth canal of the cow/heifer.

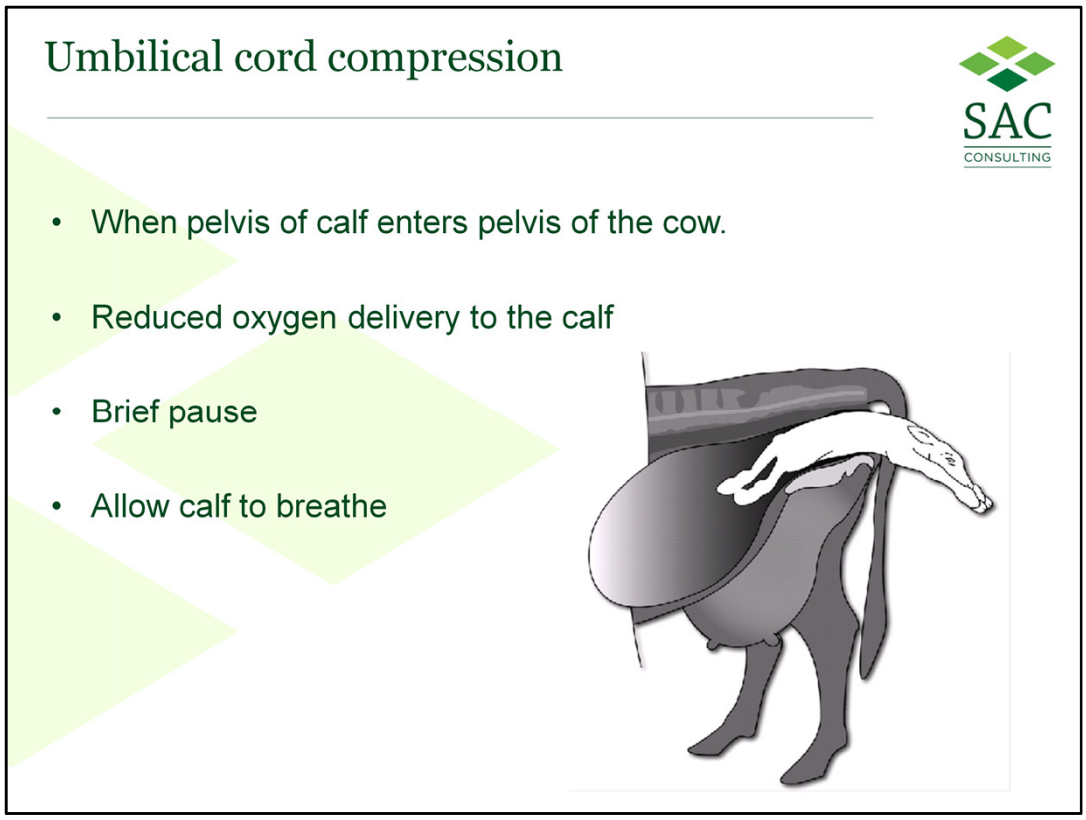
As the maternal pelvis is oval in shape, the widest part is diagonally across. The aim here is to rotate the calf so the widest part of the calf pelvis passes through the widest diameter of the cows pelvis.

Rotation of the foetus can begin once the shoulders are out of the vulva.

If using a calving jack, an assistant is necessary to twist the calf.

Wrap hands and arms around neck and shoulders and manually twist.

You are looking for a 60 to 90 degree rotation in the pelvis.



Umbilical cord compression

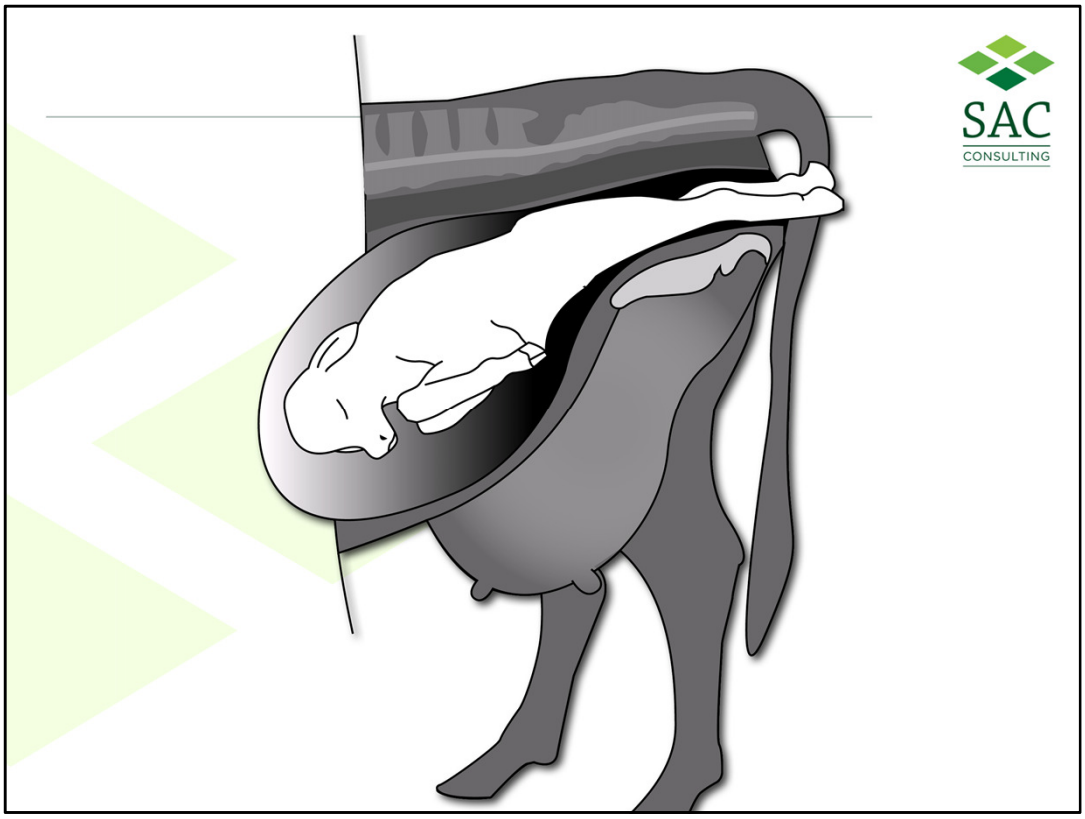
In normal unassisted calvings, once the shoulders and chest are out, the cow usually takes a break and the calf establishes its own breathing. This is because the umbilical cord is compressed between the calf and the pelvic floor. Calves need to start breathing as the oxygen supply from the umbilical cord is diminished.

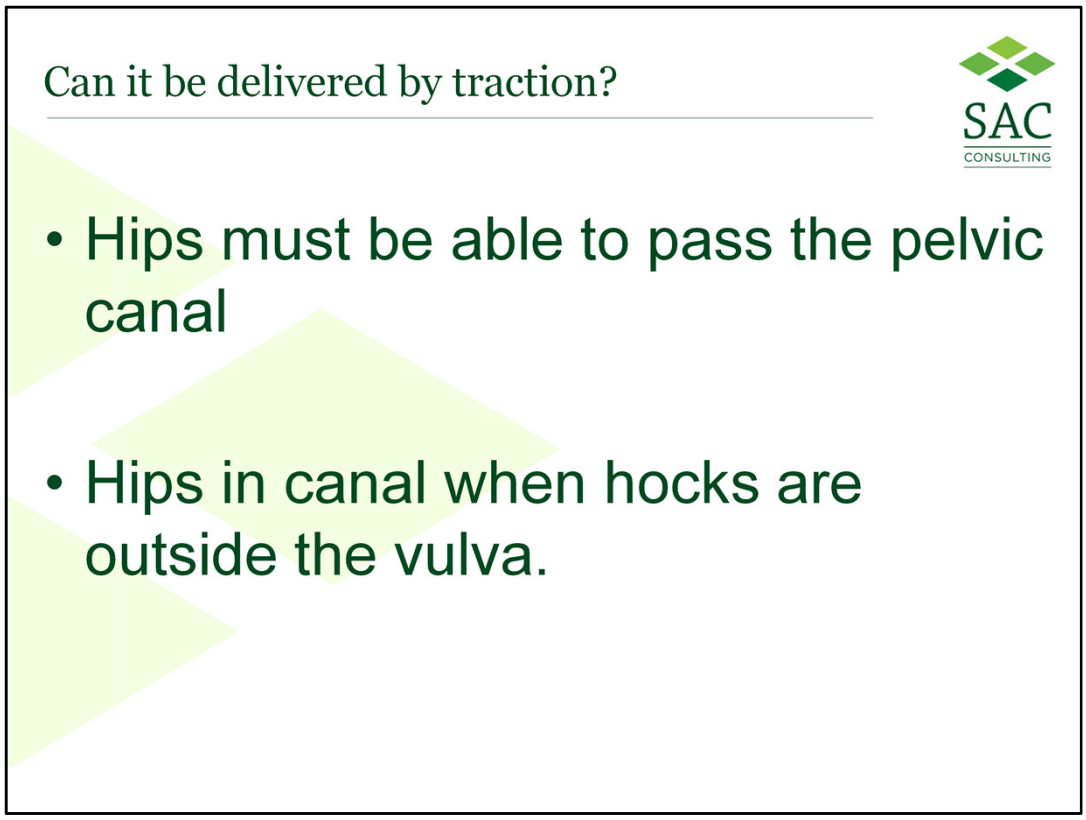
When applying traction, it is a good idea to take a brief pause from applying traction once the chest is out. If the second water sac is still over the head, this should be removed. Mucous can be cleared from the nostrils and the calf can be stimulated to breathe. A piece of straw up the nose may be used. Two or three breaths will be sufficient.

Constant pulling will not allow the calf to expand its chest and take in any oxygen.

Occasionally calves are lost because of the failure to allow the calf to breathe at this point.

How to deliver a calf in backward presentation

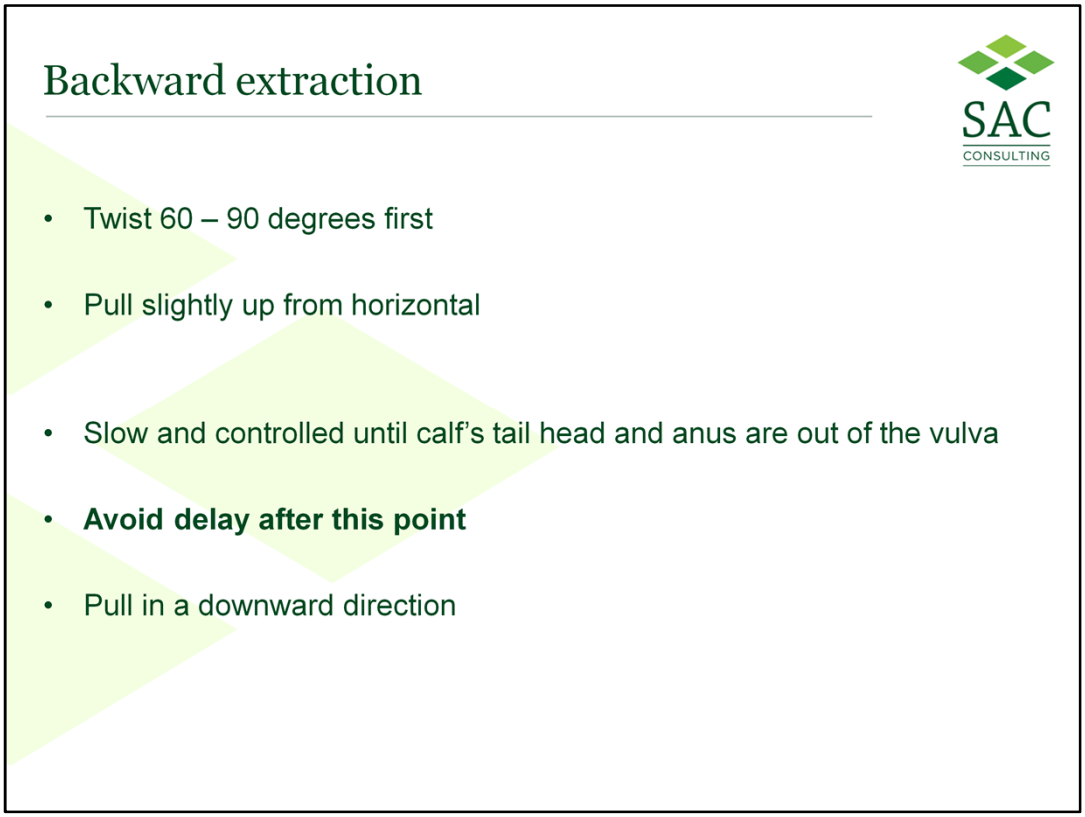




In backward presentation, the hips are the most difficult body part to deliver.

As a general rule, the hips are in the birth canal when the hocks are outside the vulva.

Once the hips have passed the pelvic canal, there is a good chance of successful delivery.



Delivery of the backwards calf by forced extraction:

Delivery of a calf presented backwards is risker because the umbilical cord ruptures early, often before the calf's head is out.

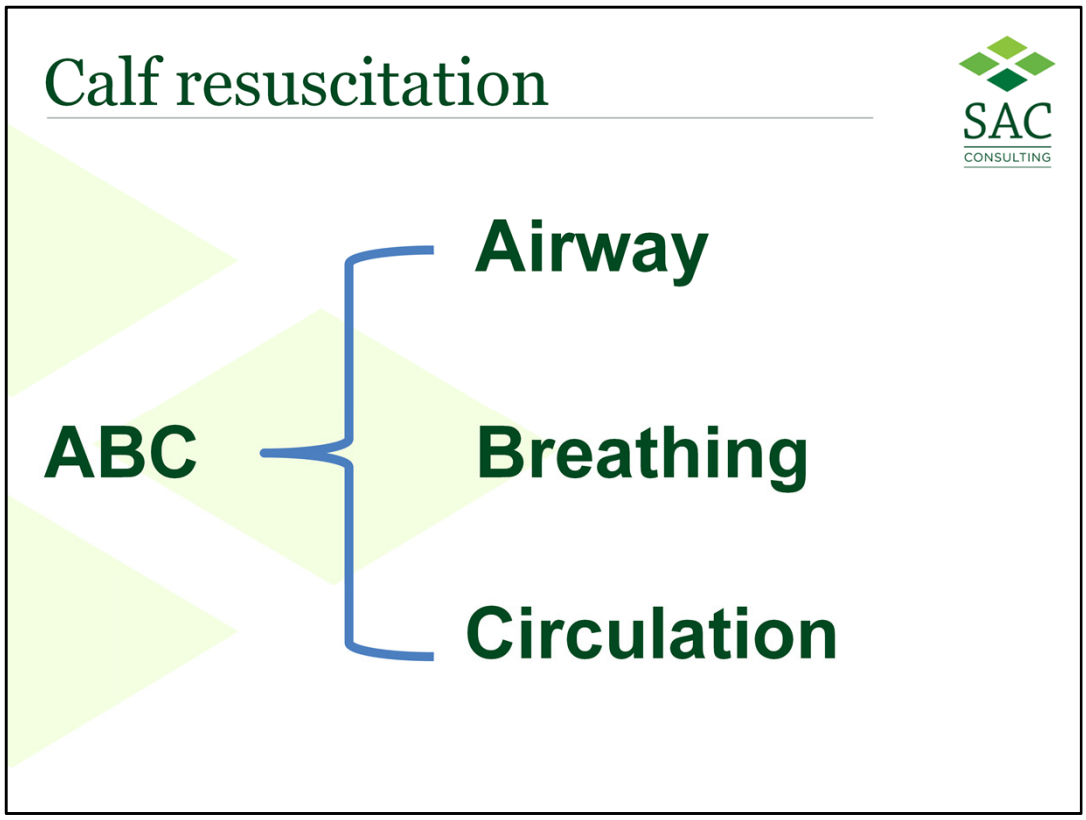
A calf in breech position should first be rotated 60-90 degrees by crossing the legs. This should be started before starting to apply traction to take advantage of the widest diameter of the cows pelvis.

The direction of pull to start is slightly up from a horizontal line straight out from the back of the cow.

Traction can be applied to both legs at the same time.

Once the hocks are outside the vulva, rotate the calf back to its normal position

Traction should be slow and controlled until the calf's tail head and anus begin to emerge from the cows vulva. Once this point is reached, delay should be avoided.

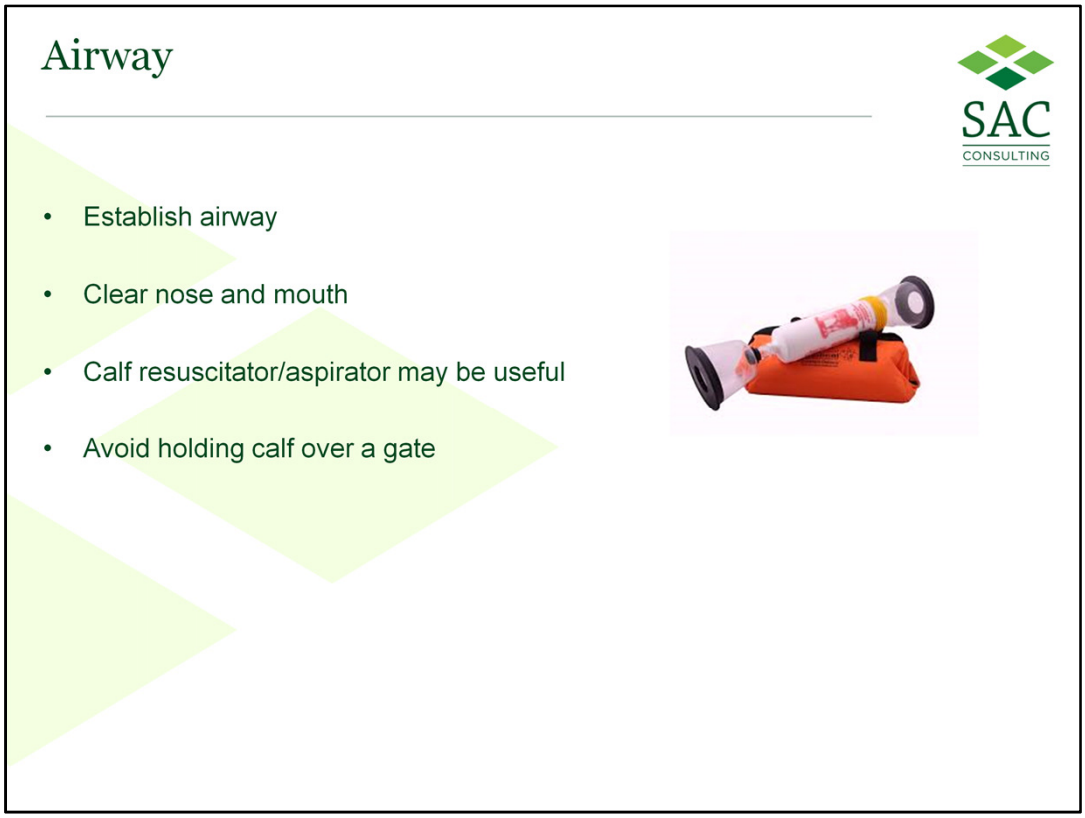


The abbreviation, ABC, used in human first aid is also applicable to calf resuscitation.

A = Airway

B = Breathing

C= Circulation



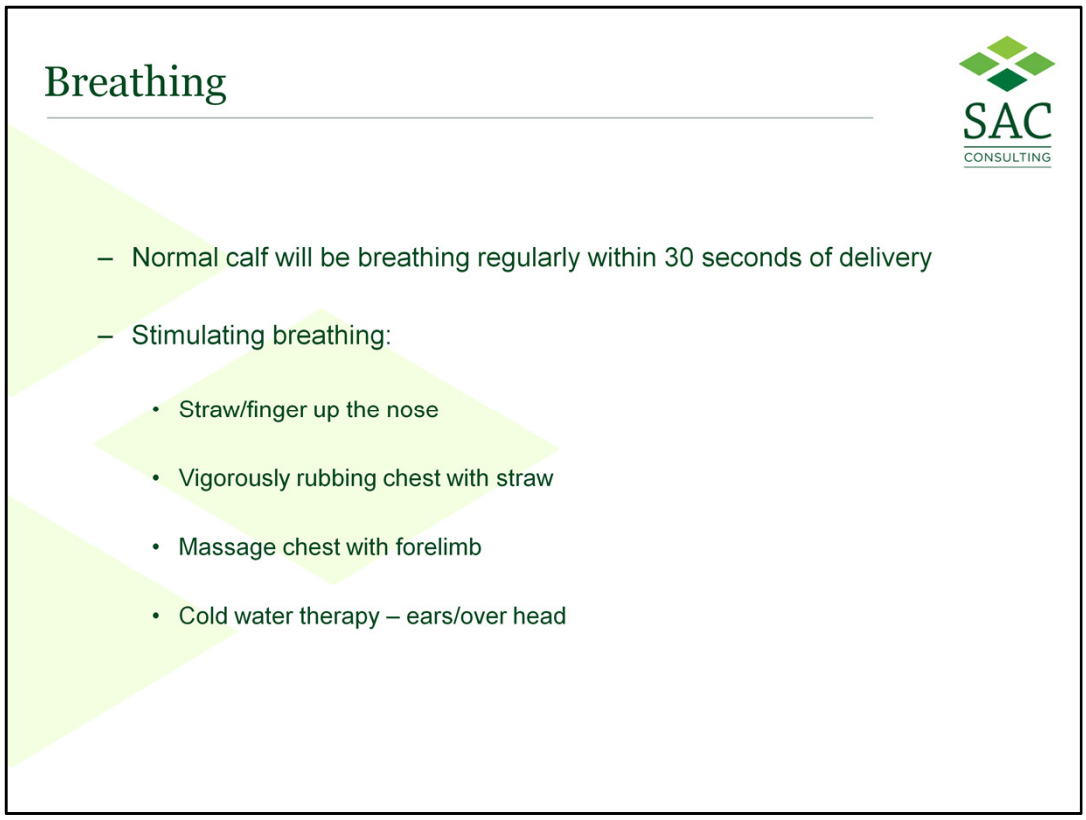
Airway

The first task should be to establish a clear airway by clearing mucus and membranes from the mouth and nose. Aspirators are available which can suck mucus from the upper airways. These may be useful in some cases.

We do not recommend hanging the calf over a gate due to the risk of femoral nerve damage (particularly if the calf is left on the gate for too long) and the risk of bladder rupture. Also the weight of the abdominal viscera on the diaphragm can reduce the ability of the chest to expand.

An alternative to hanging a calf over a gate is to lift the calf with the calving jack. By using the calving ropes to tie the back legs of the calf to the calving jack, the calf can be hung upside down for a brief period using the ratchet mechanism and the jack for leverage. We do not advise this is done on a routine basis.

Remember that most of the fluid actually comes out of the stomach.



Breathing

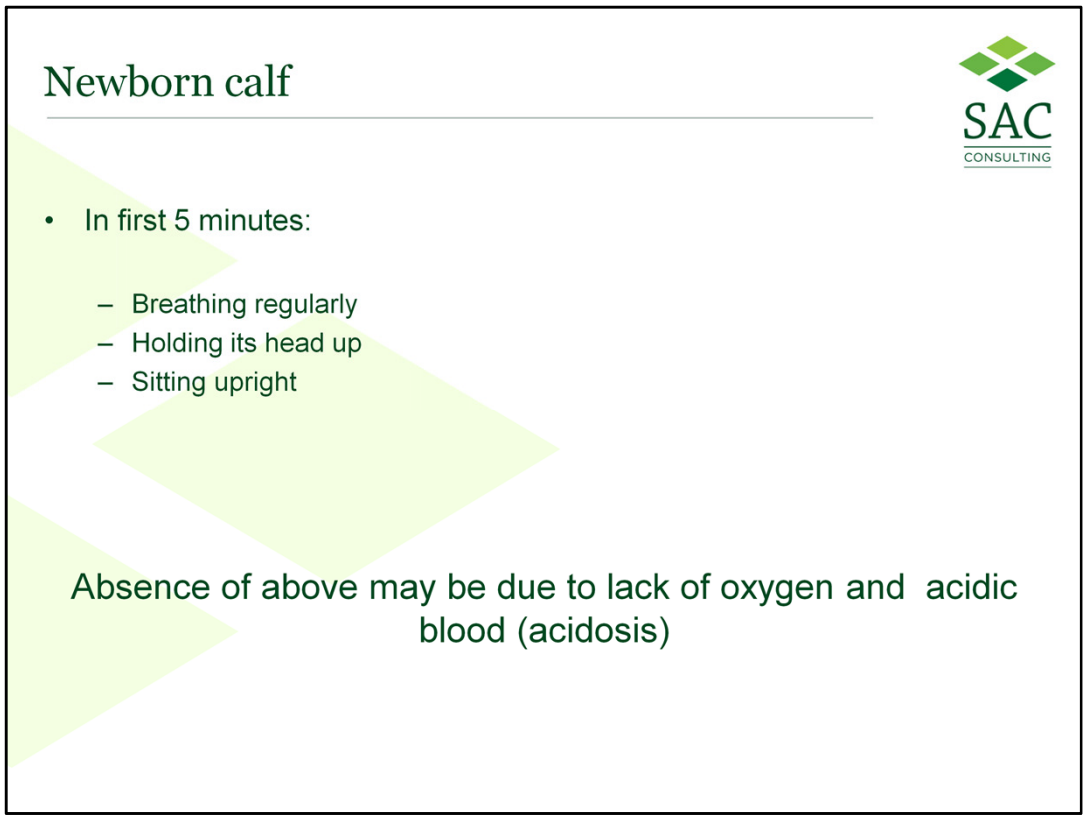
A normal calf will be breathing within 30 seconds of delivery. Breathing is irregular at first but soon settles to 45-60 breaths per min.

There may be a delay in calves born by caesarean section as CO2 in the blood tends to be lower.

If breathing is not established within 2 minutes, ideally direct positive pressure ventilation would be carried out using a tube passed into the trachea. This is a veterinary procedure.

However, on farm, this is impractical. Some of the commercially available calf resuscitators may be used. Farmers are more likely to have these. However unless the oesophagus/gullet/food pipe is closed off by pressing on it from the outside, air will also enter the oesophagus and the stomach. Air entering the stomach causes distension of the stomach which can restrict the movement of the diaphragm. Farmers should practice feeling for and closing off the oesophagus which is located just behind the windpipe.

In the absence of the above, stimulation of breathing should be attempted by inserting straw up the nose, putting cold water over head or into the ears, massaging the chest with forelimb and vigorously rubbing chest with straw.



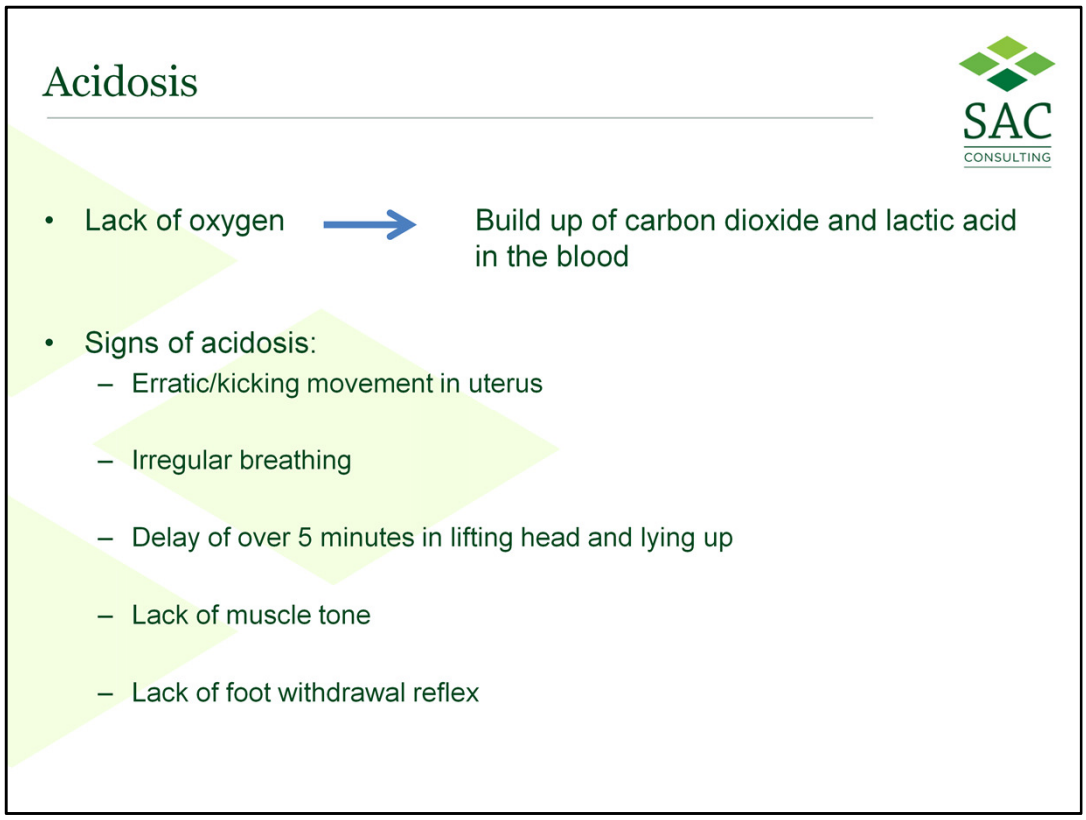
A healthy newborn calf

A healthy calf raises its head within a few minutes and soon achieves sternal recumbency.

In normal calvings, 4 minutes +/- 2 minutes was found to be the time to sternal recumbency (lying upright).

In forced calvings, the time to sternal recumbency was 9 +/- 3 minutes

This delay to lying upright may be due to
- Trauma
- Oxygen deficiency
- Acidosis

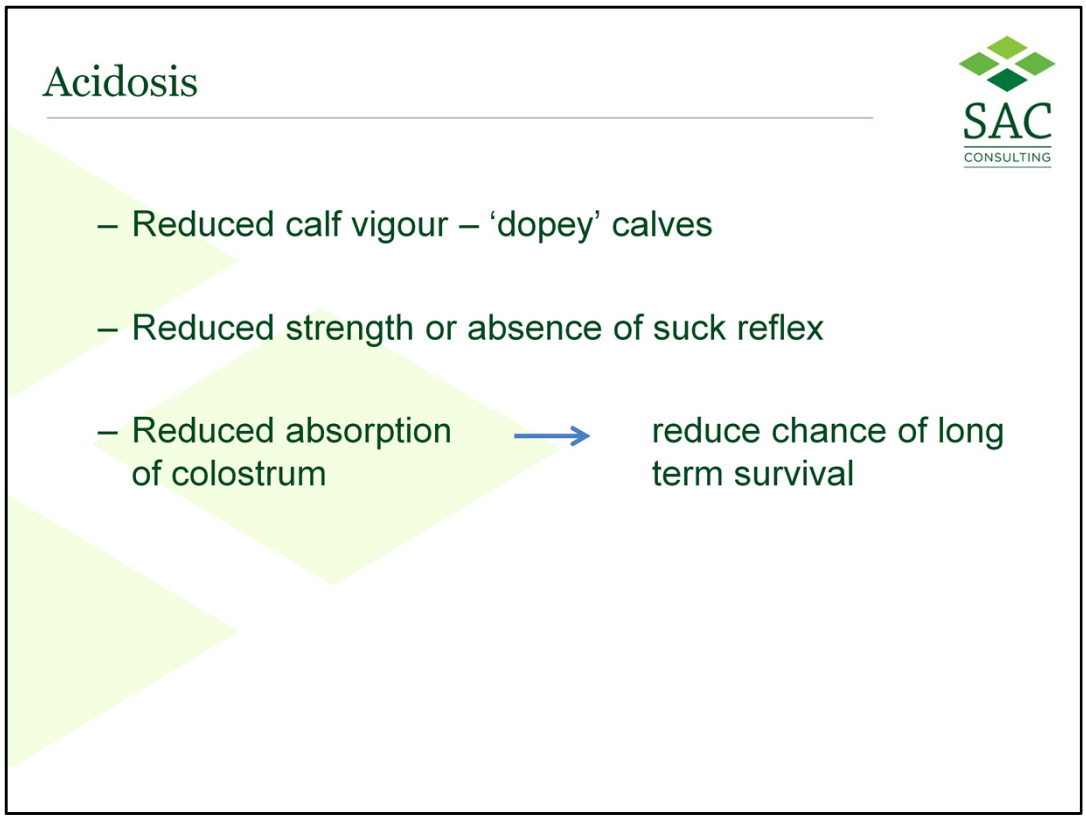


Circulation

During difficult calvings (dystocia), oxygen deficiency (hypoxia) and a marked increase in CO2 may be severe enough for foetal tissues to switch to anaerobic respiration resulting in lactic acid production. As a result, the compromised newborn calf may be suffering from severe respiratory and metabolic acidosis sufficient to threaten survival.

Signs of acidosis include:

Erratic kicking movement in the uterus (pre birth)
Irregular breathing
Delay of over 5 minutes in lifting head up and sitting upright
Lack of muscle tone
Lack of foot withdrawal reflex.



Consequences of acidosis

Severe acidosis has a detrimental effect on respiratory and cardiac function.

It causes a reduction in calf vigour and the strength of suck reflex. It also impairs absorption of antibodies in the calf intestine which increases the risk of pneumonia and diarrhoea which in turn reduces the chance of long term survival.

Treatment of acidosis

- Correct the acidity of the blood
- Bicarbonate solution into the vein
- Administer ASAP after birth
- Vet to administer

Bicarbonate therapy for treatment of acidosis

Bicarbonate solution administered into the vein can be successful in neutralising acidosis however response in practice is very variable. Solution must be administered intravenously. Subcutaneous or oral administration is not recommended.

The solution should ideally be administered as soon as possible after birth to calves showing signs of acidosis.

Calves should be breathing before bicarbonate therapy is administered. Bicarbonate therapy is contraindicated in calves that are not breathing. This is because one of the by product of bicarbonate metabolism is CO2. The calf must be able to breath this out. If the calf is not breathing, this will worsen the acidosis.

A safe dose is 50-100mls of 8.4% sodium bicarbonate solution administered into the vein over 30 seconds.

(Grove-White 2000).

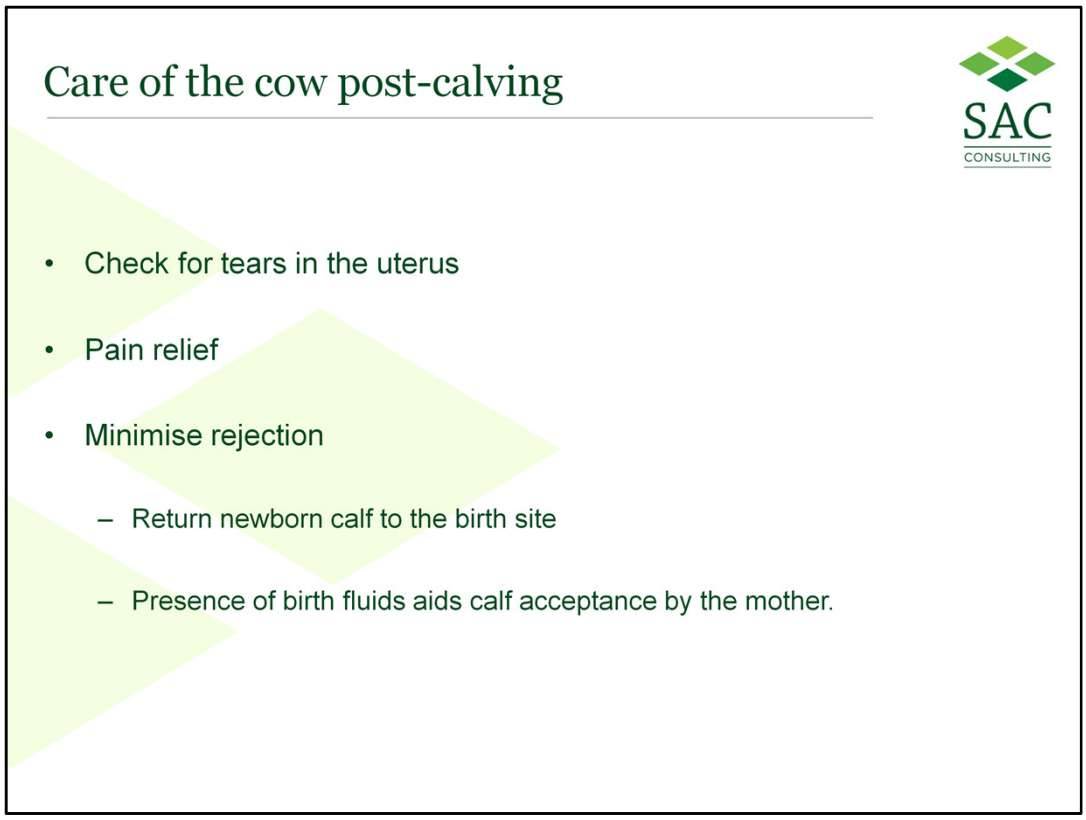
Glucose

- Glucose into the vein may also be beneficial

Hypoglycaemia

Many acidotic calves are also hypoglycaemic at birth.

10% glucose solution administered into the vein at a dose rate of 3.5 ml/kg may be beneficial.



Care of the cow post calving

After intervention, we advise administration of pain relief in the form of non steroidal anti-inflammatory drugs. This helps reduce any inflammation resulting from trauma during the calving process.

If the calf was moved from the calving area for resuscitation, the calf should be returned to the birth site as the birth fluids are an important part in mother accepting the calf, particularly in heifers.

- Thank you for listening

- Acknowledgments

David MacNeil, SRUC for producing the illustrations for this presentation.

Any feedback/comments/suggestions for improvement on the course?

Franz.Brulisauer@sruc.ac.uk

References

- Becker, M., Tsousis, G., Lüpke, M., Goblet, F., Heun, C., Seifert, H., & Bollwein, H. (2010). Extraction forces in bovine obstetrics: an in vitro study investigating alternate and simultaneous traction modes. Theriogenology, 73(8), 1044-1050.
- Grove-White, D. (2000). Resuscitation of the newborn calf. In Practice, 22(1), 17-23.
- Gundelach, Y., Essmeyer, K., Teltscher, M. K., & Hoedemaker, M. (2009). Risk factors for perinatal mortality in dairy cattle: Cow and foetal factors, calving process. Theriogenology, 71(6), 901-909.
- Kersting, K. (1997) Parturition and dystocia in Current therapy in large animal theriogenology. W. B. Saunders company. 324-329
- Mee, J. F. (2004). Managing the dairy cow at calving time. Veterinary Clinics of North America: Food Animal Practice, 20(3), 521-546.
- Mee, J. F. (2008). Prevalence and risk factors for dystocia in dairy cattle: A review. The Veterinary Journal, 176(1), 93-101.
- Mee, J. (2011). Bovine neonatal survival–is improvement possible. WCDS Advances in Dairy Technology, 23, 161-174.
- Shah, K. D., Nakao, T., & Kubota, H. (2006). Plasma estrone sulphate (E< sub> 1</sub> S) and estradiol-17β (E< sub> 2</sub> β) profiles during pregnancy and their relationship with the relaxation of sacrosciatic ligament, and prediction of calving time in Holstein–Friesian cattle. Animal reproduction science, 95(1), 38-53.
- Youngquist, R., S. (1997) Parturition and dystocia in Current therapy in large animal theriogenology. W. B. Saunders company. 309-324