European Innovation Partnership (EIP) Wales

Targeting anthelmintic use in ewes

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Executive summary

The successful control of roundworms is a key element in the health, welfare and profitability of sheep flocks. Historically, there has been a heavy reliance on anthelmintics to achieve control, but increasing levels of roundworm populations that are resistant to the products available means that sheep farmers need to adopt sustainable practices which rely less on chemical control and more on management and genetics.

The treatment of ewes around lambing is a long established practice. The objective is to reduce the worm egg output of ewes on to pasture in the peri-parturient period, when it is believed their immune system relaxes a few weeks pre and post lambing, allowing worms to lay more eggs in the faeces. This is known as the Peri-parturient rise (PPR). However, this involves the use of large quantities of anthelmintic, at a time when the proportion of worms *in refugia* is likely to be low. This is a major concern in terms of the selectivity for resistance in the worm population.

SCOPS principles advocate that a proportion of the fittest ewes are left untreated at this time to reduce the selection pressure. The aim of this project was to see if, by monitoring the egg output of ewes and their immune responses (IgA levels), we could minimise the need for ewe treatments through a better understanding of the timing and extent of the PPR. This group of farmers were already using Body Condition (BCS) as a Key Performance Indicator (KPI), along with lamb 56 day and weaning weights, therefore were well placed to provide data on the impacts on both ewes and lambs.

The results of this project highlight the differences between individual farms both in terms of timing and the extent of the PPR, and it has generated a large amount of supporting data. We could not demonstrate any useful role for IgA, but the evidence did support the role of nutritional challenge in terms of the timing of the PPR on the individual farms.

There is a clear indication that loss in (BCS) is a measure that can be used to signify which ewes require treatment. The implication is that maintaining good BCS is the best way to minimise the need for any ewe treatments. Only one of the farms in this project needed to treat any ewes in two of the three years. One other farm, which is organic, is considering very targeted treatment for some twin bearing ewes in years when they are under pressure post lambing following the results of this project and the effect of high worm burdens on their lambs.

Individual sheep farmers should be encouraged to use BCS targets. They need to monitor change in BCS, together with some FEC monitoring in their ewes to determine the need for any treatment. Attention to nutrition and the use of dry matter predictions vs requirements at grass are key elements in reducing the number of ewes receiving an anthelmintic treatment.

If ewes are in good BCS coming into the peri-parturient period, the findings of this project are that good nutrition and pasture planning will result in a very small proportion of ewes requiring treatment. This is increasingly important, because our data also shows that *T. Circumcinta* was the predominant species on these farms, and also the species that most survived treatments, indicating resistance. There is therefore an urgent need to remove unnecessary

treatments if we are to maintain the efficacy of those anthelmintic groups that are still working on these farms.

The speciation of worm populations is also important and highlights the need for sheep farmers to have access to this technology. Understanding which species are present and their response to different wormers helps to further refine the control programmes on farms, targeting not only the right animals but also the right products for the worms involved, avoiding unnecessary over-use.

Contents

1. Introduction

Parasitic Gastroenteritis (PGE) caused by gastrointestinal nematodes (gut roundworms) is a major contributor to reduced productivity in sheep all over the world and their control is a central part of health and welfare in flocks. PGE is primarily a disease of lambs and historically control has been heavily reliant on the use of anthelmintics (wormers). Even a modest worm burden, with no clinical signs of infection in lambs, can reduce performance and increase costs. However, increasing levels of resistance to these medicines in recent years has led to the need for sheep famers to employ other strategies to reduce reliance on chemical control (SCOPS principles). These measures include pasture and grazing management, better nutrition and harnessing and strengthening of the sheep's acquired immunity to these parasites when they are ingested.

Surveys and reports from farms in the UK suggest that resistance to three of the main anthelmintics is increasing. Most farms have detectable resistance to the white Benzimidazoles (1-BZ White Drenches) and resistance to Levamisoles (2- LV Yellow drenches) and Macrocyclic-lactones (3-ML Clear drenches) is increasing year-on-year.

Worming ewes around the time of lambing remains a common practice on the majority of UK sheep farms. The rationale behind this is that as ewes approach lambing, their immune system wanes, allowing the worms in their gut to produce a lot more eggs, which are passed out in their dung, contaminating pasture which is then grazed by their lambs*. However, there is evidence to suggest that only a small proportion of ewes are affected in this way and a blanket treatment of all ewes around lambing is, potentially, highly selective for anthelmintic resistance (AR).

To mitigate this selection pressure, the current SCOPS advice is to leave at least 1 in 10 of the fittest ewes untreated. However, as the incidence of AR increases across the UK there is a need to minimise the of number ewes treated. Evidence has shown that Faecal Egg Count (FEC) varies significantly between ewes around lambing, with some ewes producing low levels of contamination, while others are very high. The factors involved in this difference are thought to be: body condition (as measured by Body Condition Scores or, BCS); level of nutrition; age and litter size; and a genetic element linked to the strength of the ewe's immune response.

**It is important to remember that the treatment of ewes is almost always only intended to reduce the contamination going on to pasture, it is not to remove the worm burden of the ewe to improve her health.*

2. Aims

The aims of this project were to:

- Provide detailed information on the PPR (Peri-Parturient Rise) egg output to improve the accuracy of any treatments in terms of which ewes are selected for treatment.
- Optimise the timing of interventions (wormers and other actions such as nutrition) while minimising the number of ewes treated, hence targeting treatments on the individuals with the highest worm egg outputs.
- Monitor ewe immune response against FEC, which may contribute to vaccine development/ roll out
- Ensure nutrition was not a limiting or exacerbating factor by providing feeding recommendations and monitoring Body Condition Scores (BCS).

- Ensure that roundworm management was not having any adverse impacts on the performance of the flock, by measuring liveweight gains of lambs against pre-set KPI targets based on previous work by the group.
- Provide guidance to the wider industry on how they can reduce the number of ewe anthelmintic treatments at lambing without any negative impact on lamb performance.

3. Methodology

3.1 Participants

The project worked with five sheep farmers based in Mid and South West Wales. They came together in the first instance as a TAG group, focusing on ewe nutrition and have looked at the impact of ewe body condition (BCS) and weight on performance. Sustainable worm control is a prime objective on all farms, and they have been using FECs and adopting SCOPS principles for a number of years

All farmers recognised that internal parasites and increasing levels of resistance (AR) are a threat to flock performance and have been reducing their use of anthelmintics in recent years. By targeting treatments better, they wanted to ensure that performance was maintained / improved while slowing down the development of resistance to anthelmintics treatments in worm populations. For the wider industry, many of whom are blanket treating, this would also present a significant saving in costs.

3.2 Time scale

The project ran from December 2019 to June 2022.

3.3 Review of historical data

Historical records from the 2 years before the start of the project were reviewed. These included: anthelmintic treatments; body condition scores; and liveweight gains of lambs. These provided the baseline against which the benefits of the monitoring and management systems implemented were measured.

Individual protocols for sampling and recording (an example of which can be found in Appendix I) were designed to suit their system, optimise timings and ensure practicality.

Forage analysis was used as the basis of diet recommendations for each flock so that energy and protein requirements were met in the last 8 weeks of pregnancy, thus attempting to remove any nutritional deficiencies that would complicate the FEC and immunological response data. Levels of Albumen in blood serum were also measured in sentinel ewes to check protein adequacy in ewes, but it was only possible to do this in year two as COVID 19 restrictions prevented vets from visiting farms to take blood samples in year 1.

3.4 Assessment of the Peri-parturient Rise (PPR) of worm egg output.

Each farmer identified a group of about 100 twin bearing ewes in good body condition to be monitored. A mob FEC sample was taken from this group and sent to Techion UK for analysis on a weekly basis in the period between 6 weeks before and 8 weeks after lambing.

In addition to the mob samples, ten individuals – or 'sentinel ewes' - were identified within the mob, and FEC samples were taken from each individual animal on 5 occasions over the same period in years 1 and 2. The purpose of monitoring the sentinels was to give an indication of the variation of egg burdens between individuals and how representative the mob tests were of the entire flock. These sentinel ewes were also body condition scored when possible and their lambing date and lamb EIDs were recorded to allow monitoring post-lambing. After two years of monitoring, the data showed a close relationship between mob and sentinel samples. The sentinel monitoring was therefore discontinued in the final year of the project and replaced by more detailed speciation of faecal samples.

FECs were also carried on lambs to explore the impact of management of worms in ewes on the subsequent infection levels of lambs. Eight week and weaning weights of lambs were also recorded where possible.

3.5 Speciation of worm burdens

A knowledge of the species of roundworm is becoming a more important element of developing a sustainable approach to worm control. This is because the efficacy of different anthelmintic classes varies between worm species and the dominant species changes between the seasons. Speciation allows us to target the right product at the right time, reducing ineffective / unnecessary medicine use.

In Year 1, mob samples were sent to the APHA Laboratory in Carmarthen for PNA staining, which is used to detect the presence of *Haemonchus contortus* (Barbers Pole Worm) in faeces. It was important to establish whether this was present because this has a big impact on worm management strategies. Results showed that this worm species was absent in all flocks and therefore we could continue the project without concern for need to protect ewes from this particular species. PNA staining was discontinued in years 2 and 3 and the budget redirected to more detailed speciation undertaken by Biobest/Moredun from mob samples in the final year of the project using PCR technology (Aus Diagnostics™) see Section 4.6.

3.6 Assessment of immunological responses (Year 1 and 2)

The relationship between worm burdens and the immune response of ewes was explored using the following data, collected from the 10 sentinel ewes at 5 points during the monitoring period:

- *Levels of Immunogloblin A in saliva (Salivary IgA).* Samples were collected by farmers using dental swabs which were turned and twisted around the mouth and over the tongue collecting saliva for around 10 seconds. The swab was then placed in a centrifuge tube and sent off to the lab (Biobest) for analysis
- *Levels of Immunogloblin A in blood serum*. Blood samples were collected by vets and sent off the lab. This was only possible in Year 2 because COVID 19 restrictions preventing vets visiting farms to take the samples.

3.7 Performance indicators

Any potential impact of on health and productivity was assessed by measuring ewe BCS and lamb weights at the KPI points of 56 days and weaning.

3.8 Collation and analysis of data

On each farm, the data was used to:

- Provide a composite graph of the peri-parturient rise in the monitored mob(s).

- Present immunological and body condition data from sentinel ewes, overlayed on to the graphs of FEC data
- Indicate the optimal time to apply anthelmintic treatments, and compare this to the timing of applications in current practice and/or historical data
- Monitor Body Condition Scores (BCS) of the study ewes and how change in BCS affected the worm egg output, to try to support the hypothesis that BCS and change in BCS could be used as an on-farm indicator of both timing of treatment and selection of individual ewes.
- Ensure lamb performance was meeting targets and in years 2 and 3 collect lamb FECs as a measure of worm burdens on pasture.

4. Results

4.1 Monitoring the PPR through FEC

The data shows there was significant variation in the extent, timing, and duration of the PPR between the farms in the twin bearing mobs that were monitored. Figures 1 – 5 show representative graphs for each of the farms based on Year 1 (2020) data. Lambing (mean date for the mob) is denoted by

The extent, timing and duration of the PPR varies across the five farms around the mean lambing date. FEC on Farm A peaked pre-lambing while, in contrast, the others peaked after lambing. This has implications for the most appropriate time to treat those ewes that have been selected for treatment.

The FECs of the sentinel ewes were collected on the 5 occasions, at the same time as they were handled for saliva sampling / BCS. Overall, these followed the same pattern as the mob FEC, showing good consistency between individual and mob and supports the use of mob FECs as a monitoring tool. An example is shown below for Farm D (Figure 6).

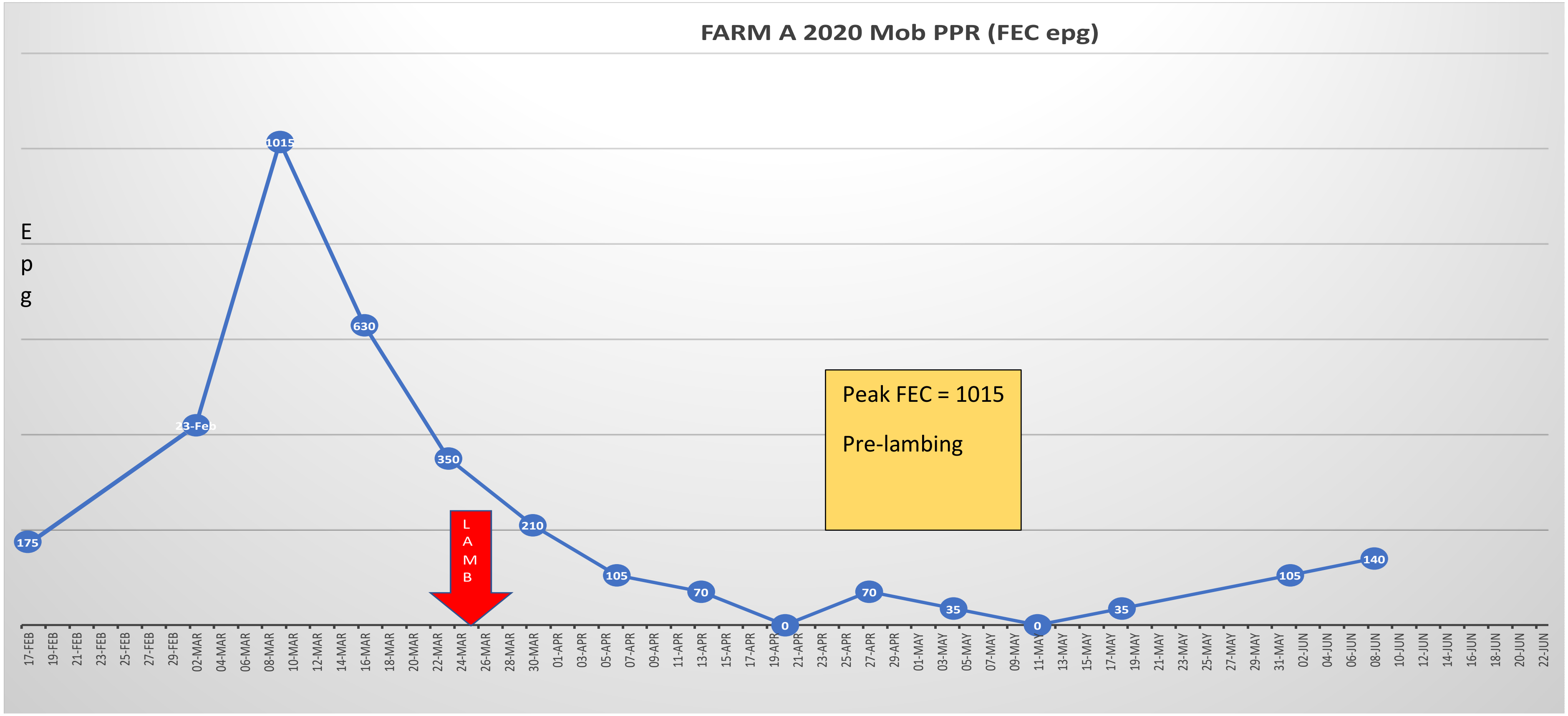


Figure 1: FEC over time relative to lambing (Farm A 2020)

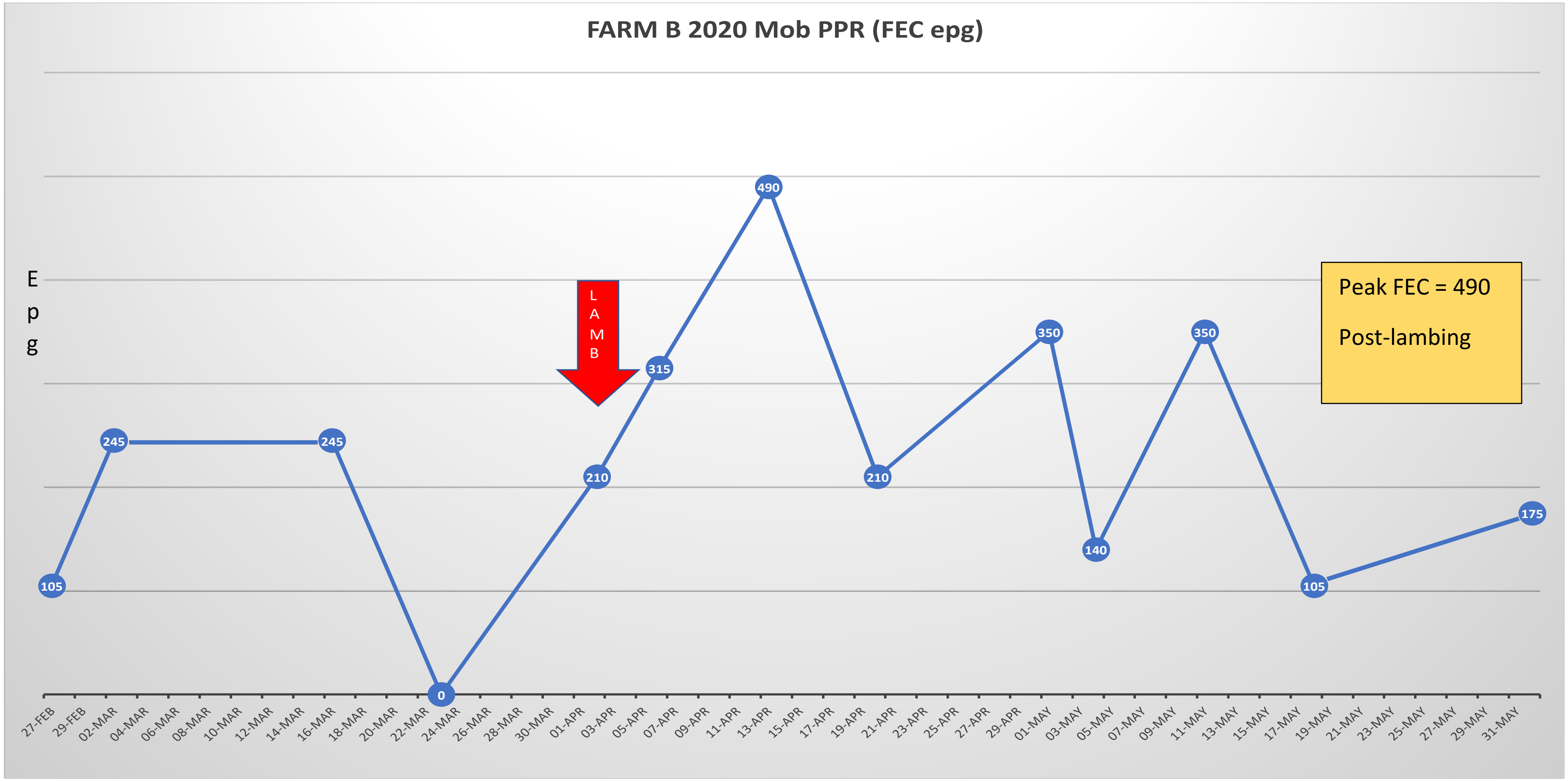


Figure 2: FEC over time relative to lambing (Farm B 2020)

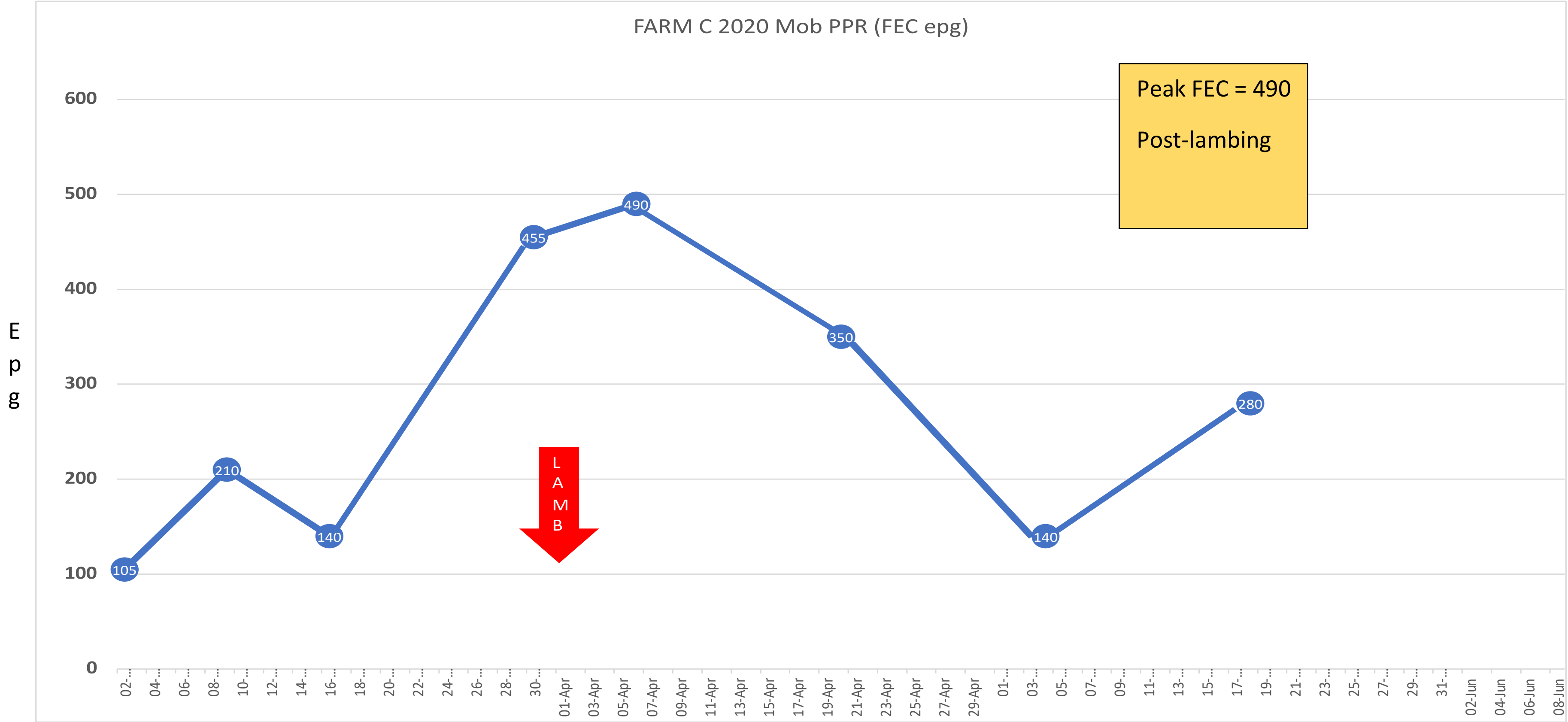


Figure 3: FEC over time relative to lambing (Farm C 2020)

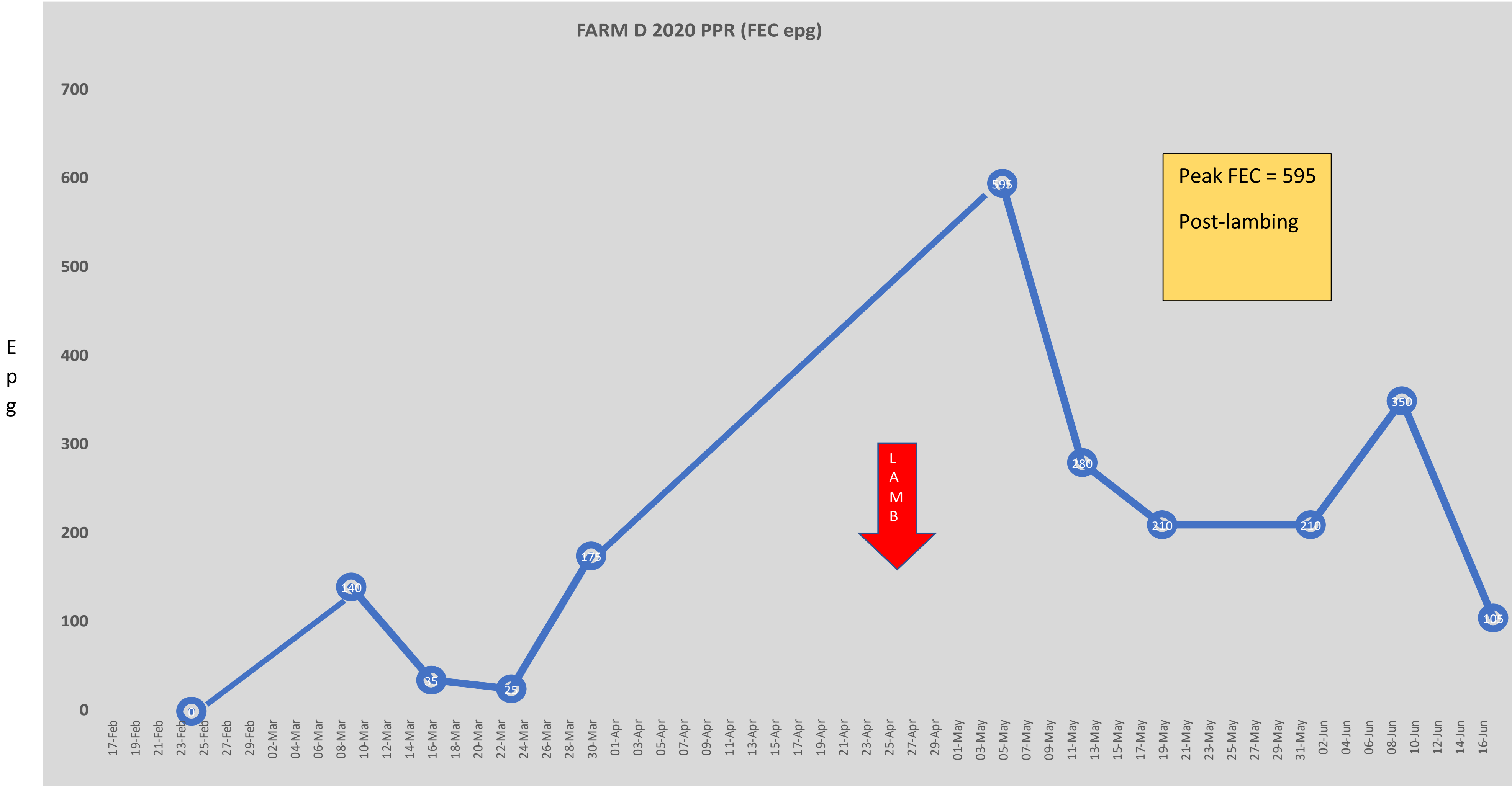


Figure 4: FEC over time relative to lambing (Farm D 2020)

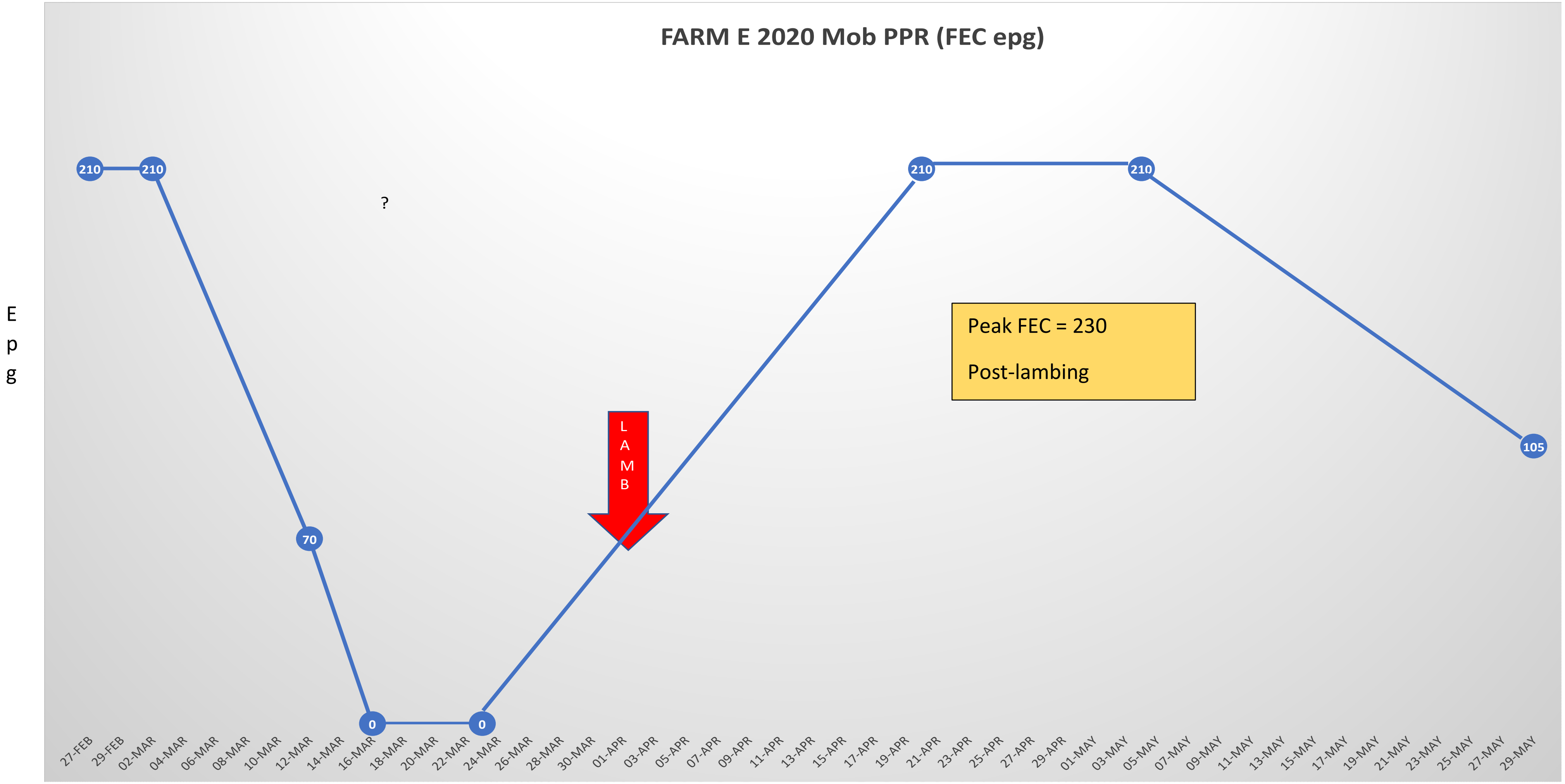


Figure 5: FEC over time relative to lambing (Farm E 2020)

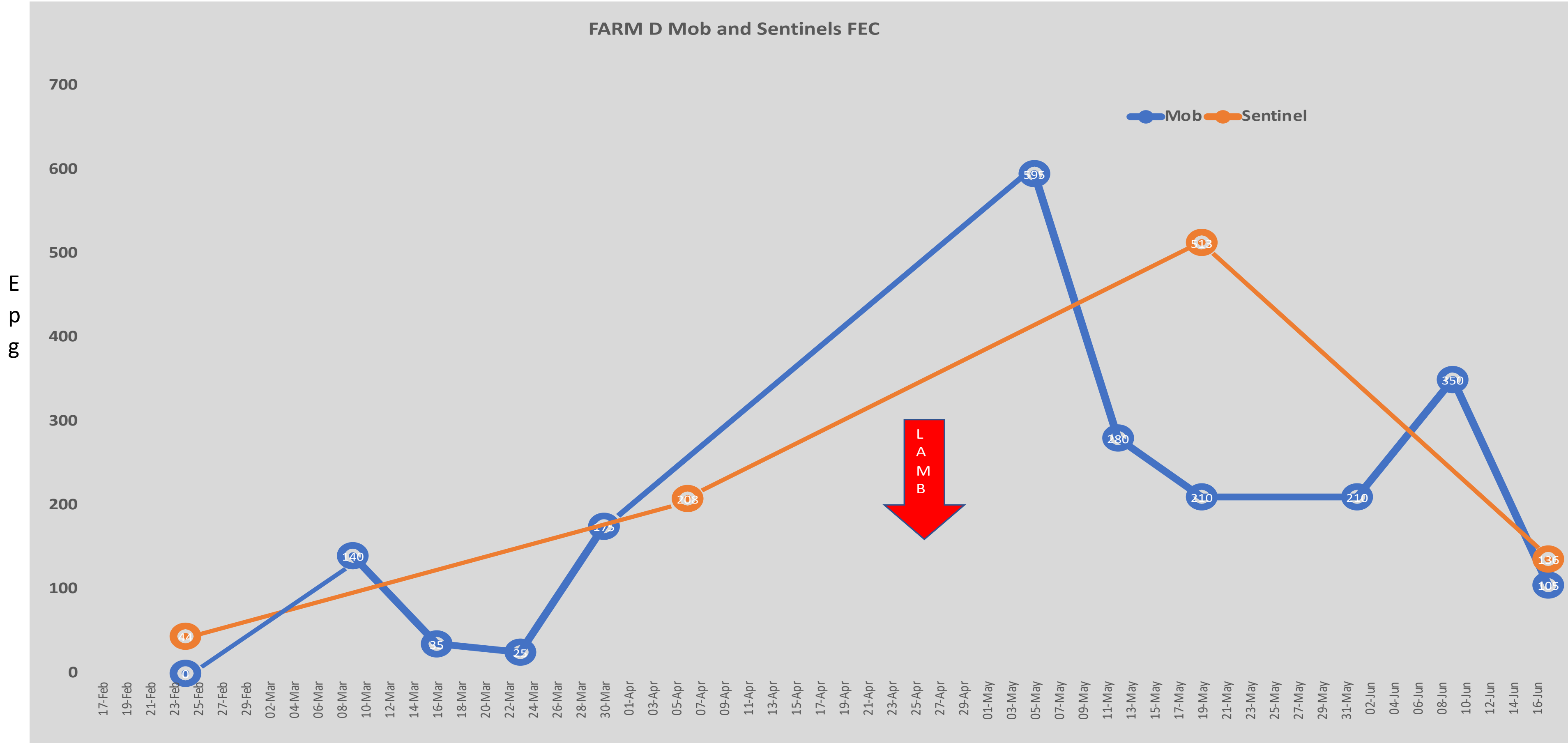


Figure 6: FEC over time relative to lambing for sentinel compared to mob samples (Farm D 2020)

4.2 PPR comparisons between years

The differences between the farms were also relatively consistent in each of the three years as shown in Figures 7-13 for three of the farms where we have enough data below.

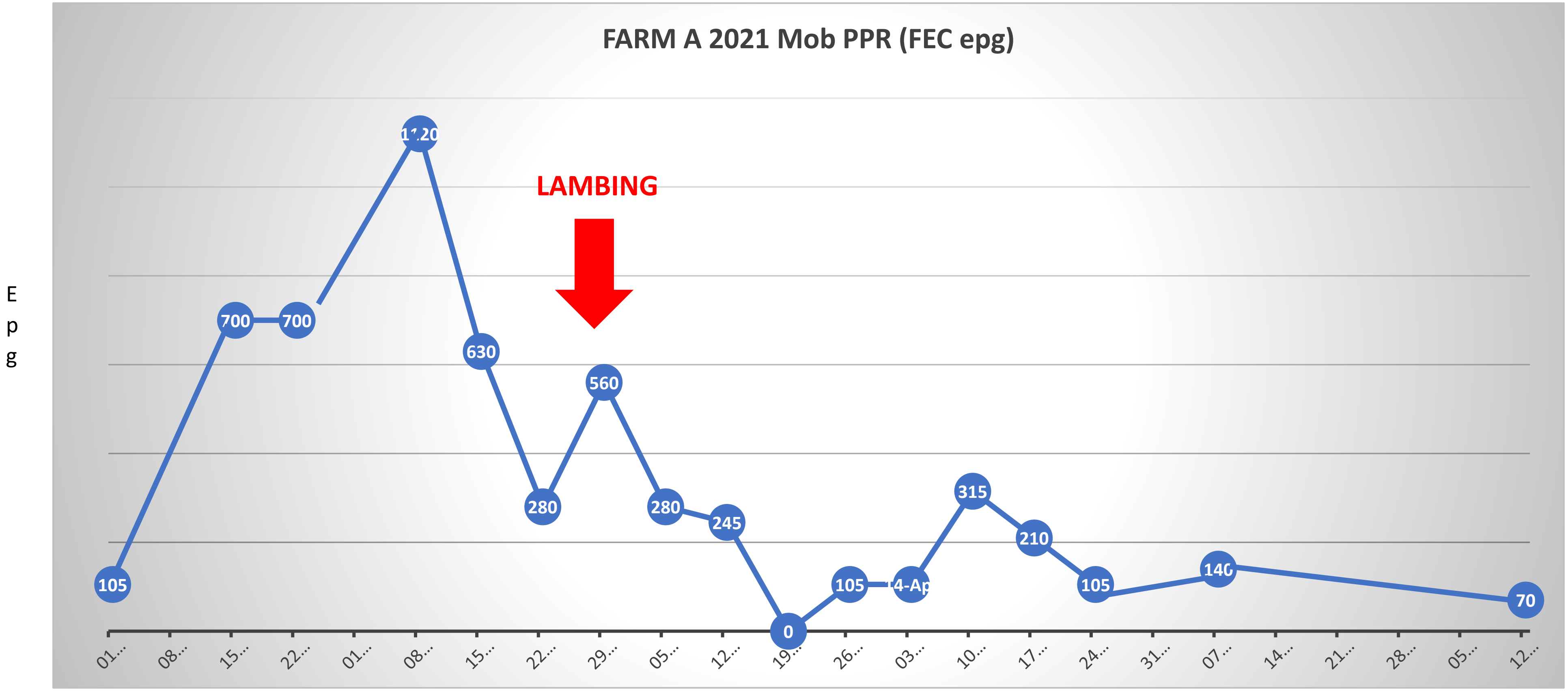
For **Farm A**, the pattern is very similar for the first two years (Figures 7 & 8), with the peak egg output pre-lambing at 1000 - 1100 eggs per gram (epg). In year 1 ewes below the ideal BCS at lambing were drenched (approximately 50% of the mob). In year 2 no ewes were drenched because they did not lose condition significantly. These data suggest that the net effect was the same and that targeted treatment - on the basis of lost BCS - reduced epg across the mob to the same level as no treatment when BCS was not under pressure. In Year 3 (2022, Figure 9,) the pattern is a little different with no significant peak pre-lambing and a lower peak just around the time of lambing. Further analysis is to be done, in Year 3 the protocol was different because ewes losing BCS in the run up to lambing were treated with moxidectin 2% injection (37 of the 100 ewes) to try to target the persistent activity to reduce contamination for lambs on pasture, while making sure it was applied to a minimum number of ewes. See Section 4.7 below for more details.

For **Farm B**, the PPR occurred after lambing in the first two years (Figures 10 and 11), with a longer delay in Year 2 which was associated with ewes losing condition when grazing was in limited supply due to the weather conditions (weather data is available for this farm). In Year 3 (Figure 12) the pattern is a little different with a single spike pre-lambing, though other results pre-lambing are similar and a significant level of FEC epgs in early lactation although without the clear spike of the previous two years.

For **Farm D**, the timing of the PPR changed between Years 1 and 2 (Figures 13 and 14) below. The management factor that changed between the two years was lambing date which was a month later in Year 2.

These data suggest that the PPR was more closely associated with the dates rather than being associated with lambing date and in turn this supports the hypothesis from Farm B that the PPR is more closely aligned with nutritional pressure on the ewes (grazing availability and the demands of lactation).

FARM A (Year 1)


FARM A 2021 Mob PPR (FEC epg)
LAMBING
E
p
g
105
700
700
1120
630
280
560
280
245
0
105
14-Ap
315
210
105
140
70
01…
08…
15…
22…
01…
08…
15…
22…
29…
05…
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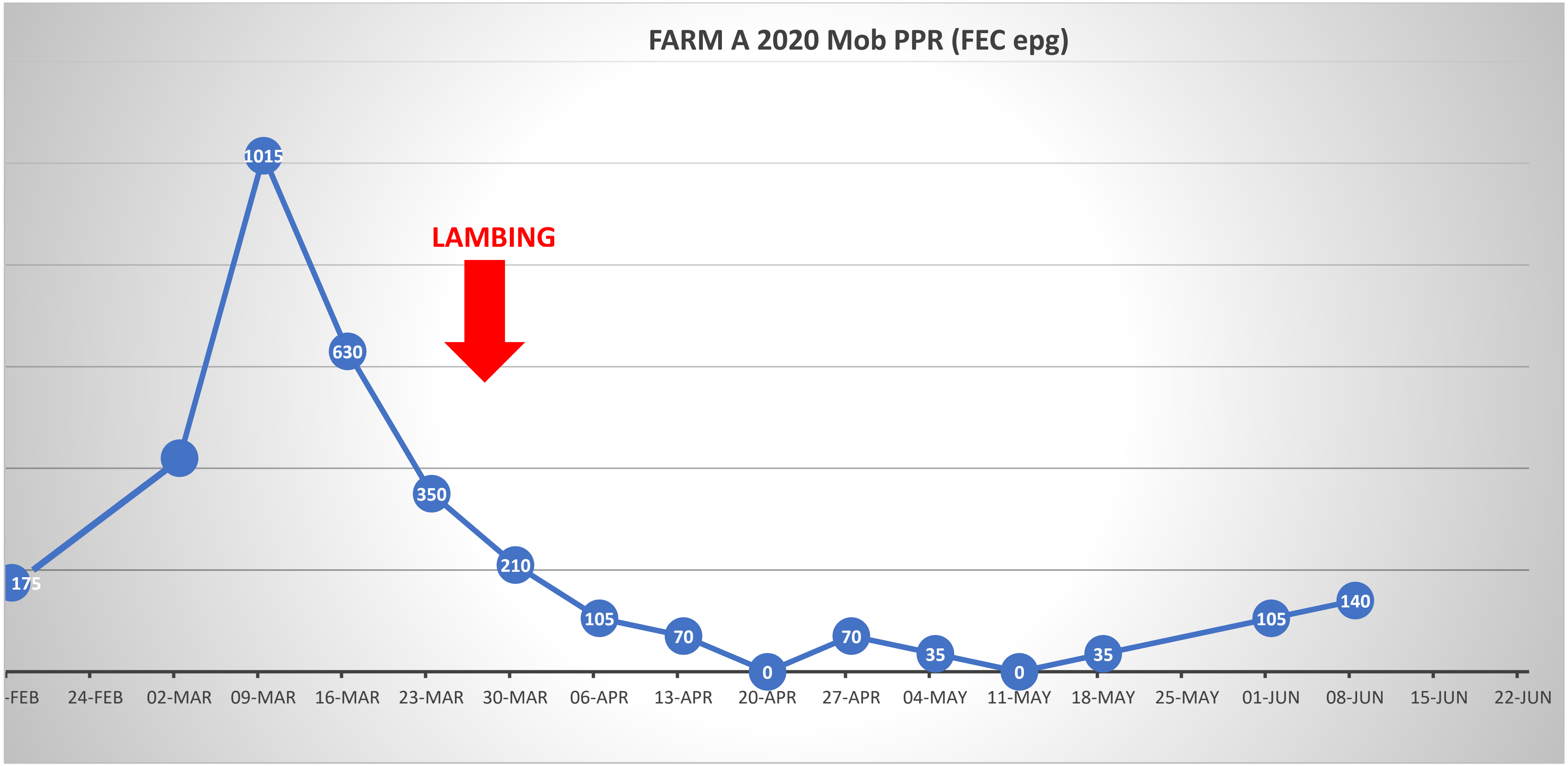


Figure 7: FEC (Mob samples) over time relative to lambing - (Farm A 2020)

FARM A (Year 2)

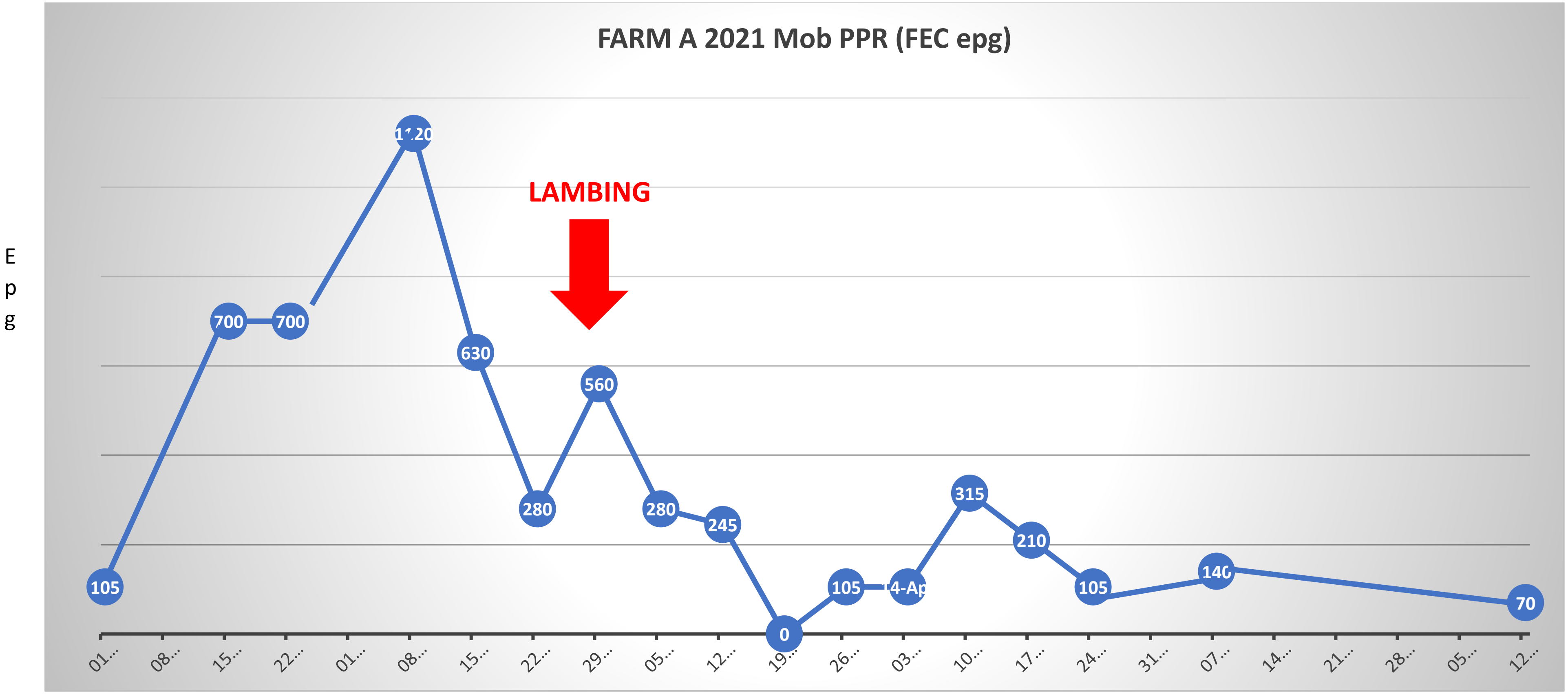


Figure 8: FEC (Mob samples) over time relative to lambing - (Farm A 2021)

FARM A (Year 3)

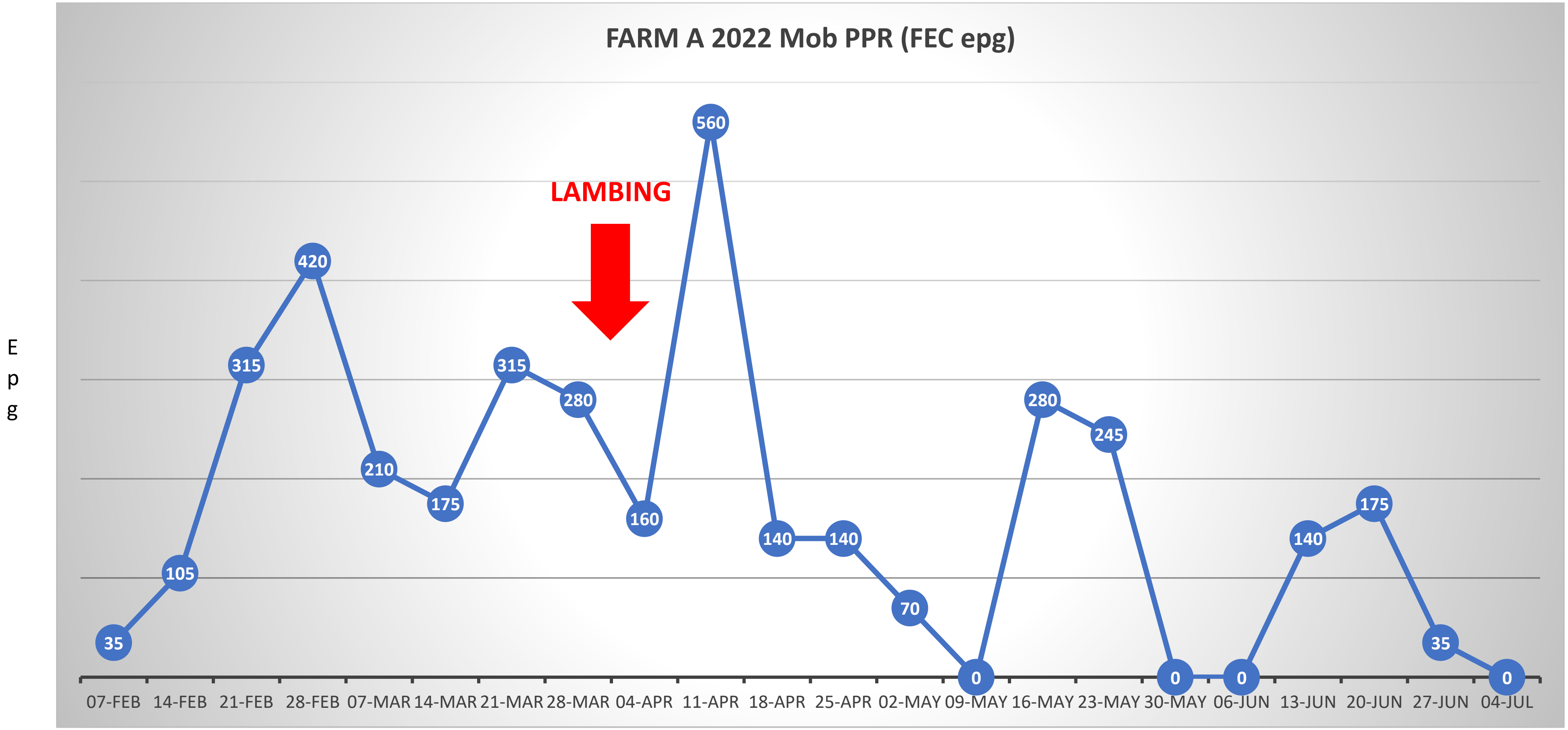


Figure 8: FEC (Mob samples) over time relative to lambing - (Farm A 2021)

FARM B (Year 1)

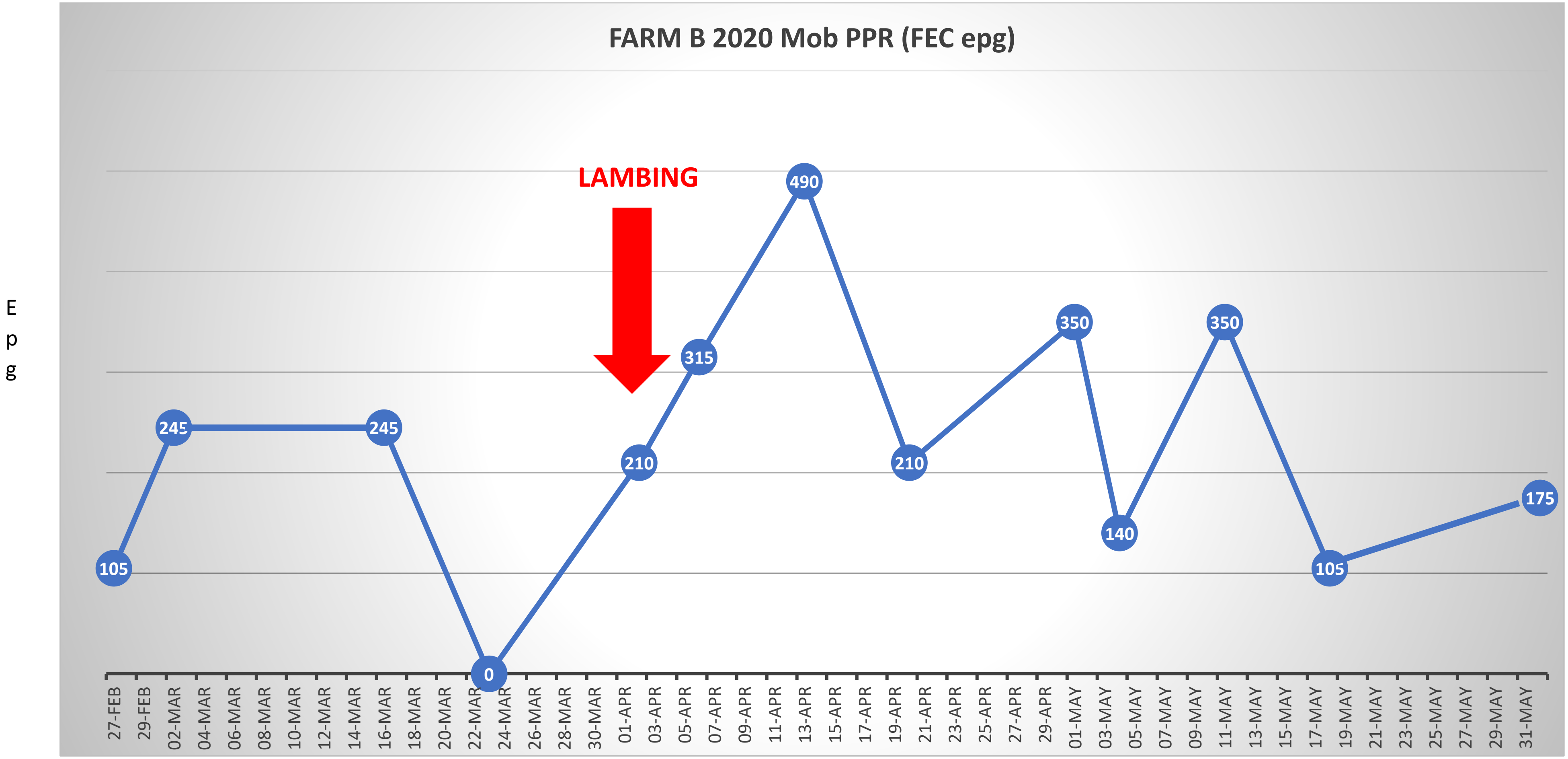


Figure 10: FEC (Mob samples) over time relative to lambing – (Farm B 2020)

FARM B (Year 2)

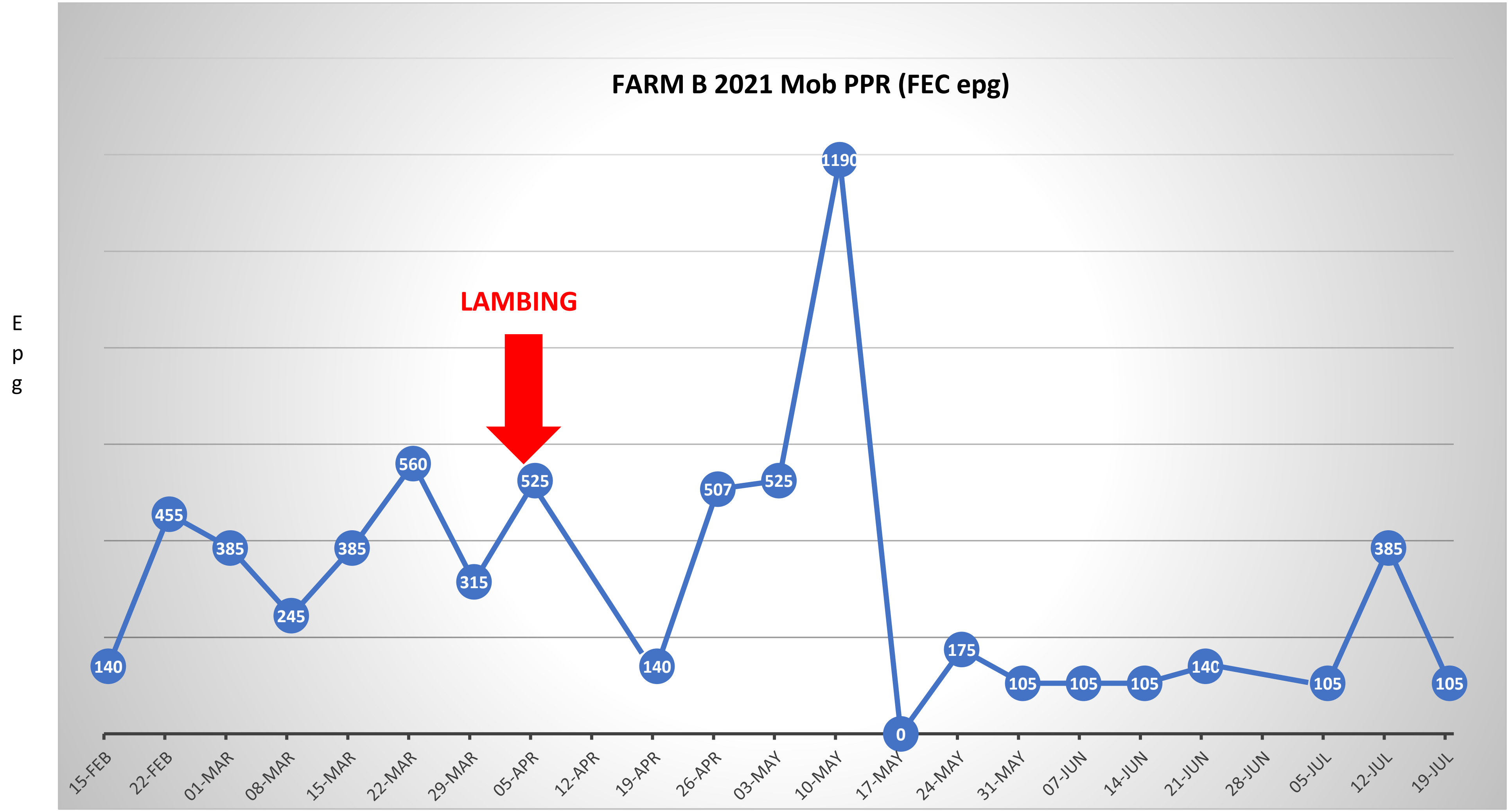


Figure 11: FEC (Mob samples) over time relative to lambing – (Farm B 2021)

FARM B (Year 3)

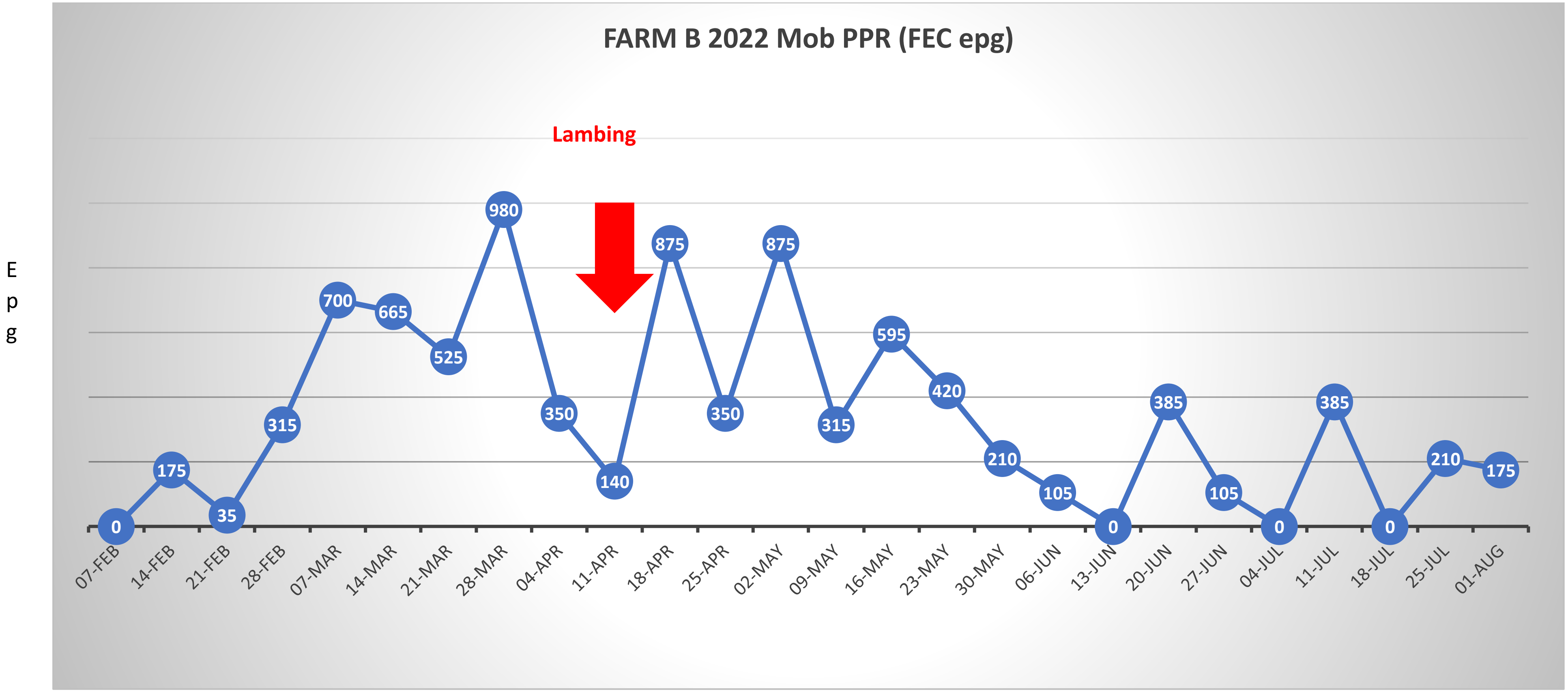


Figure 12: FEC (Mob samples) over time relative to lambing - (Farm B 2022)

FARM D (Year 1)

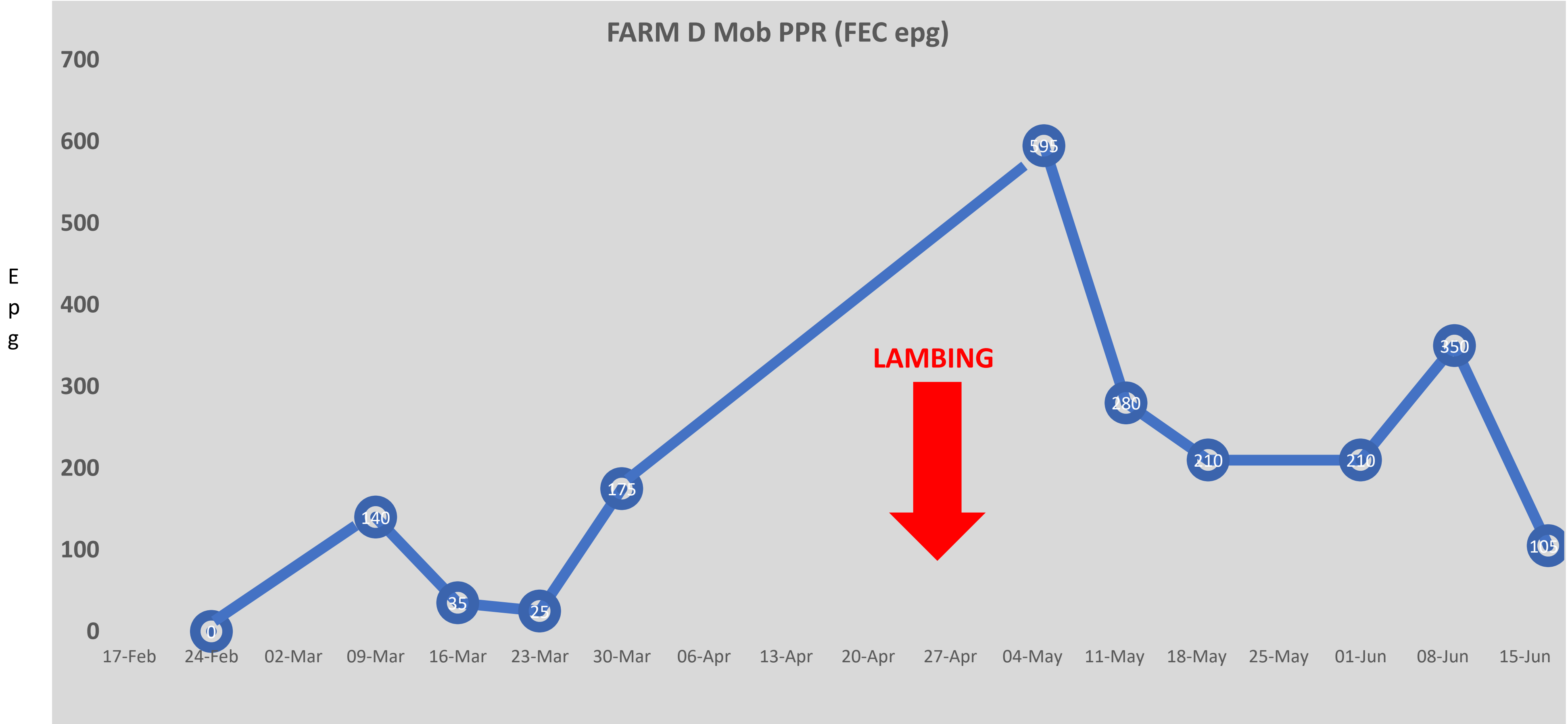


Figure 13: FEC (Mob samples) over time relative to lambing - (Farm D 2020)

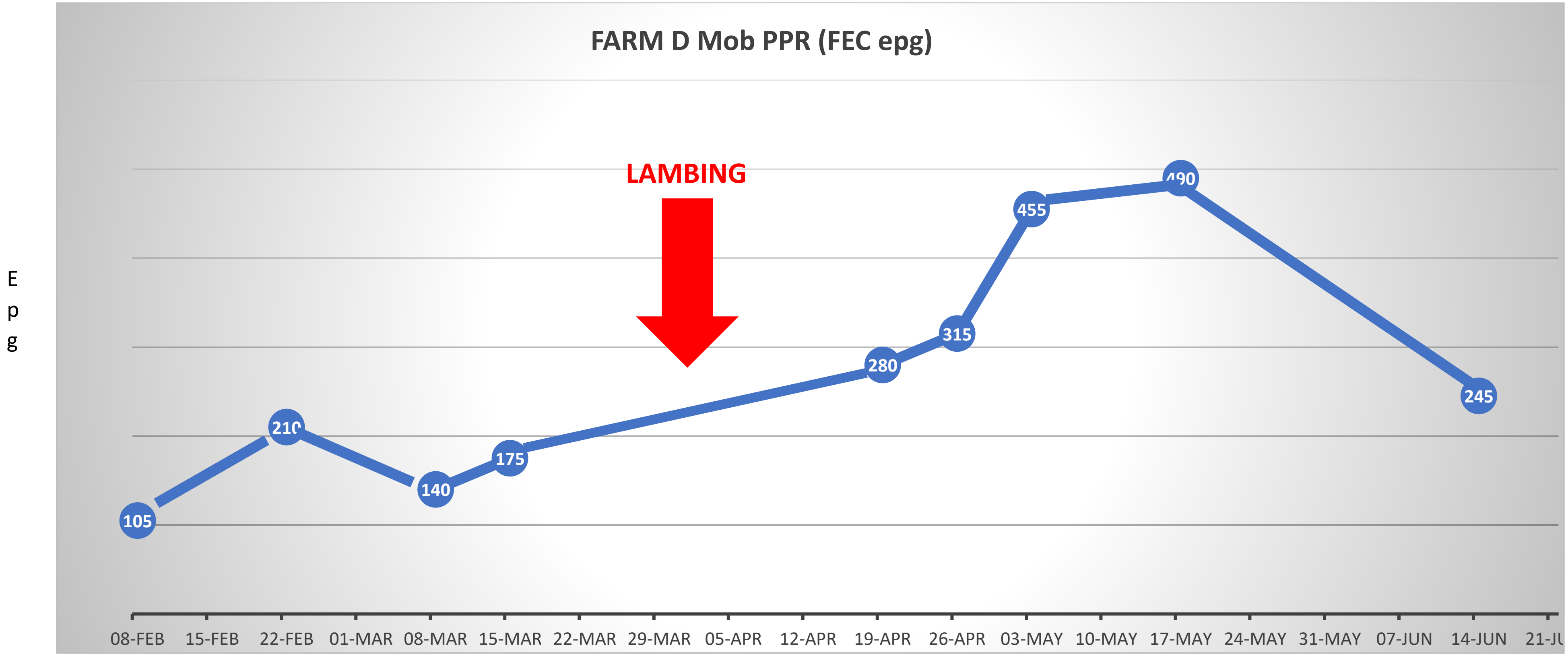


Figure 14: FEC (Mob samples) over time relative to lambing - (Farm D 2021)

4.3 Analysis of the Peri-parturient Rise

For farms A and B for which we have a full data set for two years, Jan van Dyke from Zoetis was able to perform some analysis on the PPR both in terms of timing and duration. In the first instance the mean epg was calculated to the upper and lower 95% confidence limits (Table 1). This effectively allowed Jan to remove the background 'noise' and look at when the rise started and ended over and above this level.

	FARM B		FARM A	
Year	**2020**	**2021**	**2020**	**2021**
Mean epg	161	382	66	180
Lower 95% CI	68	265	29	96
Upper 95% CL	253	498	102	263

Table 1: Mean epg on farms A and B (Years 1 and 2)

The next step was to calculate the start and end dates of the rise in epg above the baseline levels shown above. Table 2 below clearly shows how different these tow flocks were and the relative consistency between the two years for the individual farms.

	FARM B		***FARM A***	
Year	**2020**	**2021**	**2020**	**2021**
Lambing (L)	2nd April	3rd April	23rd March	29th March
Start PPR (SPPR)	5th April	25th April	15th February	8th February
Difference (SPPR–L)	*+ 3 days*	*+ 22 days*	*- 37 days*	*- 50 days*
Duration of PPR	*16 days*	*21 days*	*52 days*	*63 days*

Table2: Lambing dates and the time and duration of the PPR on farms A and B (Years 1 and 2)

Jan was also able to look at time relative to lambing as an indicator of the ewe epg as shown in Figure 14 below. As we might expect from the farm results, this is not a strong relationship because of the variation between the farms, though there is a more normal distribution of the data points which also illustrating that while each farm had some degree of PPR around the wider peri-parturient period, there was variation on when this took place.

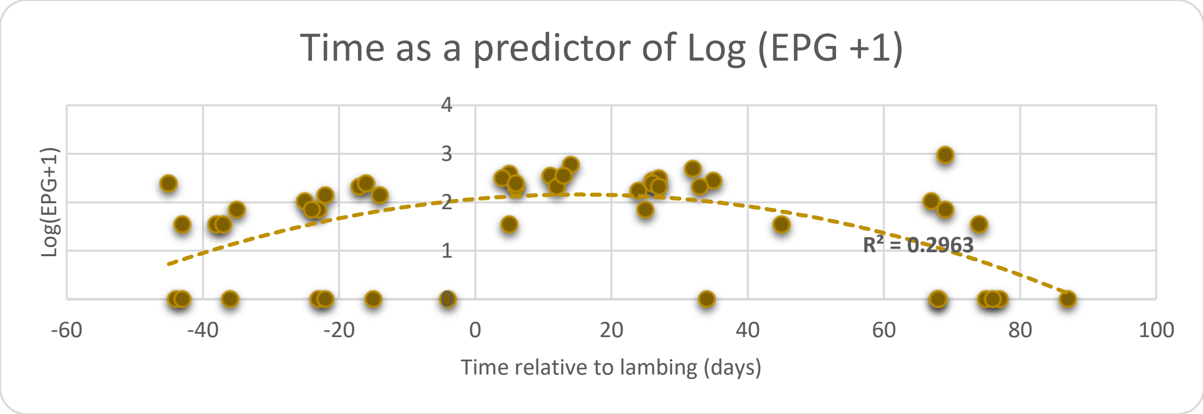


Figure 15: Influence of time relative to lambing on epg

4.4 Relationship between FEC, the immune response and BCS

As highlighted previously, COVID 19 restrictions severely limited the collection of blood samples. The immunological data therefore relied heavily on salivary IgA sample, which the farmers were able to collect themselves.

The relationship between FEC, levels of salivary and IgA varied considerably between different farms, years and ewes. In some instances there did appear to be a relationship and Figure 16 is illustrative of this (Farm B), where there appeared to be a relationship between these three factors in the data for one of the sentinel ewes. As BCS falls (red circles) towards and after lambing the FEC starts to rise (blue bars - though not to a high level) and at the same time the IgA level in saliva (orange bars) falls indicating that the immune system may be under pressure.

In the second example (Figure 17), we can see again that as BCS falls the FEC rises, but there is no change in the saliva IgA. Note also that the fall in BCS and rise in epg is 35 days post lambing which was the pattern overall for farm B.

The third example below from Farm A, is a ewe that was drenched in Year 1 because she lost body condition in the run up to lambing. Her FEC count was very high and drenching reduced this with a count of <200 epg, 22 days after lambing.

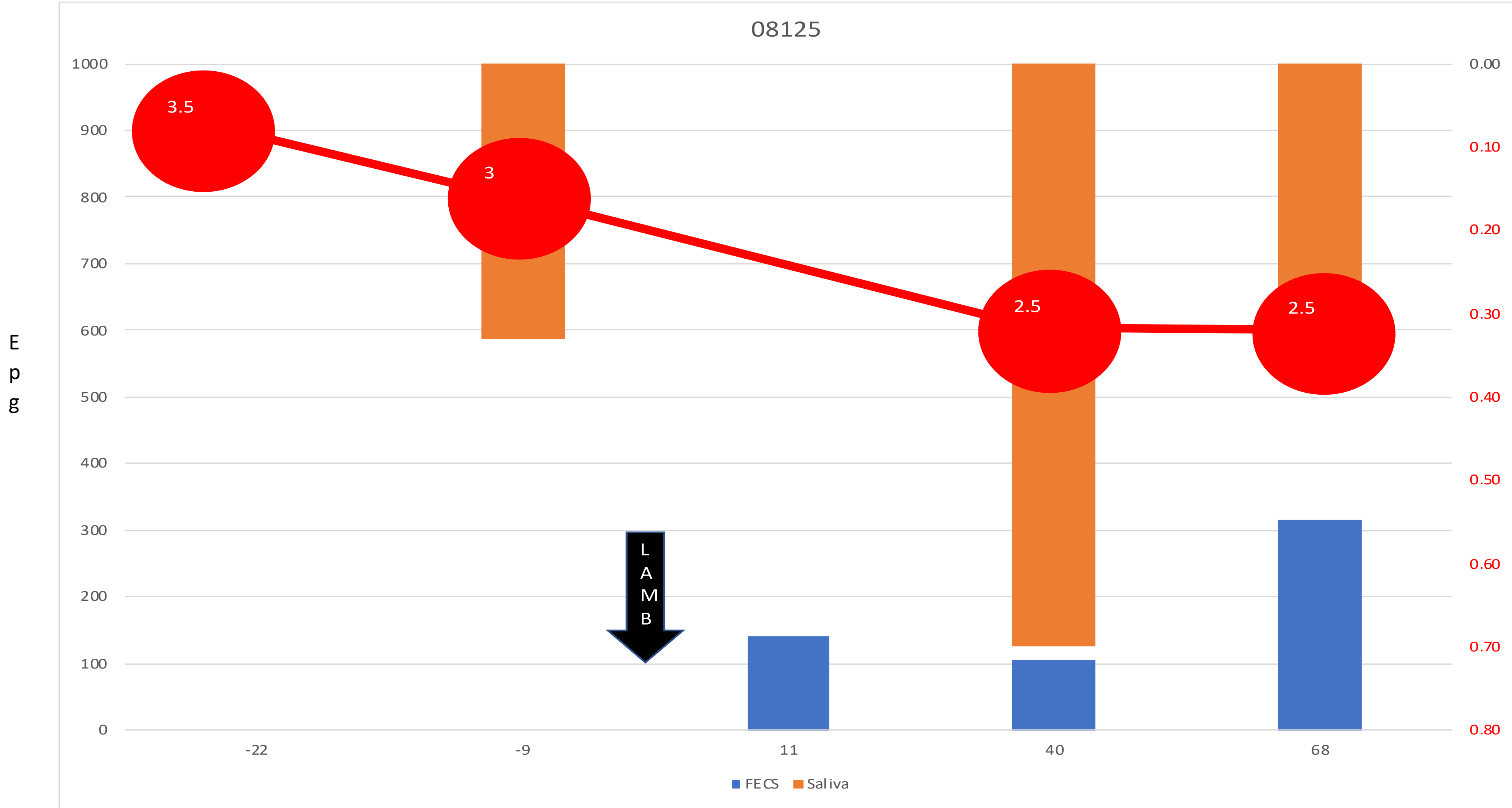


Figure 16: Interaction between FEC, Salivary IgA and BCS (Farm B)

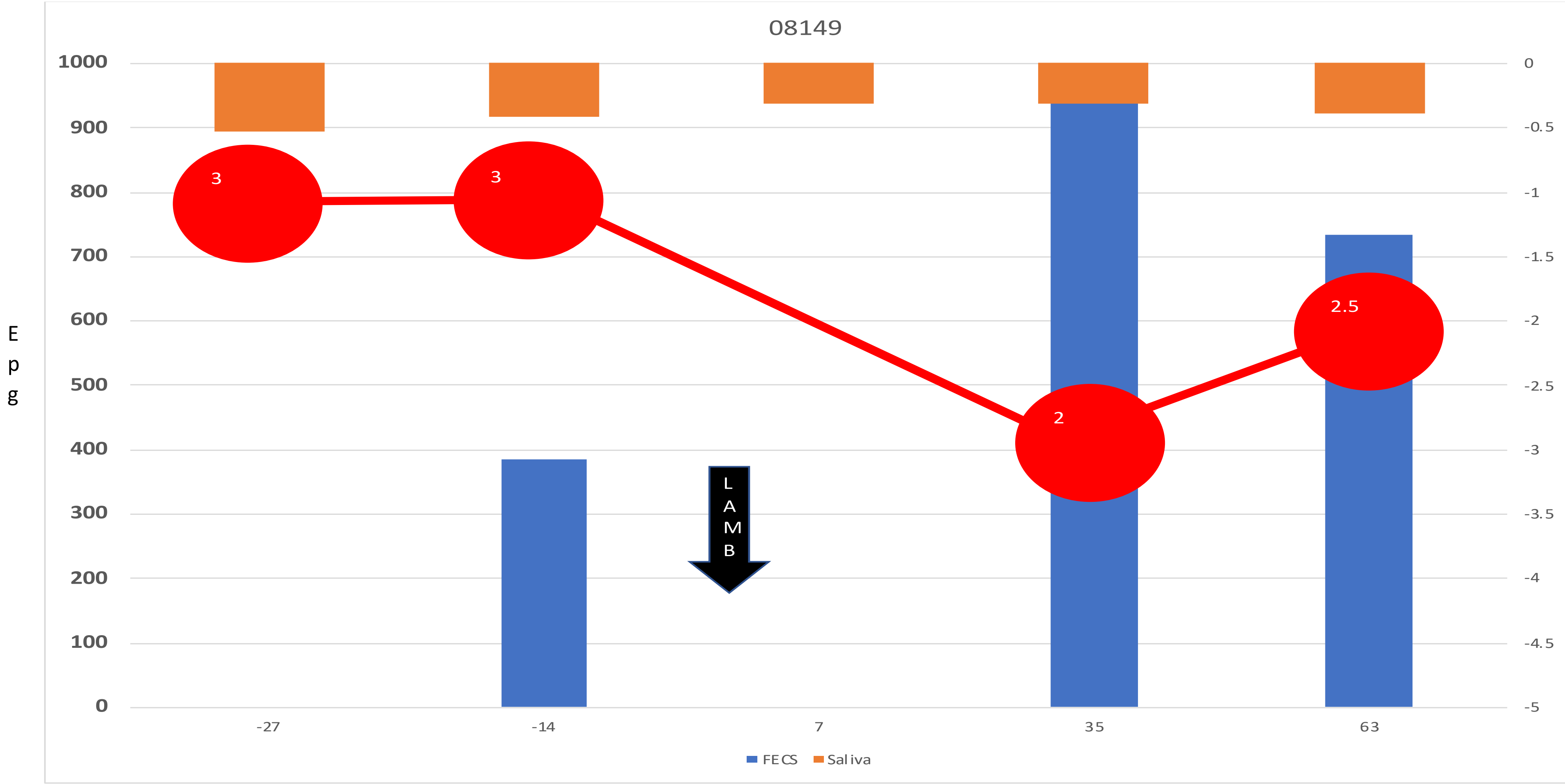


Figure 17: Interaction between FEC, Salivary IgA and BCS

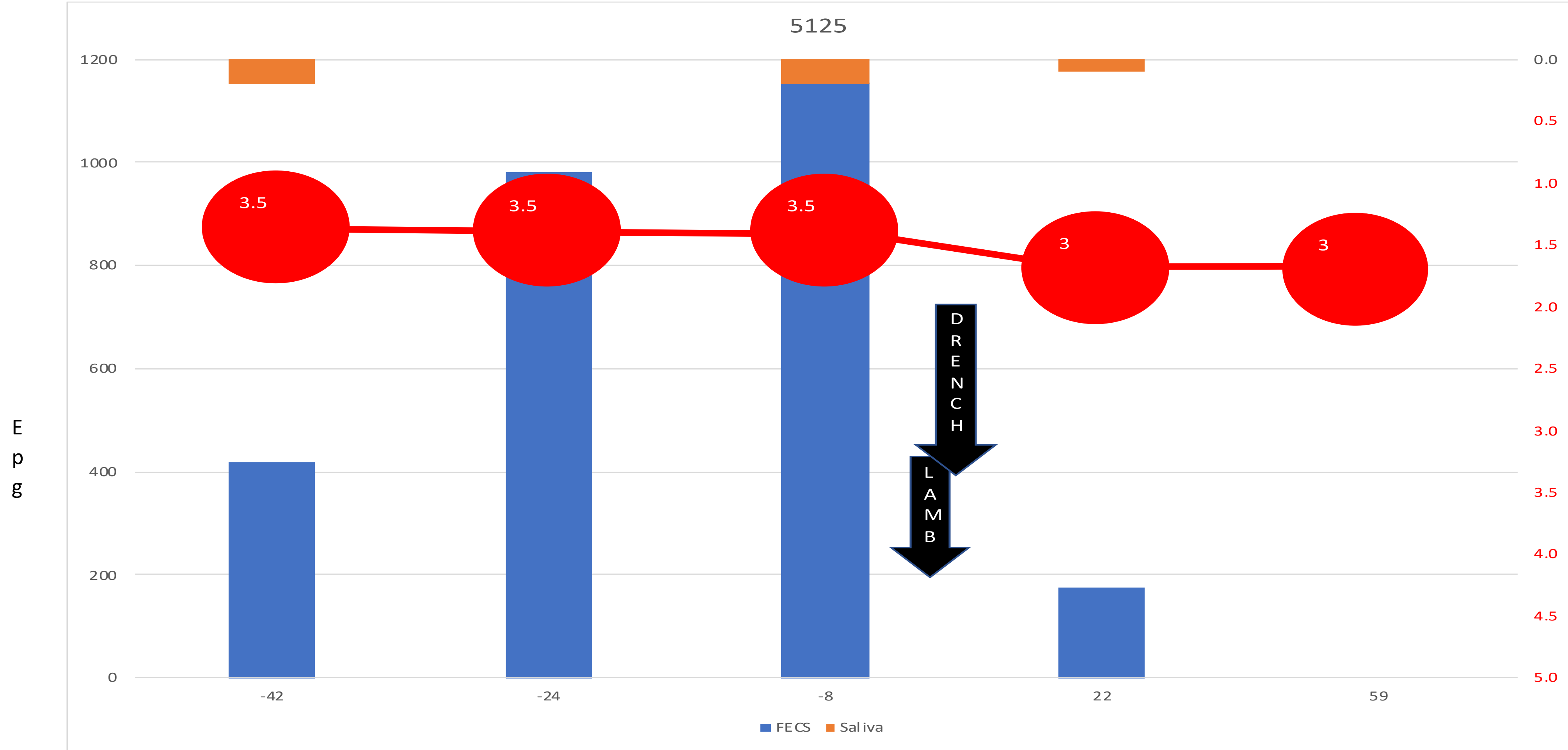


Figure 18: Interaction between FEC, Salivary IgA and BCS

The project generated a large number of these graphs for individual ewes and the overall conclusion is that there is no reliable relationship between saliva IgA and FEC epg in the ewes that could be exploited to help to improve the timing / targeting of anthelmintic treatments. Figure 19 below was kindly provided by Jan Van Dyke of Zoetis using the sentinel data and illustrates the overall random nature of this IgA levels as plotted against time.

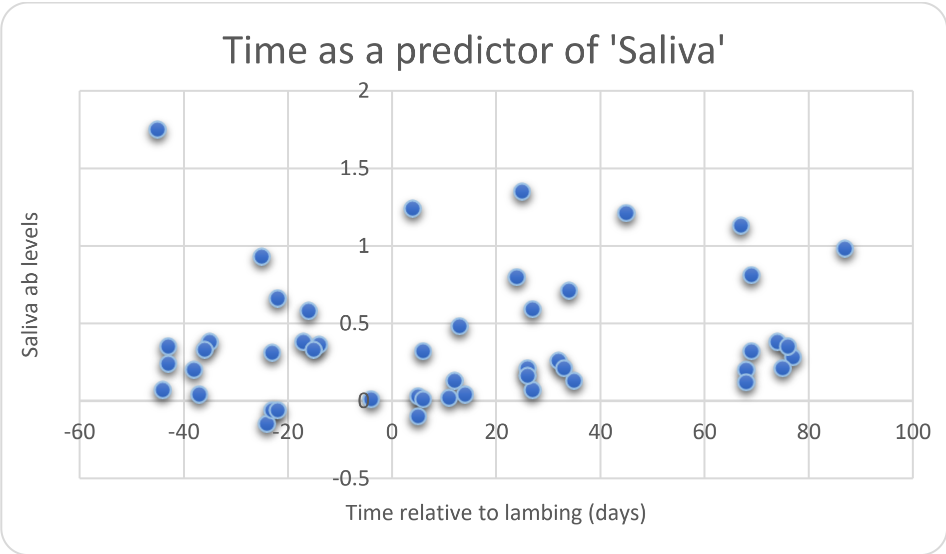


Figure 19: Salivary IgA over time relative to lambing

We could only carry out a small number of serum IgA samples because of Covid restrictions. Figure 18 below (Jan van Dyke) is taken for the data on Farm A and this does suggest a relationship between serum IgA and time of lambing.

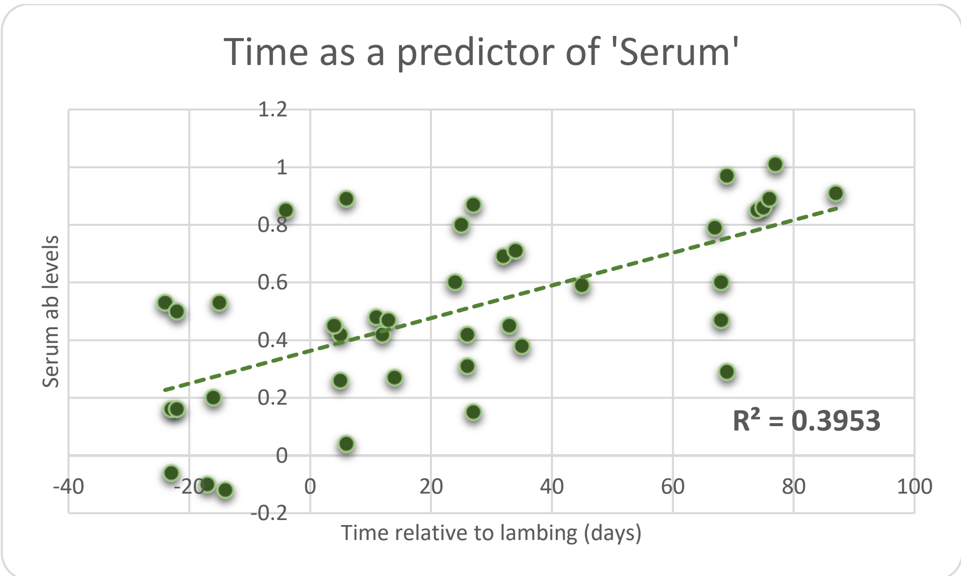


Figure18: Blood serum IgA over time relative to lambing

In Year 2, blood serum albumins were taken from sentinel ewes to check that there was no evidence of any protein deficiency that could add a stress factor to the immune system. In all cases the levels were found to be within or above the normal range for albumin in pregnant ewes. We concluded that the diets were indeed supplying demand and re-focussed the investigation (and findings) towards the speciation work carried out in Year 3.

4.5 Relationship of FEC epg and BCS in ewes.

This project did not have enough data points to be able to analyse this relationship in detail. Jan van Dyke did have a look at the data from two farms and found no significant pattern in terms of FEC and epg with the limited data available. However, in our project all ewes started with good BCS and this analysis looked at BCS *per se* - rather than the *change* in BCS, and it is the former that is the key indicator on whether ewes beginning the last trimester of pregnancy are in good condition.

There was, however, a relationship between the BCS and the time relative to lambing (Figure 19), suggesting that BCS reflects how the ewes are coping after lambing, rather than how they are coping with worms.

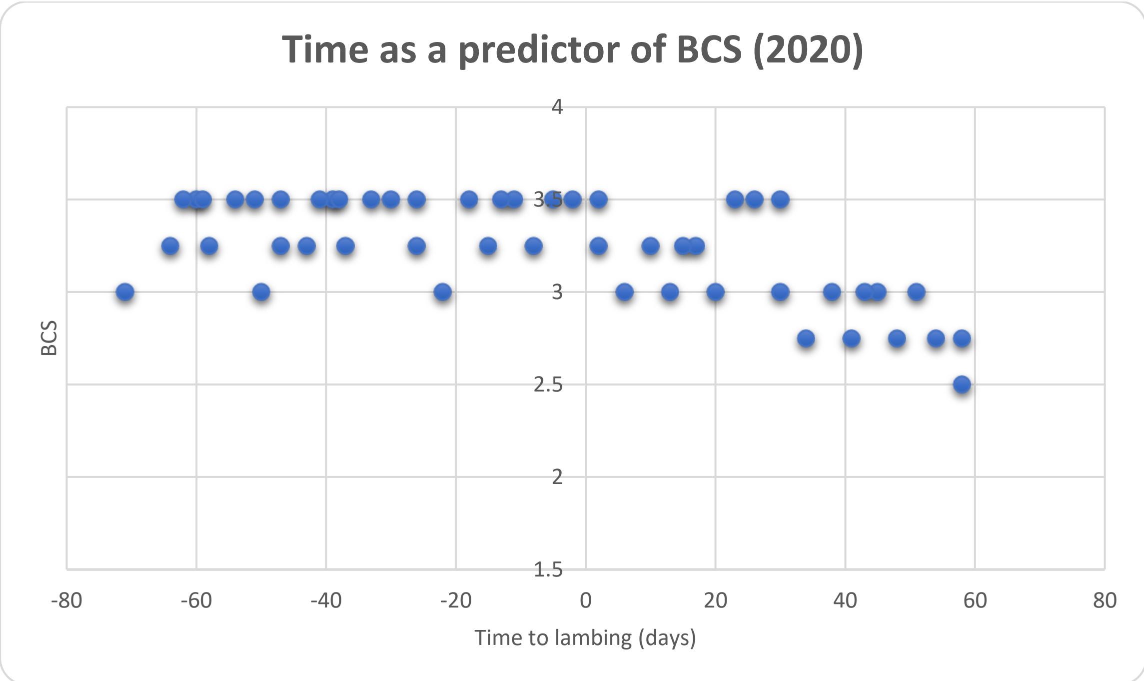


Figure 19: Relationship between BCS and EPG (2020)

In summary:

- FEC remains the best measurement for mapping the timing and magnitude of the PPR in ewes. IgA levels were not good indicators in this project.
- Each farm needs to understand what the PPR looks like in terms of magnitude and timing before they can target the right / most effective timing of any treatments.
- BCS was sensitive enough to capture fairly subtle changes in body condition in ewe around lambing when they all started at the same level of BCS 6-8 weeks from lambing.
- Our results suggest that selecting the ewes most likely to be responsible for a high proportion of the pasture contamination (those with a high egg output) relies on being able to find those that lose BCS at the time when the flock is under nutritional pressure.

- Simply using litter size and a set time (e.g. at lambing) as a guide as to which ewes to treat and when is not accurate enough, farmers should be advised to monitor FEC levels in ewes in the run up to, and after lambing in addition to following BCS changes in order for them to decide when is the right time to treat.

4.6 Relevance of Immunological studies for vaccine roll out

The results of the IgA work clearly demonstrate the wide variation between individual ewes and the epg levels recorded. We have also shown that the PPR varies in terms of its timing and duration between flocks, but that there is a similar pattern within flocks from year to year if the management stays the same.

The implications for the vaccine roll-out are therefore, that in order for farmers to get the most benefit from a vaccine they may need to understand the general pattern of the PPR for their own flock if they are to time the vaccinations for maximum efficacy.

Given the relationship between FEC and loss of BCS that we have seen, there is also the need to ensure that the vaccine is not seen as a substitute for good nutrition and management.

4.7 Speciation and drench efficacy testing

Two of the farms in the group were able to join in with another project being run by Queen University Belfast (QUB) in conjunction with Moredun which allowed us to look at the species of worms surviving treatments in lambs. One farm completed three pre and post drench tests in 2020/21 and the other farm completed two pre and post drench tests in 2020. An example of the outputs is shown below for one of the samples using a 2-LV (yellow) wormer on Farm A:

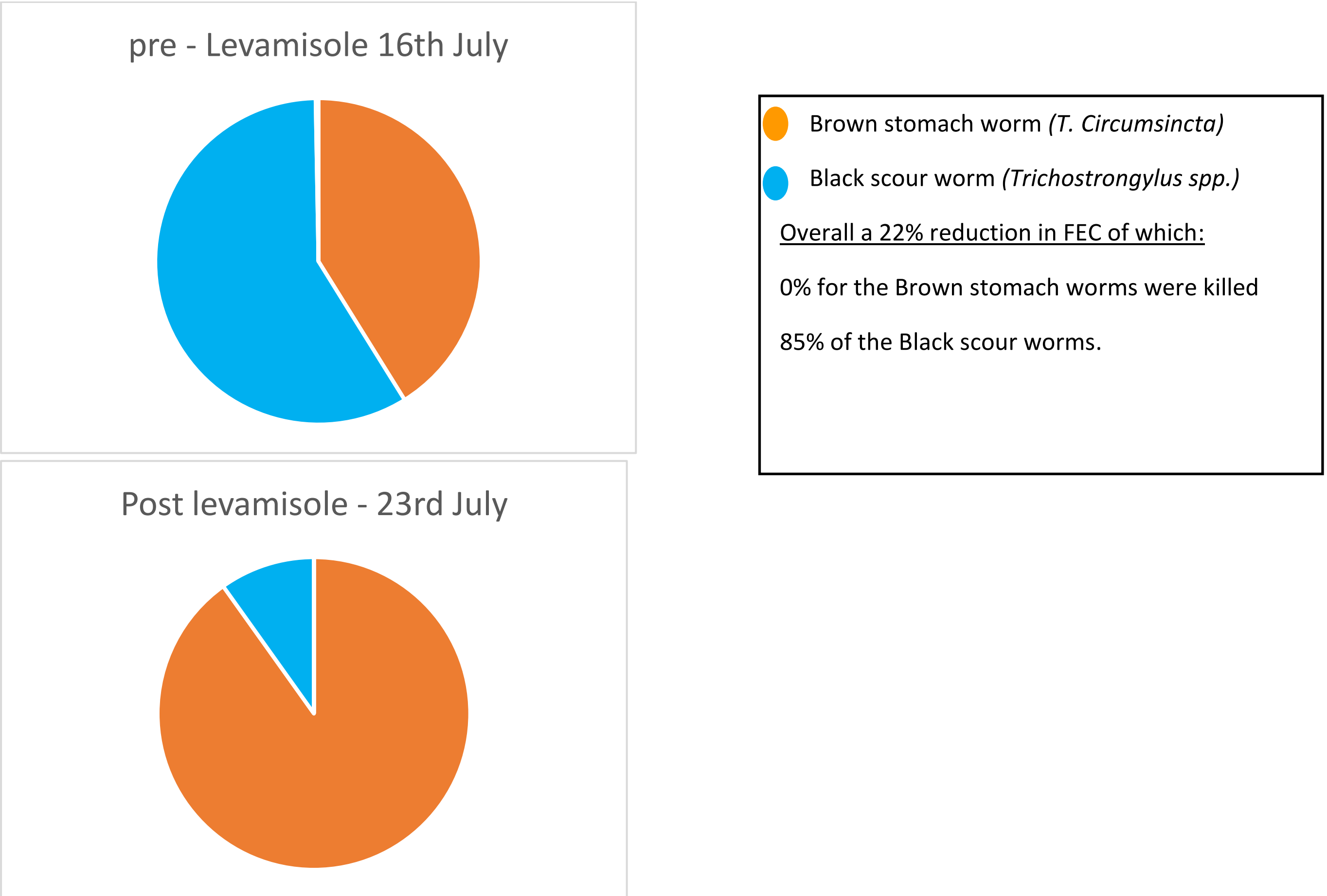
This highlights the issues seen generally in the other testing and speciation work (see below). Firstly, the predominant species is *T.* Circumsincta (brown stomach worm) and this is also the species that is surviving anthelmintic treatments (i.e. is exhibiting resistance).

In Year 3 the group decided to expand this to look at the worm species in the ewes. Mob samples were sent to Biobest for processing before being sent to Moredun for speciation using the Aus Diagnostics system. The full results for 24 samples from four farms for speciation work completed between April and June 2022 can be found in Appendix 2 which clearly demonstrate the predominance of *T. Circumsincta* with *Trichostringylus spp* (black scour) the next most prevalent. There was the occasional sign of *Haemonchus contortus,* in particular on Farm B which means it needs be to kept carefully under control. The species mix did change on the individual farms even over this relatively short period of time.

Knowledge of the resistance status on a farm combined with the species mix at different times of year therefore ensures the product chosen when treatment is required will be effective. However, given the issues with *T. Circumsincta* highlighted here it does add weight for the need to only use other effective products when necessary, leaving as high a proportion of the worm population *in refugia* as possible and employing a Group 4 or 5 product in the late season to mitigate the selective effects of any treatments earlier in the season.

This underlines how vital this information is becoming for the individual farmer and in particular the issue with *T. Circumsincta* which predominated in the samples from these farms. If ewes are treated in the peri-parturient period this would expose the worm population to further selection pressure making it imperative that only the minimum number of ewes, based on indicators, are treated with the right product at the right time.

Each of the four farms have their results and will receive guidance on the future management of their ewes based on the speciation overlayed on to the three years PPR work.



4.8 Impact on lamb KPIs and FEC counts

In essence, for most of the project we did not fundamentally change what the farmers were doing compared to previous years in terms of ewe treatments around lambing. Most did not treat ewes unless they were lean and this continued to be the norm for the rest of their flocks. Farm A was the only one where we treated ewes in the study group because the FEC counts were very high and this was, in turn, resulting in some very high counts for lambs later in the season.

Lamb weights were monitored in each year of the project to ensure that these were in line with the KPIs set by previous work done by the group. In most instances these KPIs were met, with the exception of Farm B, an upland organic farm, where grazing limitations for rearing twin lambs puts the ewes under pressure and hence the lower lamb weights.

In Year 3, based on the previous two years data we tried a new protocol on Farm A.

Figure 21 below shows the FEC counts for ewes and lambs on Farm A in Year 2, with the lamb FEC epg peaking at 770/800 in May and early June (a treatment was given in between those two peaks so we can see how quickly they became reinfected). This represents a high challenge for the lambs later in the season. 56 day weights were excellent in this flock however, historically, the worm challenge holds them back to weaning. This is a situation that has been repeated over a number of years, where lamb counts are very high later in the season, against a background of issues with anthelmintic resistance which means any wormers have to be used carefully and minimally.

Following on from the results of the first two years, we wanted to see if administrating moxidectin 2% only to the ewes losing BCS in the run up to lambing, could reduce their egg outputs for a longer period and reduce the worm challenge for lambs later in the season. The results are shown in Figure 22 above. Using BCS loss as the parameter, thirty seven of the one hundred ewes (37%) in the mob were treated at lambing. The first two lamb FEC results shown are mainly nematodirus (not influenced by ewe egg output) therefore it isn't until late May that the strongyle epg counts start to rise. Without further lamb data it is not possible to draw any robust conclusions from this, although the farmer reported better performance later in the season and overall feels that this strategy has got potential benefits.

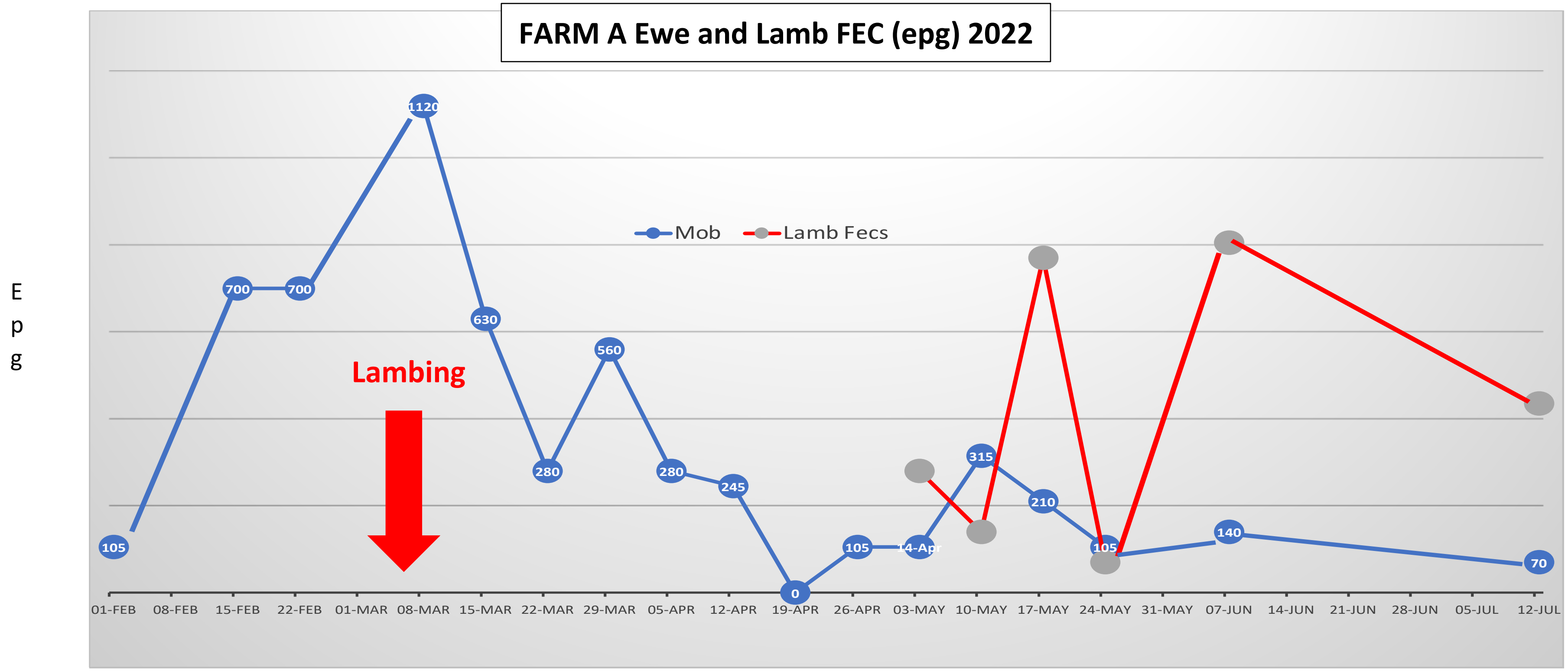


Figure 21: FEC counts for ewes and lambs -Farm A 2021

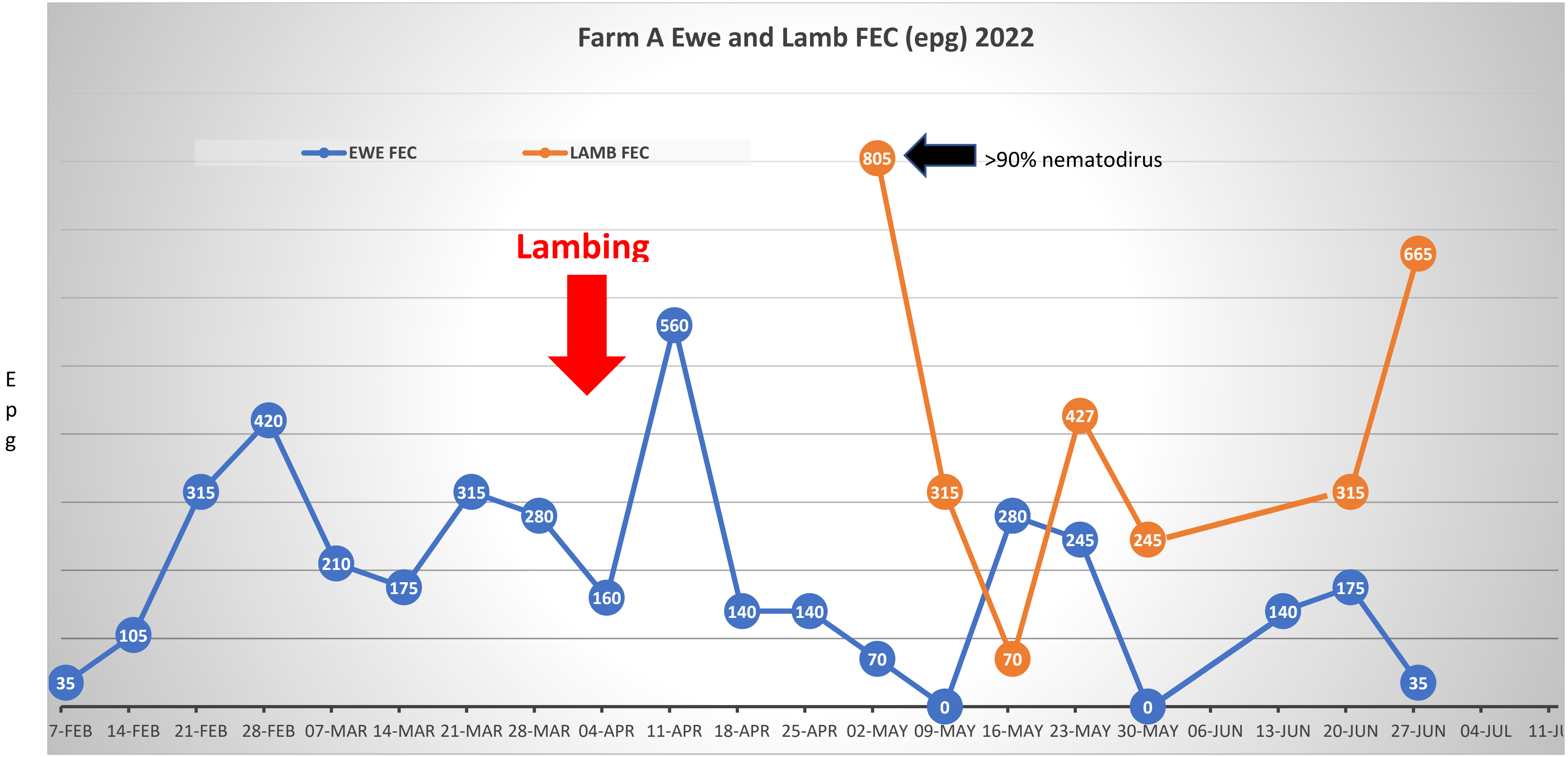


Figure 22: FEC counts for ewes and lambs -Farm A 2022

5. Conclusions and key messages for farmers

5.1 The PPR varies between farms in both extent, timing and duration. This has shown to be the case over all three years of the project. Sheep farmers therefore **need to monitor their flock** to find out what the pattern is on their farm in order to choose the most effective time to administer any treatments to ewes.

5.2 Mob and sentinel FEC results were generally in good agreement, which supports the **use of a mob FEC as a monitoring tool** (providing the samples are taken according to best practice).

5.3 The patterns of the PPR between years on the same farm are similar which suggests (assuming consistent management systems and grazing availability) - **ewe nutrition may be a determining factor**. This implies that **once farmers have established your pattern and understand where the 'pinch' points are for your ewes, timing of treatments can be much more accurate**. This is further supported by the findings on Farm D, where a significant change in lambing date did not shift the timing of the PPR, which seemed to be more closely associated with the date i.e. grazing availability.

5.4 The analysis of the PPR on Farms A and B also supports the **consistency of the pattern on individual farms** between years (assuming the same management) and the differences between them.

5.5 This project measured IgA levels in sentinel ewes in both saliva and serum. We were able to demonstrate that these levels varied over the peri-parturient period, but that individual animal variations were huge. There was **no relationship between IgA levels and the PPR which would be useful as an indicator for the targeting of anthelmintic treatments**.

5.5 Body condition is often quoted as being a factor to consider when choosing which ewes to treat in the peri-parturient period. This is because lean ewes are considered to be under more nutritional stress than others and that this results in a less robust immune system. In this project, we attempted to remove the effect of ewes that were already at a less than ideal BCS and also any effects of a diet deficient in energy and/or protein by carefully adhering to feeding recommendations based on forage analysis. Overall, we were successful in this with blood albumin levels showing no protein deficit and BCS loss minimal pre-lambing in most cases. Post-lambing however, the ewes were much more reliant on the grazing available and where this became limiting there were effects on BCS that appear to have elicited a PPR in some of the flocks. It is our conclusion therefore that in the case of this project, **it was the *change (reduction)* in BCS that was the indicator of an increased FEC** and this is what the farmers in the group will use in future to indicate those ewes in need of treatment coupled with their knowledge of FEC patterns and to determine the timing. Simply using litter size and a set time (e.g. at lambing) as a guide as to which ewes to treat and when is not accurate enough.

5.6 In the third year of the project the speciation of the worm populations clearly shows the **predominance of *T. Circumsincta (*Brown stomach worm)** in all the samples from ewes in the April-June period. This is particularly important when viewed alongside the reduction testing carried out which suggests that this worm species is also the one exhibiting the most resistance, adding weight to the need for us to test more, choose products carefully and only treat the ewes selectively and if necessary.

5.7 **This project supports the use of selective targeted ewe treatments in the peri-parturient period** where ewes are responsible for a large rise in worm egg output around lambing. However, the timing of this treatment and the proportion of ewes treated is not prescriptive and is dependent on the individual flock. Our findings would suggest that where nutrition is not limiting (i.e. BCS remains good) ewes do not need to be treated; in contrast, where periods of nutrition challenge are identified, those ewes losing BCS at that time should be treated. The timings and proportion of ewes involved will be unique to each farm, but overall this project suggests that fewer ewes need to be treated.

5.8 There is a clear message to sheep farmers that **achieving BCS targets is essential to minimise the need to treat ewes** and that forage analysis and effective diet formulation are key factors. Furthermore, monitoring dry matter availability and predicting 'pinch points' which would reduce BCS would help predict when farmers should monitor ewe FECS to confirm the timing of the PPr rise in egg counts.

Appendix I: Example of sampling plan

Week beginning	**1/2**	**8/2**	**15/2**	**22/2**	**1/3**	**8/3**	*LAMBING* **15/3**	**22/3**	**29/3**	**5/4**	**12/4**	**19/4**	**26/4**	**3/5**	**10/5**	**17/5**		**31/5**		**14/6**
1. Ewe mob (Pooled FECs)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
2. Sentinels (10) Feacal * & Saliva** samples Blood ** * antibodies and albumin	✓ * **BCS**			✓ * **BCS** Hept Booster?			✓ * **BCS** Lambs tagged/ ewe caught				✓ * **BCS**				✓ * **BCS**					
3. Lambs Gen2 FECs and weights												✓ start at 5/6 weeks			✓ 56 day weight			✓		✓ 90 day weight

1. The Mob of ewes to be monitored:

- **Pre-lambing mob –** This will be a mob of approx. 100 fit twins (BCS 3). The are housed and on a haylage / silage diet and good quality Cowindale concentrate. Weekly FEC sample sent to Techion. 10 individual samples for up to 100 ewes which are then pooled for a mob sample.
  In terms of when you switch over the post-lambing FECs on this mob I suggest this is when you have the sub-group nearly complete (even if some of the sentinels are yet to join them). I have taken a lambing date the about a week later than your start date to try and get a mid point – if you feel you need to change that then let me know. As discussed just decide when in the week to start (and as it's this week getting the sample bags will be the trigger!) then try to space out to as b near 7 days as practical.
  Twin ewes have historically been given a wormer at lambing (not singles) but this year we agreed we will see what the Techion results are showing and use those to determine the need to treat the twins.

- **Post-lambing mob –** a sub group of 30- 50 ewes from above (which contains the 10 sentinels). As tight on lambing date as possible and kept as a group until after 56 days weighing – again 10 samples in the weekly pooled FEC. The aim is to try and follow the same ewes as pre-lambing albeit I accept it will not be all of them. I appreciate that the sentinel samples at about 3-4 weeks post-lambing are the trickiest ones but can be a bit flexible so it fits in with them being handled anyway.

<u>These weekly samples are the ones that go direct to Techion – bags and pre-paid envelopes are provided.</u>

FECs run on other mobs in the flock using the FECPAK Gen 2 when possible.

2. Sentinel Ewes

These are 10 ewes taken at random from the monitored mob. Record EID their BCS. Probably a good idea to mark them so they are easily seen in the mob suggested by some of the other group members. Lambs recorded to these ewes at birth. These are the tricky ones for you – in particular the sampling post lambing at about 3 weeks but if we can get a set of samples around then it would be a great help.

The idea with these ewes is to look at their immune status (using antibody levels in faeces and saliva). We will also use these FEC samples to make sure that Haemonchus is not on the farm by staining the samples.

<u>*These FEC samples will go to Moredun and we will provide the consumables. You will probably need to wear gloves and take rectal samples from these.</u>

<u>Saliva samples go to Biobest and we will provide the consumables</u>**

3. Lambs

The growth rate of the lambs is our output measure and based on all the work the group has done before, their **<u>56 day weight is a critical</u>** measure of ewe performance. **<u>90 days</u>** adds in what the lambs have done for themselves subsequently. Ideally all the lambs are recorded **<u>to the ewes at birth</u>** so we can get adjusted 56 day weights and follow them to finishing as I assume that they will get mixed up with others somewhere down the line from 56 days.

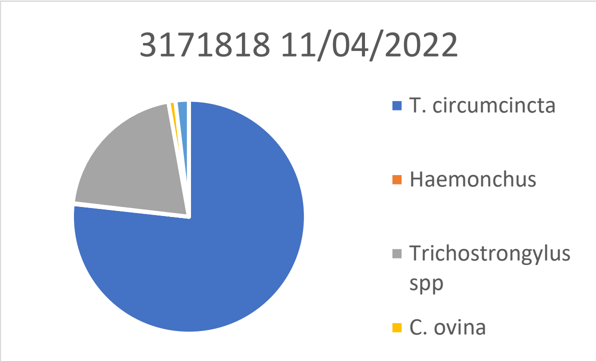
FECs on lambs – these will be done using the FECPAK Gen 2s as per normal practice so I have put this in as starting at about 5/6 weeks of age at 3 weekly intervals. We will use this to drive the need for treatments.

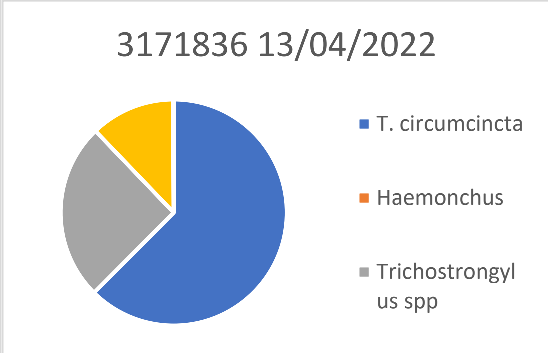
For Nematodirus – I will send everyone the link to the SCOPS forecast and will keep in touch with regard to the need for treatment – I am assuming that everyone will use a White (1-BZ) for this unless the risk is very late and coincides with the other worms starting to build up as per the FECs.

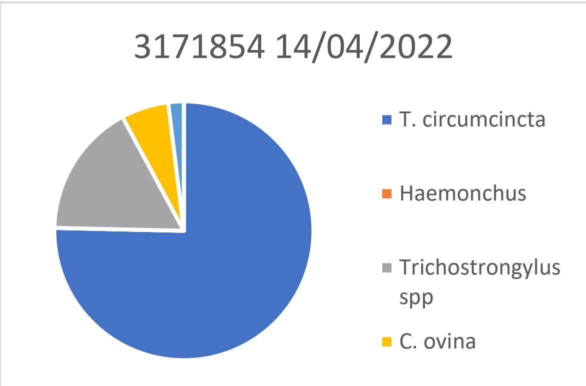
4. Other Records

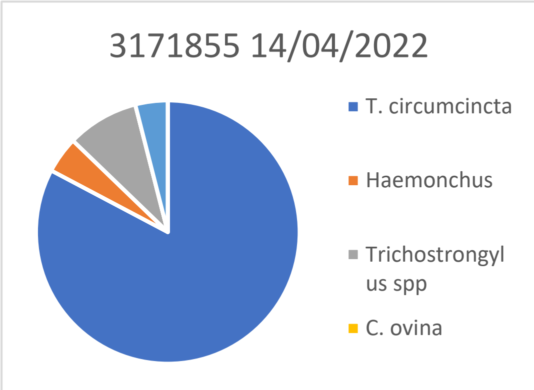
- BCS of the mob ewes where possible – and/or they have been allocated according to the fact that they are fit and it a tight range. It would be good though to have a BCS on them all at 56 days so we can have a measure of what they have lost
- BCS on the sentinels at each handling
- Any ewe wormers given – what and when
- Any lamb wormers given – what and when

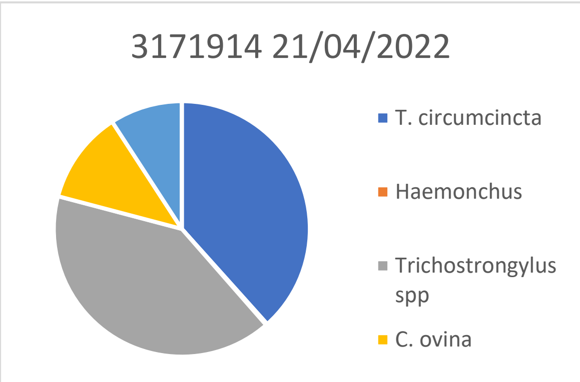
Appendix 2 – Speciation Results 2022

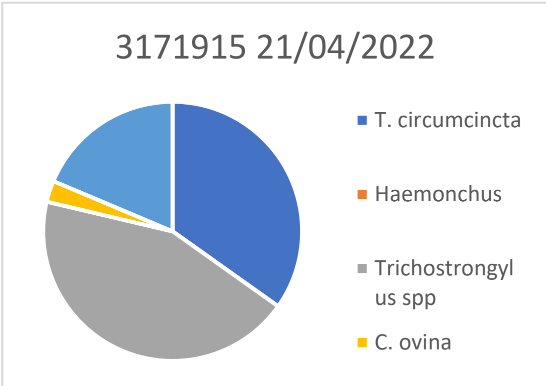


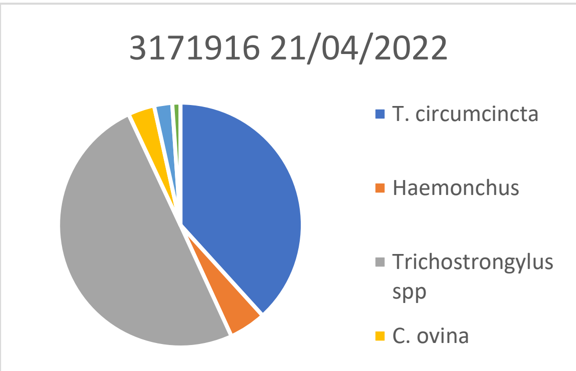


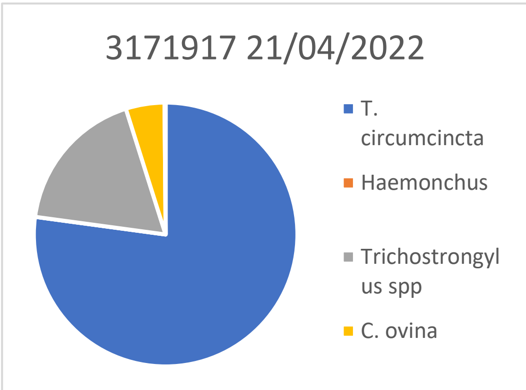


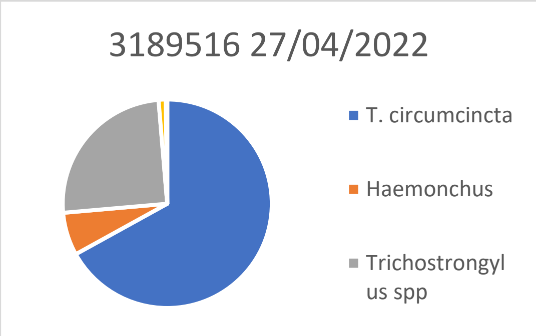








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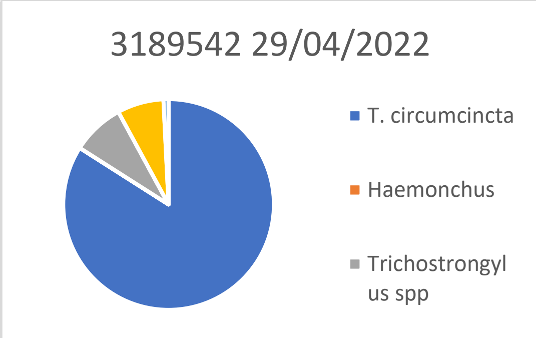
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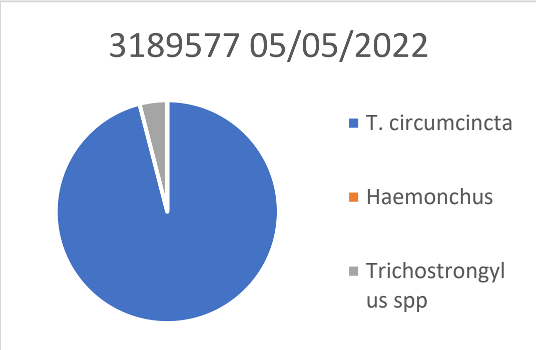
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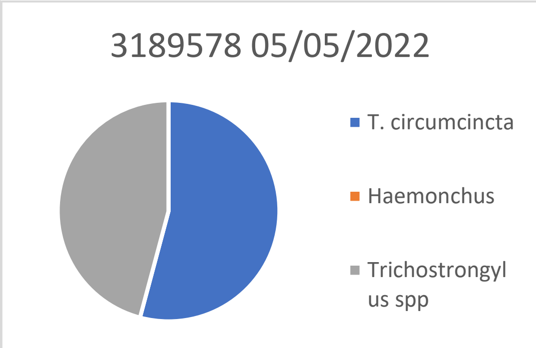
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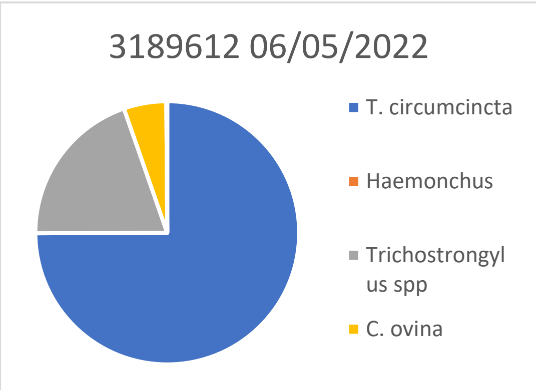
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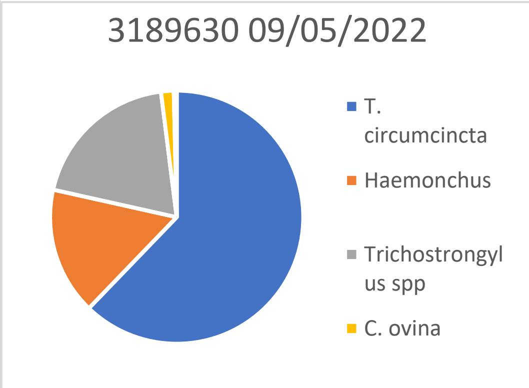
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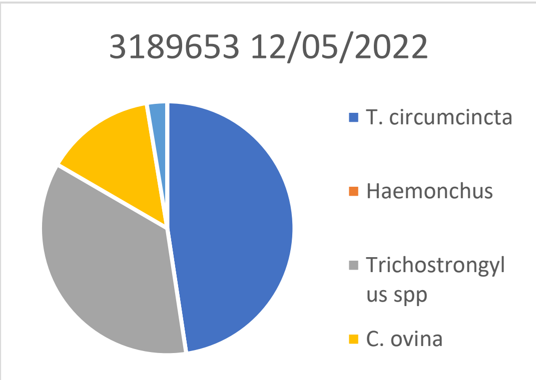
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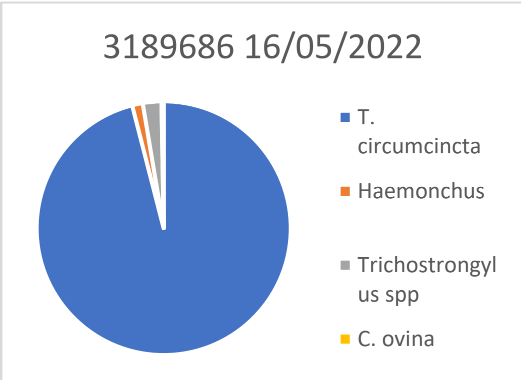
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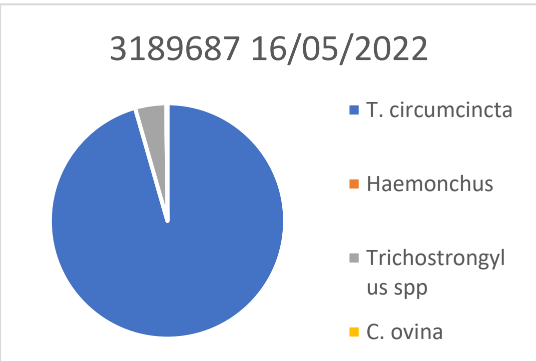
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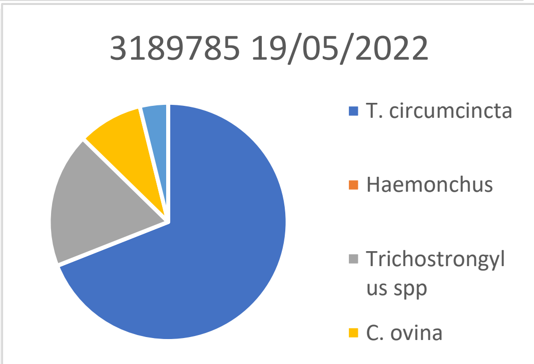
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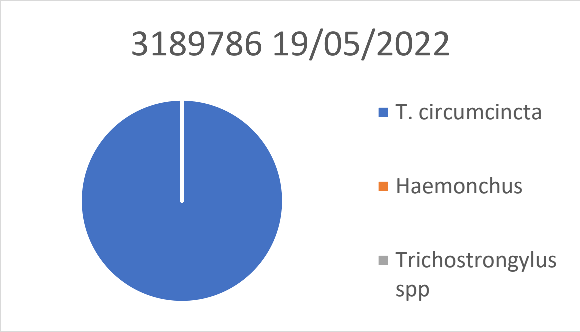
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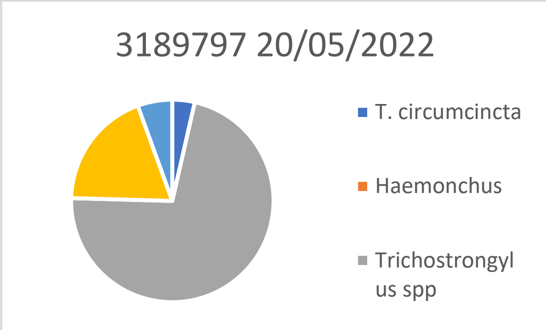
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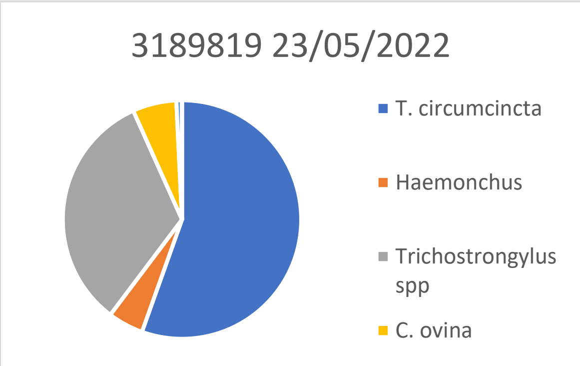
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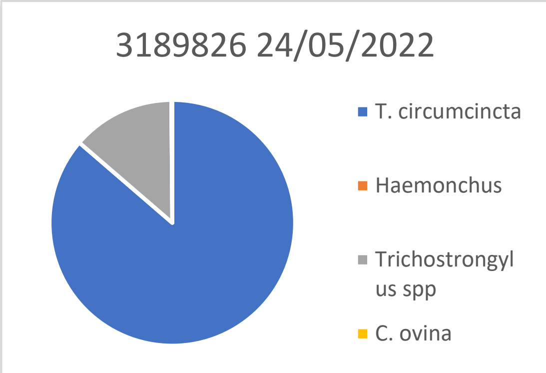
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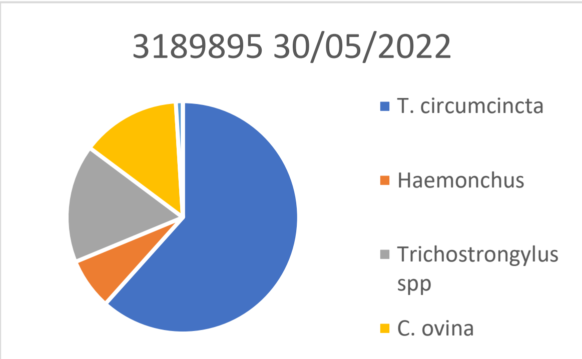
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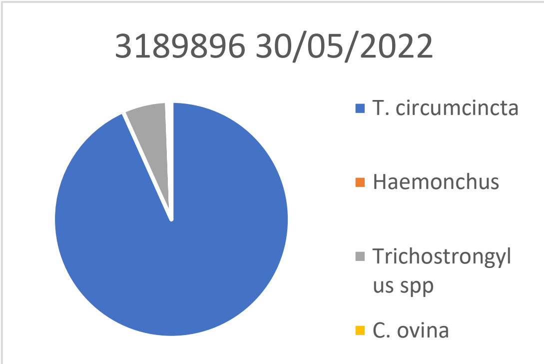
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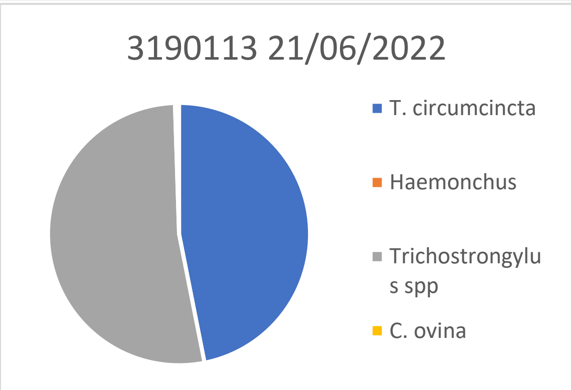
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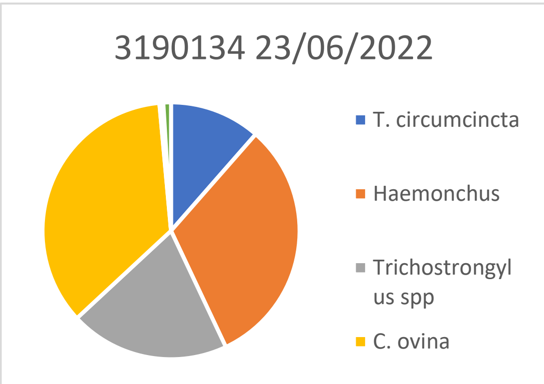
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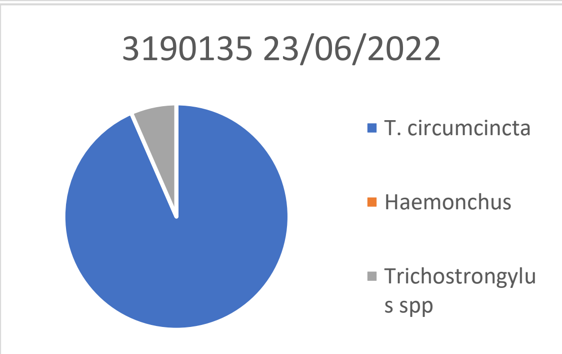
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