Final Report

Prevalence of and risk factors for Failure of Passive Transfer (FPT) in English suckler herds

Short Title	Do suckler calves absorb enough antibodies from colostrum?		
Start date	01/01/2018	**End date**	31/03/2019

Project aim and objectives
To define the prevalence of and risk factors for Failure of Passive Transfer (FPT) in English suckler herds. 1) To understand the prevalence of FPT in suckler calves under typical English husbandry conditions 2) To identify risk factors of FPT in suckler calves under typical English husbandry conditions 3) To gain a clearer understanding of the relationship between nutritional status (including iodine status) during late gestation and FPT in suckler calves

Lead partner	University of Edinburgh

Full Report

Results: What did the work find?

This work was combined with an existing study of the same design in Scotland. There were no differences in the results between England and Scotland and hence the results are presented together. 49 suckler farms from 16 veterinary practices in England were recruited, which included nine AHDB Strategic Suckler farms. Signed consent forms from all the participating farmers were provided to AHDB previously. Figure 1 illustrates the geographic distribution of both the English and Scottish study farms.

Two metabolic profiles (including feed data and forage analysis) from 49 English herds were completed, with a total of 585 cows sampled. Calf blood samples were submitted from all 49 English herds. In total, 654 English calf samples were received. The results from this testing were reported to both the herd's veterinary surgeon and farm manager. The average number of calves per farm was 13.3 calves/farm. We do not anticipate that this will prevent the project from achieving its objectives.

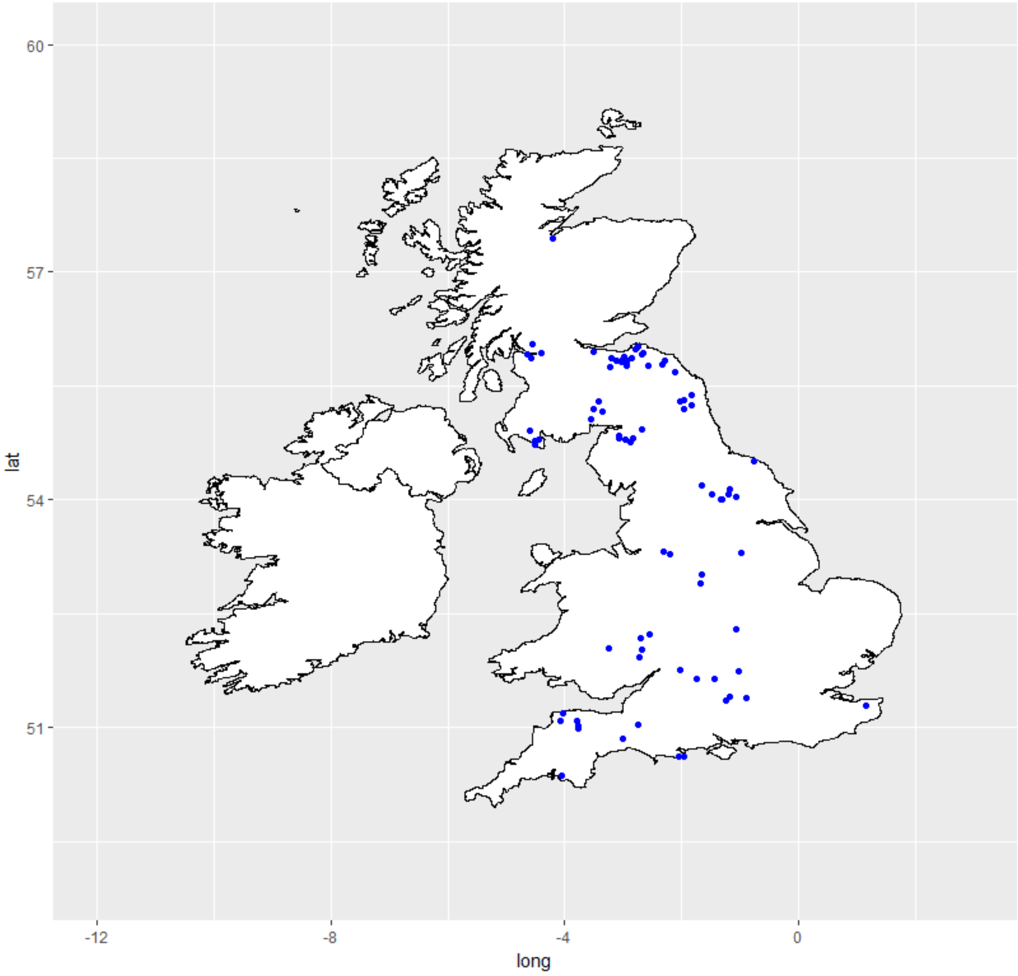

Figure 1: Geographic distribution of study farms.

2.1 Calf blood samples

Figure 2 shows the serum Total Protein (TP) results from the wet chemistry analysis, for all the 1171 calves in England and Scotland tested. Each x axis tick represents an individual farm. As can be seen, there is significant variation in TP results, however overall 18% of calves have a TP < 50 g/l, which is indicative of FPT. This is consistent with reports in the literature for other countries and indicates that over 1 in 6 suckler calves in England and Scotland are at serious risk of infectious disease during the first few weeks of life due to FPT. This not only represents an area of economic loss and poor animal welfare, but also a significant driver of antibiotic use in beef production.

Furthermore, 15% calves have a marginal TP result of 50-55 g/l, suggesting that passive transfer could be improved. This leaves 66% calves with an optimal TP of > 55 g/l.

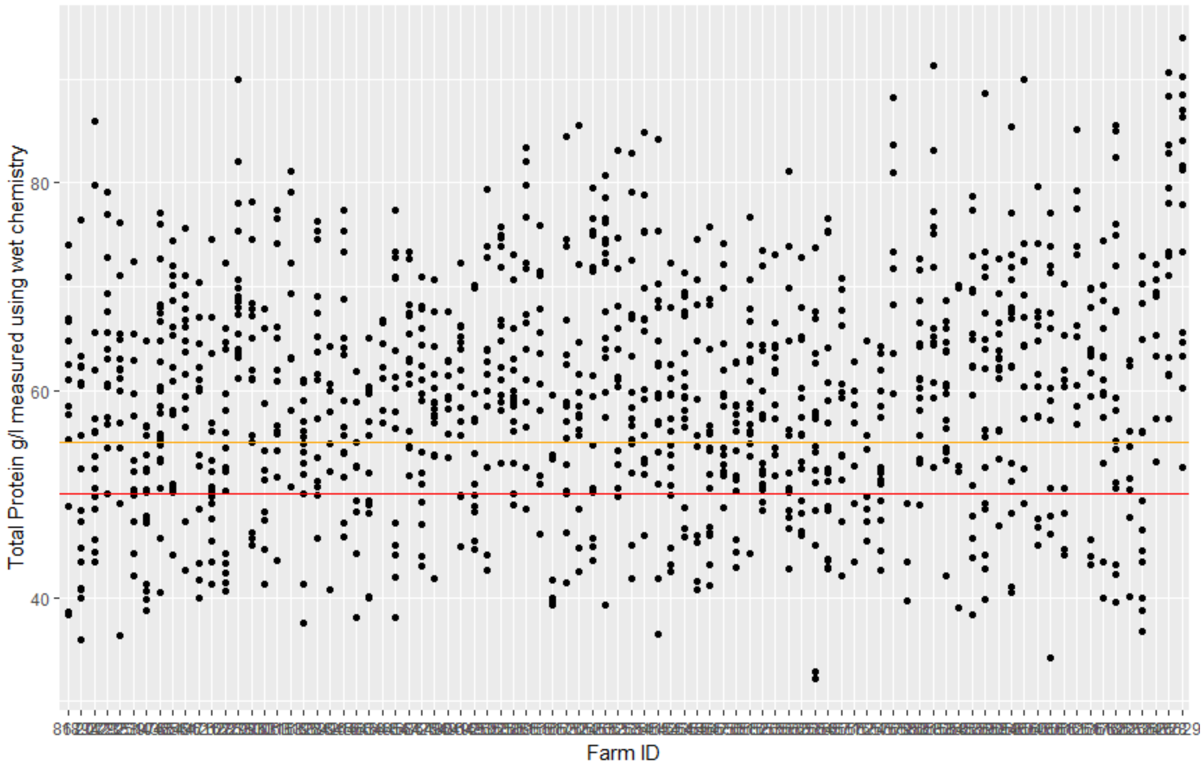

Figure 2: Calf TP results plotted by farm. The red line indicates the threshold for FPT, whilst the orange indicates the marginal range.

We sent most of the calf samples for total serum IgG quantification and have plotted both TP and GGT against the gold-standard IgG concentration as measured by RID. GGT has been reported as another indicator of FPT, however the literature is currently conflicted as to the utility of GGT, which is dependent on the time of sampling after birth. As is evident in Figure 3 where GGT and IgG results are compared, there is significant variation in the GGT results and only a minority of calves have a GGT below the threshold of 75 IU/l. There is also poor correlation between GGT and IgG measurements. We are therefore sceptical that GGT is likely to be a useful proxy for FPT in beef calves.

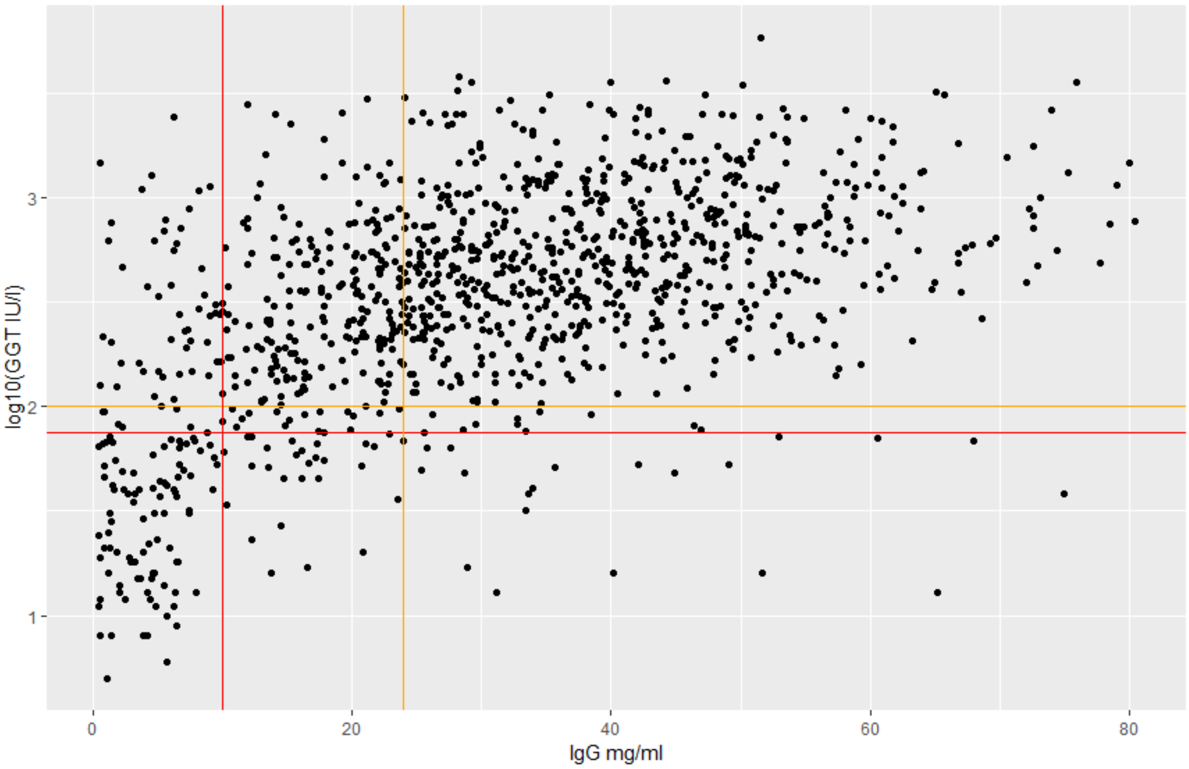

Figure 3: Calf GGT results plotted against IgG results. Orange line indicates marginal range, red lines indicate cut off for FPT.

As can be seen in Figure 4, the correlation between our total protein results (determined using wet chemistry on fresh samples) and the IgG results is not as good as previously reported. This is something we intend to look into further, given that the total protein results as determined using digital refractometry on freeze thawed samples and IgG results correlate much better (R^2 = 0.8, Figure 5). This may be something to do with the handling of samples or another factor. We intend to chase this up internally with testing calf serum from clinical monitoring samples taken from the University dairy farm to see if freezing has an impact on TP results, or whether it is more of an issue derived from field sampling compared to study trials sampling.

Having these IgG results allows the IgG concentrations of calves in England to not only be compared to the data relating to FPT, but also to a number of international studies (Beam et al. 2009 and Dewell et al. 2006) showing that morbidity and mortality prior to weaning is actually higher in calves with IgG concentrations < 24 g/l (i.e. significantly higher than the 8-10 g/l cut-off used simply to define FPT).From these IgG results, 15% of calves sampled can be definitely diagnosed as having complete FPT with IgG results of < 10mg/ml. Further to this, 37% of calves sampled had IgG results of <24mg/ml (partial passive transfer – PPT), leaving 63% as having adequate passive transfer, which is similar to the findings of Waldner and Rosengren, 2009 in samples collected from suckler calves in Canada.

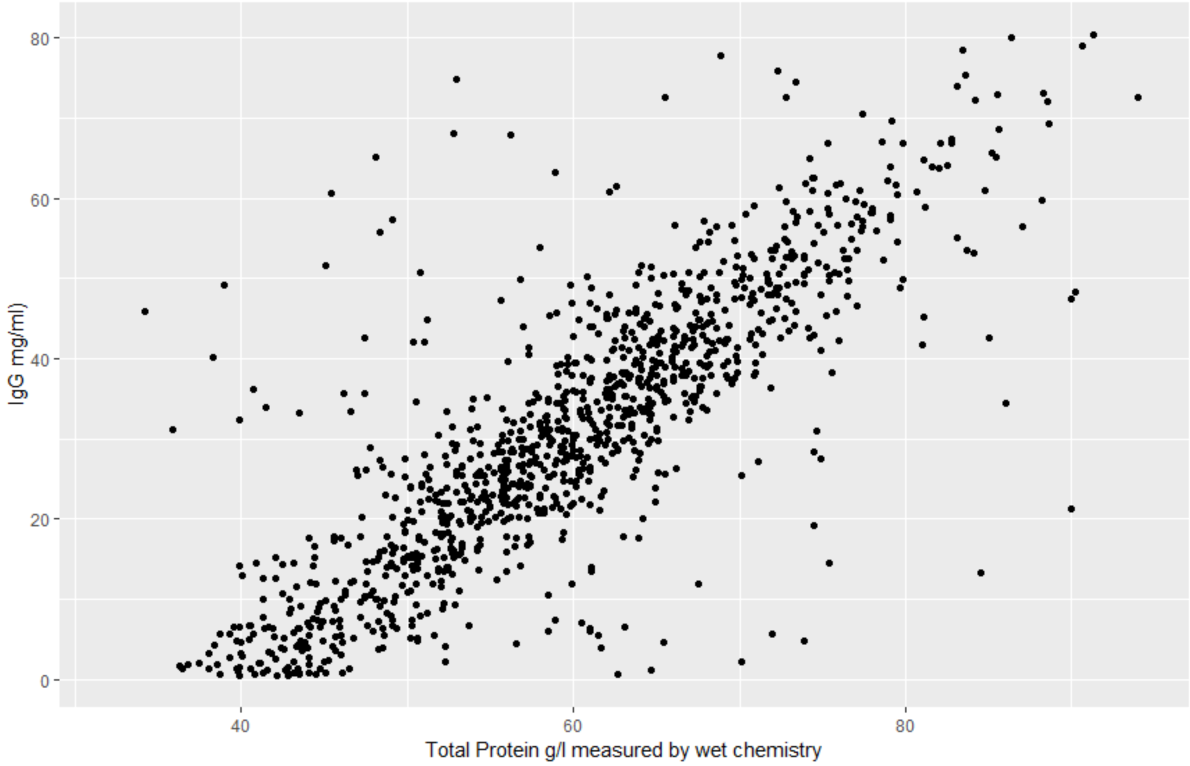

Figure 4: Calf IgG results plotted against Total Protein as determined using wet chemistry on fresh samples.

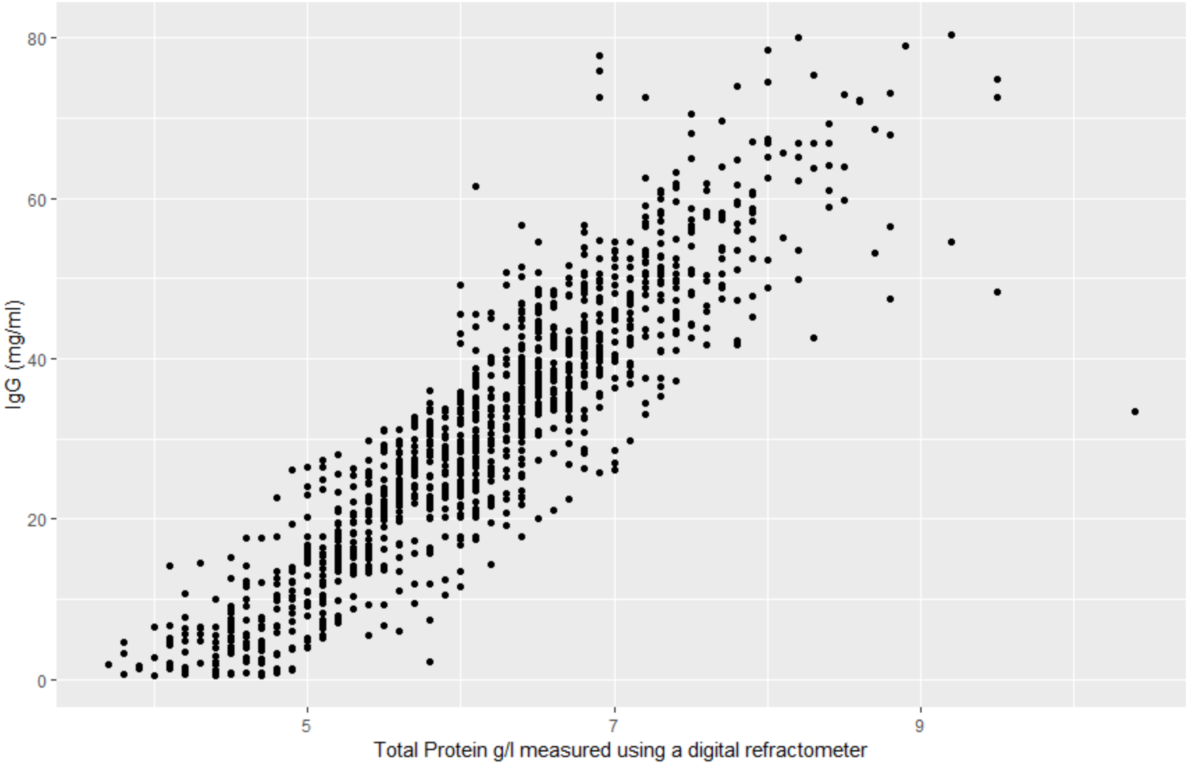

Figure 5: Calf IgG results plotted against Total Protein measured using a digital refractometer on freeze thawed samples.

As can be seen in Figure 6 and Figure 7, the serum TP and IgG results for the samples received do not vary significantly between England and Scotland.

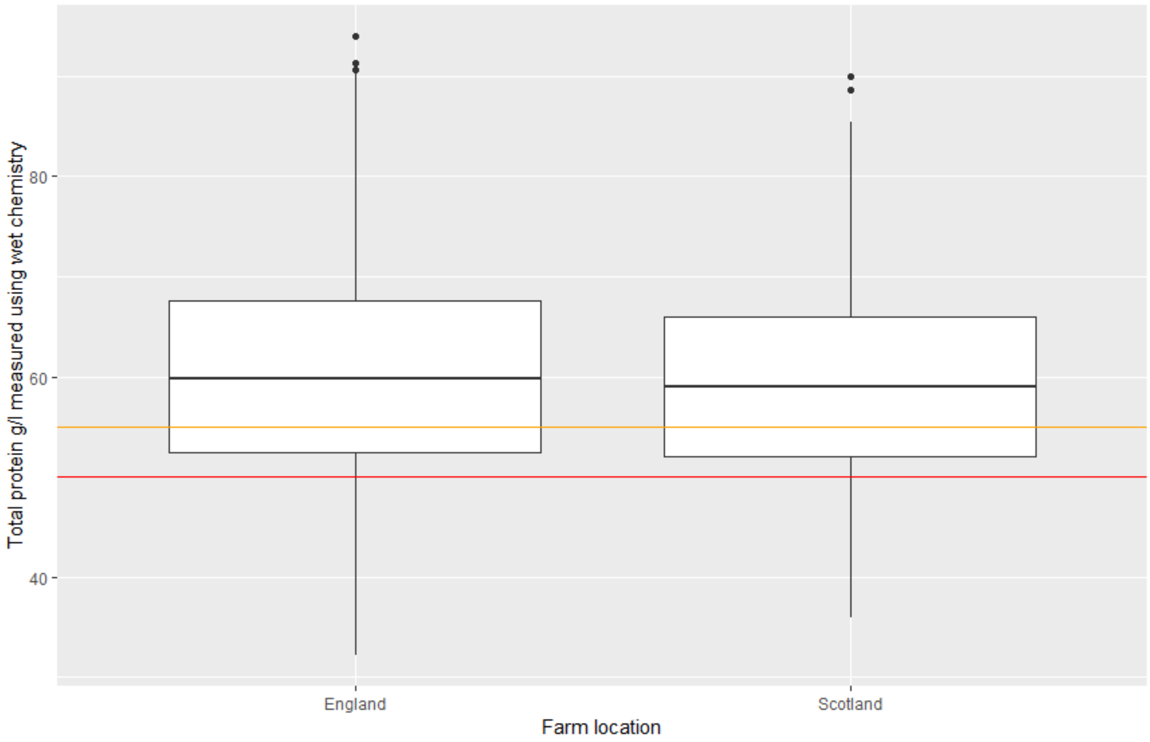

Figure 6: Calf TP results plotted by country. The red line indicates the threshold for FPT, whilst the orange indicates the marginal range.

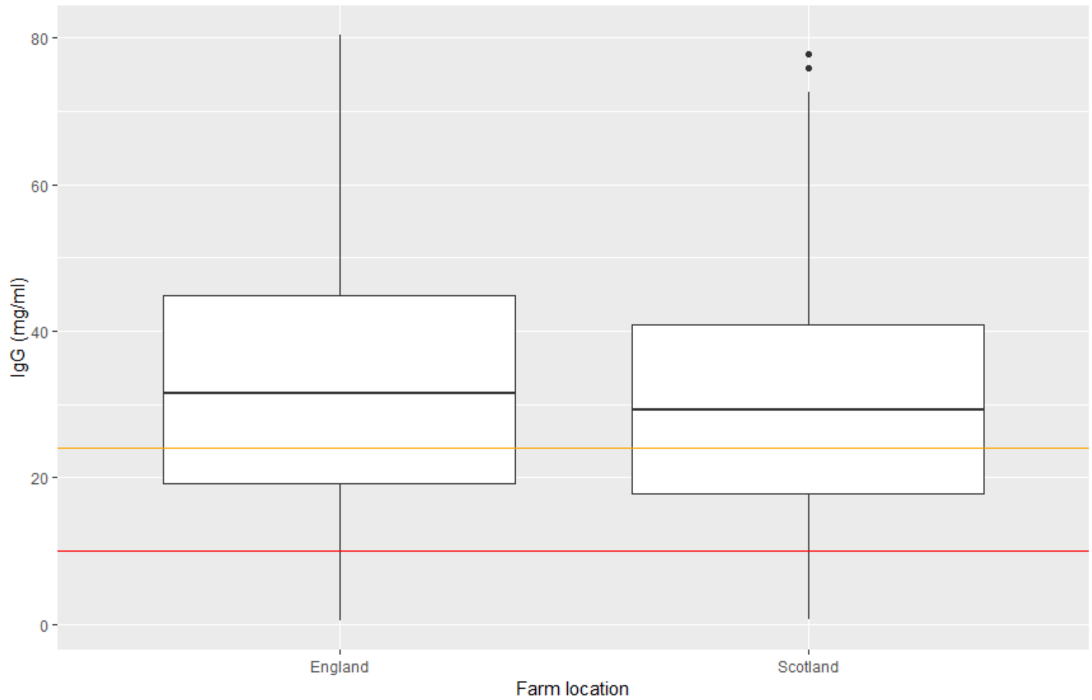

Figure 7: Calf IgG results plotted by country. The red line indicates the threshold for FPT of 10mg/ml, the orange line indicates 24mg/ml as a marginal cut off value

It is also informative to examine the prevalence of FPT at the farm level. This is illustrated in Figure 8, where the proportion of calves with FPT in each farm are shown. On 25 farms, none of the calves sampled were suffering from FPT, whilst there were two farms where over 50% of the calves had FPT (IgG < 10 g/l).

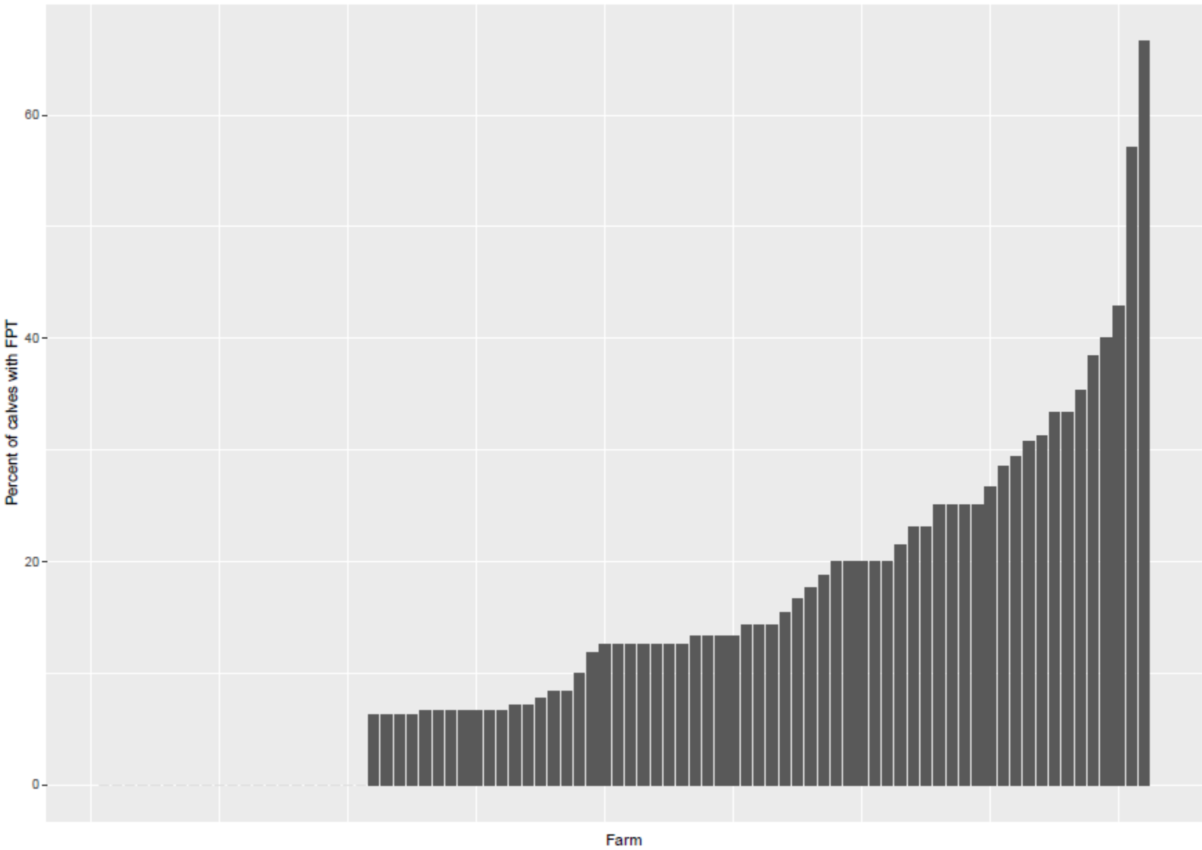

Figure 8: Bar chart showing calf IgG results plotted as the proportion (%) of calves in each herd with FPT (IgG <10 g/l).

As we are now in possession of the RID IgG results, the majority of the conclusions about the level of FPT in GB suckler herds will be drawn from this data as this is the more reliable testing method and is considered the gold standard. The total protein and GGT measurements will be used in subsequent work to determine the most appropriate screening test and cut-off values for field samples collected from commercial suckler farms. This will be undertaken by Rachel Bragg, who is pursuing a PhD after the conclusion of this project.

2.2 Metabolic profile data

The metabolic profile results from the 988 cows in England and Scotland tested are plotted in Figures 9 and 10. The distribution of the results are broadly similar between the two countries. All together, the following headline summary can be taken from the metabolic profiles:

- 6.7% cows sampled had an elevated BOHB result and hence were failing to meet their current energy requirements and mobilising body fat reserves at an excessive rate in the run up to calving
- 30.9% cows had a low glucose result, which may be indicative of either particularly severe negative energy balance, or problems with short term energy supply from the rumen i.e. low levels of Fermentable Metabolisable Energy (FME) in the ration
- 35.4% cows had an elevated NEFA result, another indicator of negative energy balance and excessive body fat mobilisation. Elevated NEFAs are of particular concern due to their association with fatty liver disease, which can have serious consequences in energy restricted suckler cows
- 57.0% cows had a low urea-N result, indicating that short term intakes of Effective Rumen Degradable Protein (ERDP) are likely inadequate. One of the purposes of this study is to determine whether low urea-N results during late gestation are associated with FPT. Poor ERDP supply also results in poor rumen function, inefficient utilisation of the ration and an increased risk of rumen impactions
- 10.4% cows had a low albumin result and hence a poor long term protein status. This is usually a consequence of a concurrent disease, potentially diseases like lameness, Johne's or liver fluke
- 29.3% cows had a low magnesium result, indicating that they were at risk of both clinical and subclinical hypomagnesaemia. Whilst clinical disease (grass staggers) is all too obvious and potentially fatal, subclinical hypomagnesaemia can be more insidious, potentially resulting in slow calvings, failure to calve unaided and a higher risk of milk fever and hence uterine prolapse
- 3.1% cows had a low phosphate result, indicating that they were failing to meet their current phosphate requirements. Most of these results appear to be isolated individual animals and probably reflect reduced dietary intakes in the run up to calving, rather than problems with overall dietary phosphate supply
- 3.8% cows had elevated globulin results, hence indicative of a chronic inflammatory disease. In our experience, this is generally something like lameness in cows in late gestation
- 0.2% cows had a low copper result. The cut-off of 3.0 µmol/l is used to define clinical copper deficiency and does not provide an accurate measure of total body copper status

due to significant liver stores in the liver. Nonetheless, only one of the cows sampled had a blood test result indicative of clinical copper deficiency

- 4.9% cows had a low GSHPx result and hence their intakes of selenium over the 2-3 months prior to calving were inadequate. As with the copper results, only a very small proportion of the cows had any evidence of selenium deficiency
- 7.6% herds had a low pooled iodine result. Again, similar to the copper and selenium results, the iodine status of the majority of herds sampled was good

Taken together, these results indicate that the energy and short-term protein status of a significant proportion of suckler cows in England and Scotland is poor. Whilst the magnesium results are concerning, the results for the other minerals tested for indicate that the mineral status for the majority of animals is generally adequate.

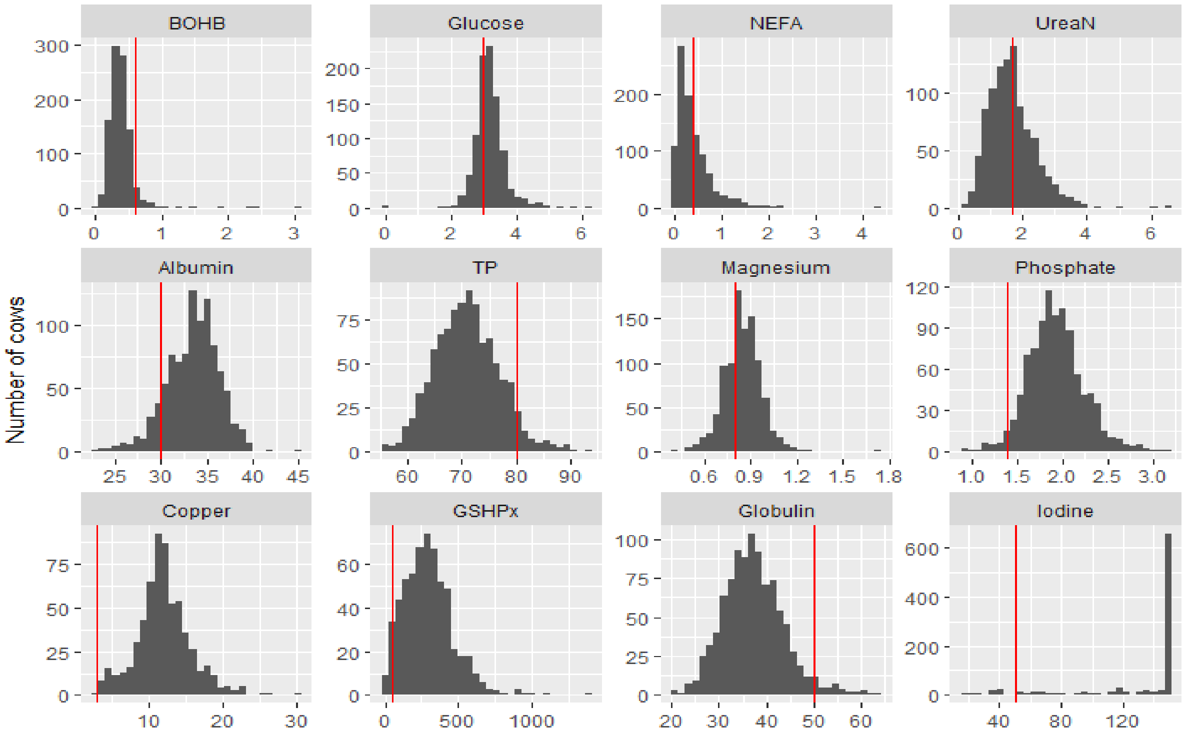

Figure 9: Distribution of metabolic profile results for suckler cows in England and Scotland in the run up to calving. The red lines indicate the optimum cut-off values for each parameter.

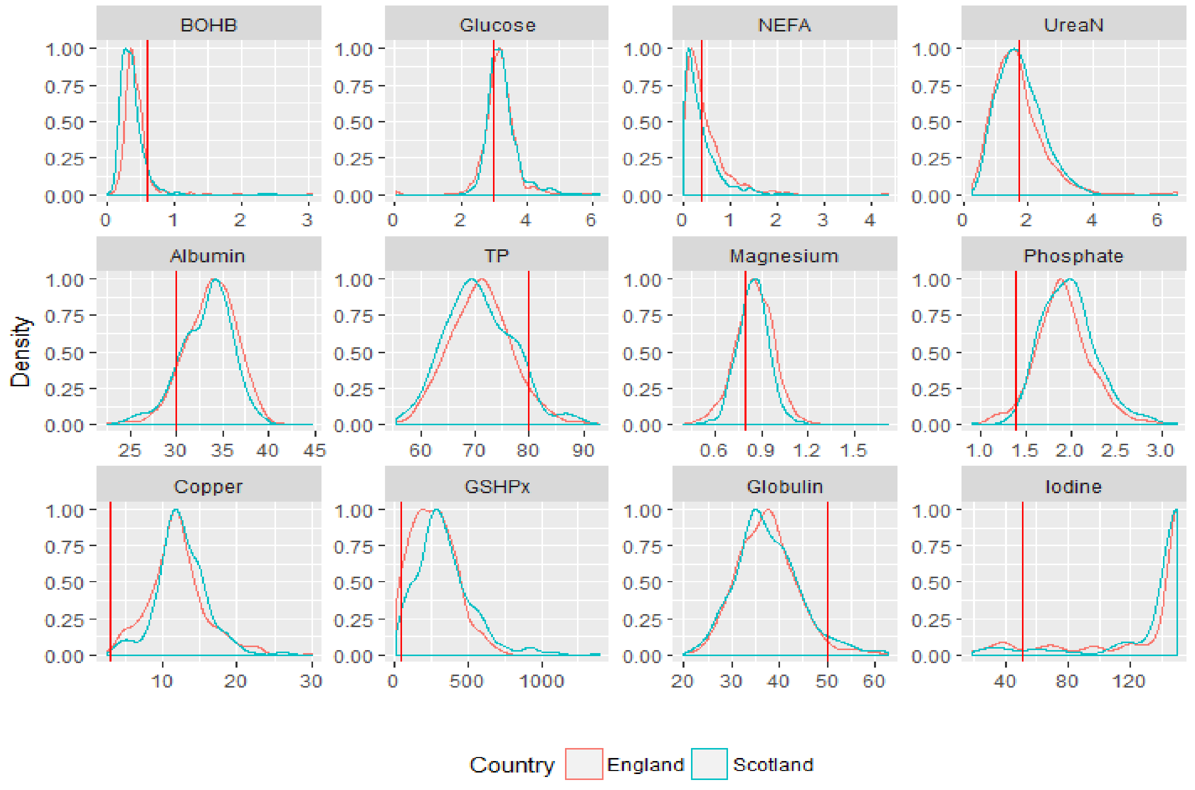

Figure 10: Distribution of metabolic profile results for suckler cows in England and Scotland in the run up to calving, plotted by country. The red lines indicate the optimum cut-off values for each parameter.

2.3 Ration information

Detailed ration information was collected for all the farms participating in the study. This will go into future analysis, however included in this report is a brief summary of the forage samples that were submitted for analysis. Most farms submitted ensiled grass (clamp, big bale or haylage) for analysis, whilst a small number submitted other forages such as fresh grass, hay, maize silage, pea straw and wholecrop. Two straw samples were submitted for analysis, however this was not something that we requested.

As can be seen in Figure 11, there was significant variation in the quality of ensiled grass being fed to suckler cows. Dry matter ranged from 18.5% to 81.8%, whilst energy ranged from 7.5 MJ/kg DM to 12.1 MJ/kg DM and crude protein from 6.0% to 19.3%. These ranges are not entirely unexpected, however given the metabolic profile results discussed above, it is clear that many farms are not analysing forages and providing supplementary feedstuffs on the basis of the forage analysis.

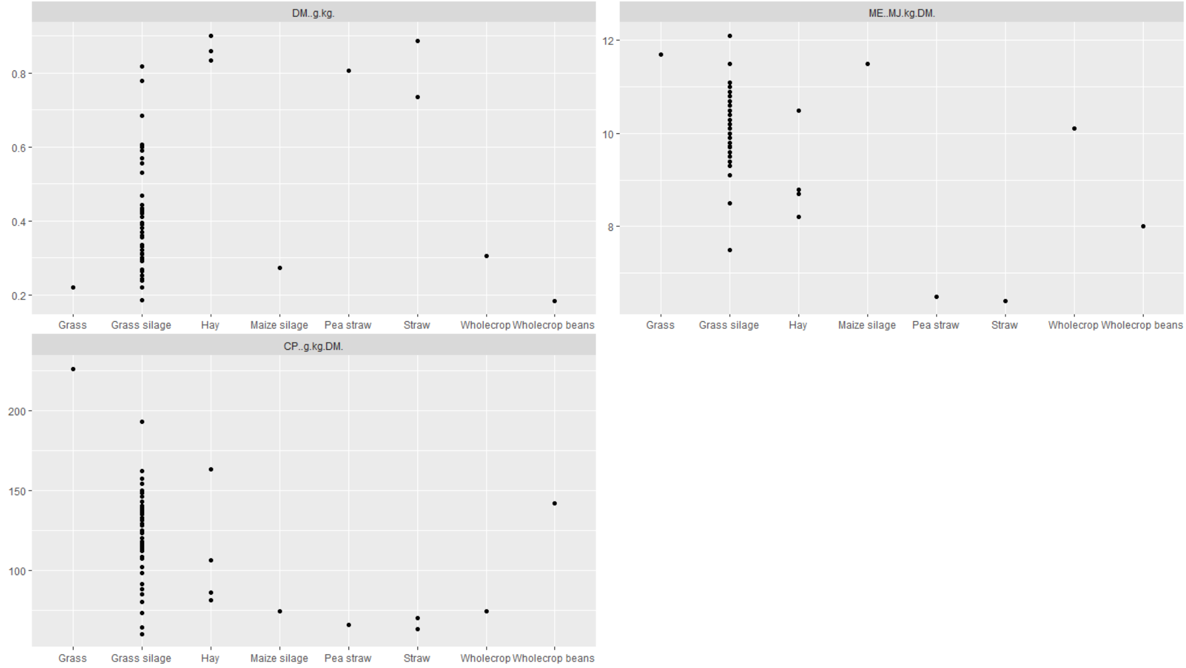

Figure 31: Summary of forage analysis results received. Y-axis units (clockwise from top left): DM = dry matter g/kg, ME = metabolisable energy MJ/kg DM, CP = crude protein g/kg DM.

2.4 Cow details

Each cow that was sampled was body condition scored and weigh taped. These measurements are summarised in Figure 12. Whilst of limited interest on their own, this information was included in the risk factor analysis. It is worth noting that whilst only 4.5% of cows were under conditioned (<2.5 units), 19% of cows were over conditioned (>3.0 units). With nearly 1 in 5 cows being over conditioned at calving, it is therefore not surprising that many herds are continuing with nutritional restriction in late gestation due to valid concerns with respect to calving difficulties. Unfortunately it is likely that once cows enter the last month of gestation, that nutritional restriction will do more harm than good.

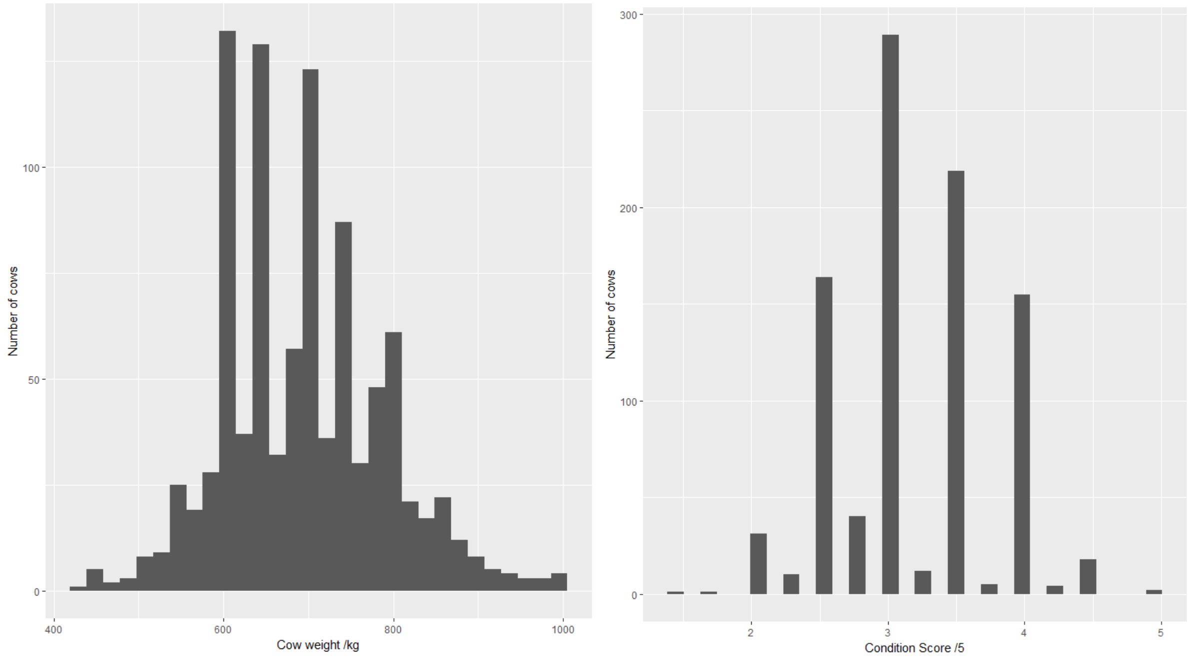

Figure 42: Cow weight and body condition scores

2.5 Risk factor analysis

The final stage of this project was to complete a multilevel logistic regression analysis to determine the major risk factors for FPT in suckler calves. A fully auditable output of this analysis from the statistical package R is included with this report.

Blood IgG concentration was used to define both complete failure of passive transfer (FPT IgG < 10 g/l) or partial passive transfer (PPT IgG < 24 g/l). The summary findings are as follows:

1) Calves that were born following an assisted calving (caesareans were excluded from this study) were up to 1.5 and 1.95 times more likely to suffer from FPT and PPT respectively than calves that were born without assistance
2) Calves that were given some assistance with colostrum feeding were up to 2.68 and 3.77 times more likely to suffer from FPT and PPT respectively than calves that were not given any assistance
3) Bull calves were 1.62 times more likely to suffer from FPT than heifer calves
4) Breed, calf weight, dam body condition, being born to a heifer and twinning had no impact on FPT risk
5) Being born to a heifer or a twin did however increase the risk of PPT 2.66 and 15.1 times respectively

6) At the herd level, only elevated BOHB concentration (an indicator of negative energy balance) in the cows pre-calving was associated with an increased risk of FPT. Organic status, herd size, cow weight, cow body condition and the other metabolic profile parameters were not associated with a statistically significant change in FPT risk
7) At the herd level, the models looking at the risk of PPT were unreliable and different modelling approaches will be required in future work to look at this in more detail.

Discussion: What do the results mean for levy payers?

Calves are born with no antibodies and rely on the ‘passive transfer’ of antibodies from the cow to the calf via colostrum. This must take place within the first few hours of life, as the ability of the calf to absorb these antibodies rapidly declines after birth. If insufficient antibodies are absorbed, then calves are at a significantly increased risk of death and disease during the preweaning period. Growth to weaning is also negatively affected. When calves do not receive any antibodies, this is called failure of passive transfer (FPT). When calves receive some, but not enough antibodies, this is called partial passive transfer (PPT).

In this study, around 1 in 7 calves sampled had FPT i.e. had not received any colostral antibodies, whilst 1 in 3 calves had PPT i.e. had not received enough colostral antibodies. At a herd level, 1 in 3 GB suckler herds had an FPT rate of at least 20%. There was no difference between English and Scottish suckler herds. These findings are concerning because they indicate that at least 1 in 5 of the calves in these herds have received insufficient antibodies from their dam’s colostrum. On two farms sampled, over half the calves sampled were suffering from FPT, however it was not clear why these herds were suffering with such severe FPT. These animals are at significant increased risk of infectious disease, contributing to increased antibiotic use, reduced growth and increased mortality. The good news is that five of the farms sampled had optimal passive transfer in all of the calves sampled, indicating that there are examples of excellent practice in the industry.

The metabolic profile results are also highly significant. Many livestock farmers continue to be concerned regarding mineral status, however the results of the testing in this study indicate that on the vast majority of farms sampled, mineral status was generally good. The one exception to this was magnesium status, which was poor in nearly 1 in 3 cows sampled. These animals are not just at risk of potentially fatal grass staggers, but also slow calvings, failure to calve unaided and a higher risk of milk fever and hence uterine prolapse. Many herds were either not supplementing with magnesium or were using buckets. Buckets are problematic due to the uneven intakes across the group. Of more concern, we have a number of examples of herds that were supplementing dry cows with growing cattle minerals. These minerals are inappropriate as they are high in calcium and low in magnesium. We would always advise that dry suckler cows are given a dry cow mineral that is high in magnesium and low in calcium, either mixed into the ration, top dressed or formulated into their compound feed during the last month of pregnancy.

The most significant findings from the metabolic profile results were the high rates of negative energy balance (over 1 in 3 cows sampled) and very poor short term protein status (nearly 2 in 3 cows sampled). These cows are at risk of uterine inertia (failure to progress during calving), exhaustion during calving, uterine prolapse, retained fetal membranes, delayed return to cycling after calving, ruminal impaction and clinical ketosis (slow fever). Our advice is that whilst feed restriction may be appropriate for suckler cows during mid-gestation, that they should be rationed to meet their current energy and protein requirements during the last month of gestation. The results of this study indicate that for energy, a significant proportion of cows were not having their needs met, whilst for protein, the majority of suckler cows were deficient.

Anecdotally, during this project, we have received reports from a number of vets that farmers are concerned regarding the production of large calves and are hence restricting feed to their cows in late gestation to try and reduce calf size. This is of concern as calf size should be controlled through genetics, and the use of nutritional restriction to essentially produce a stunted calf is not a sensible strategy for the industry. The suckler cow is required to calve unaided, produce good quality colostrum and milk and return to cycling within six weeks of calving. She will be unable to do this if she is nutritionally restricted in an attempt to compensate for poor genetic selection with respect to calf size. This project has therefore identified a significant need for a coordinated knowledge exchange effort to improve genetic selection with respect to calving ease, and discouraging the use of nutritional restriction in late gestation to control calf size.

A number of risk factors for FPT and PPT in suckler calves were examined at both the individual calf and herd level. The following were demonstrated to increase the risk of FPT and/or PPT:

- Assisted calving
- Assistance with colostrum feeding
- Bull calves
- Being born to a heifer
- Being born a twin
- Poor herd energy balance (elevated cow BOHB levels prior to calving)

This is the first time that poor energy balance in the run up to calving has been associated with an increased risk of FPT and highlights the importance of good maternal nutrition in late pregnancy. The increased risk in calves receiving assistance with colostrum feeding was also interesting, as it implies that high risk calves are being correctly identified and receiving help, but that they are not receiving sufficient help. This study did not look at how farmers stored and administered colostrum (timing and amounts fed), however industry advice is that calves should receive 3 litres of cow’s colostrum immediately after birth.

New knowledge: What key bit of new knowledge has come out of this project?

Integrating the findings of this study, with existing best practice in the industry, the following advice is made with respect to GB spring calving suckler cows:

1) Ensure that cows are in body condition 2.5-3.0 at least one month prior to calving

2) Ensure that cows are fed to meet their current energy and protein requirements (as per AFRC 1993) during the last month of pregnancy

3) Use a high magnesium (10-15%) dry cow mineral to supplement suckler cows in the last month of pregnancy

4) Failure of passive transfer affects 1 in 7 suckler calves in GB

5) 1 in 3 GB suckler herds have a failure of passive transfer rate of 20% or more in their calves

6) When assisting calves with colostrum feeding, ensure that they receive at least 3 litres of cow's colostrum immediately after birth

7) All calves born to an assisted calving or with a weak suckle reflex at 10 minutes old should be given additional colostrum, ideally from their mother and failing that, another cow in the same herd

8) Bull calves, calves born as twins and calves born to heifers are at increased risk of receiving insufficient colostrum. Even if these calves have been seen sucking, supplement these calves if there is any doubt that they have received 3 litres of cow's colostrum

Gaps in knowledge: What gaps in knowledge has this project identified?

This work focussed on the prevalence of and risk factors for FPT in English suckler calves. It has not determined the biological basis of FPT in suckler calves and so the relative importance of the following mechanisms for FPT has not been determined:

1) Poor antibody concentration in colostrum
2) Poor total colostrum antibody yield
3) Poor antibody uptake by the calf
4) Delayed colostrum feeding