Production and variation in response from ewes given controlled release capsules prior to lambing

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Introduction

The economic reality of modern sheep practice is that investment decisions on animal health treatments need to be justified in terms of efficacy, safety and economic return. This study was initiated by the farmers that belong to the Whangaehu and Alfredton farm business discussion groups in the Wairarapa region of New Zealand. A lively discussion about the pros and cons of long- acting anthelmintic use in sheep and the risk of development of anthelmintic resistance in the nematode parasite populations in those animals led to the questions of the expected production response and optimal timing of use of controlled release capsules (CRC).

Data from randomised controlled trials on the production response of controlled release capsules was sought and there was a significant lack of comprehensive data on the likely response a farmer can expect from use of controlled release capsules in ewes.

This lack of data to a question about a popular treatment that is both a significant animal health expense and one that increases the exposure time of nematodes populations within the hosts to anthelmintics and by inference also increases the selection pressure on those parasite populations was a serious deficit.

This study was conducted to address this information gap. Funding was sought by way of application to the Ministry for Primary Industries sustainable farming fund and Beef and Lamb New Zealand for a study to measure the response to treatment of ewes with a controlled release capsule administered prelamb, at scanning, in comparison to no treatments, a treatment with an effective oral drench and selenium and vitamin B12 supplementation for a similar period of time as that supplemented by the controlled release capsule.

Materials and methods

The study is comprised of multiple trials on eight commercial farms in the Wairarapa. There were three experiments designed to answer three questions, and within the design there were farms involved concurrently in more than one experiment. The ewes used in the study differed in each of the years on each farm, thus the farm by year combination is a trial. This paper discusses the results of the first experiment. The results of the other experiments will be published elsewhere.

Experiment 1. What is the production response resulting from administration of a CRC 2-3 weeks before lambing?

The three treatment groups were an untreated control group, a selenium and vitamin B12 supplemented group, and a controlled release capsule treated group. The selenium and vitamin B12 supplemented group received 3ml subcutaneous injection of Smartshot B12 Plus Se®, whereas the CRC treated group were given a single bionic capsule administered orally. The amount of Smartshot B12 Plus Se to use as the positive control was estimated (N Grace pers comm.) and it provided 36mg of barium selenate and 9mg of hydroxycobolamin hydrochloride per ewe. This was to ensure that blood Se and serum B12 concentration were greater than 1000nmol/L and >500pmol/L respectively for at least 100 days. Experiment 1 was run on eight farms in 2011 and six farms in 2012, resulting in 14 trials. Experiment 1 involved 1468 ewes in the 2011 and 854 in 2012, a total of 2322 ewes throughout the study.

Table 1. Treatment detailed information

Smartshot B12 Plus Se®, Stockguard Laboratories New Zealand Ltd, an oily suspension containing 12mg/ml selenium as barium selenite and 3mg/ml hydroxyocobolamin HCl encapsulated in a lactide/glycolide co-polymer for expended release.

Bionic Hi Mineral Combination Sheep Capsules®, Merial New Zealand Ltd. A controlled release capsule containing 160mg abamectin and 4.62g albendazole with 24mg selenium and 120mg cobalt.

Treatment protocol

On each farm 300-350 ewes pregnant with twin lambs were identified by ultrasound, from the pool of mixed age ewes on farm. Selected ewes were drafted into two groups selected on body condition. Each animal was then tagged into a treatment group by blindly selecting a coloured ear tag from a container containing all the treatment colours and the correct number of tags per treatment, with half of the animals derived from each of the condition groups. This process was intended to ensure that each treatment group contained ewes that varied in their body condition score.

Each animal was then weighed, condition scored from 1-5, and dag scored before each scheduled treatment.

All ewes were set-stocked for lambing and where mob sizes were too large for a single paddock, equal numbers of ewes from each treatment group were allocated to each paddock to ensure paddock effect did not confound treatment. On all farms except one, lambs were tagged at birth and their tag numbers recorded along with their mothers ID tag. On one farm lambs were tagged and identified to their mother in the weeks after birth.

Measurements of liveweight, body condition score and dag score were made for all ewes 2-3 weeks pre-lambing, at tail docking (4-6 weeks after the start of lambing), at lamb weaning when the lambs were approximately 12 weeks old, approximately one month after lamb weaning, and approximately two months after lamb weaning which was regarded as the pre-mating measurement. The number of lambs weaned and their liveweights were recorded at weaning.

Analysis of the data

The production data collected was ewe liveweight premating, at weaning, lamb liveweight at weaning, the kilograms of lamb weaned per ewe treated, number of lambs born per ewe (birth rank), the number of lambs reared to weaning (rearing rank) and dag score.

Ewe liveweight, ewe body condition score at the time of first treatment, and rearing rank were considered as covariates for all variables except kg of lamb reared per ewe treated. The covariates for kg lamb reared per ewe treated were ewe liveweight and body condition score. Each of the responses was modelled separately using analysis of covariance (ANCOVA). In addition to the treatment effects, the model also included the interaction between treatment and ewe body condition score (BCS). This was done to determine whether the response to treatment was conditional on body condition score.

Ewes with missing response or covariate data were omitted from the analysis. In Experiment 1 a multiple regression analysis was used to investigate the variability between treatment effects on kilograms of lamb reared per ewe treated in different trials. Treatment effects were included to determine if relationships differed between treatments.

Results

Experiment 1. What is the production response resulting from administration of a CRC 2-3 weeks before lambing?

The administration of a Bionic Hi Mineral Combination Sheep Capsules® (Bionic), to ewes prelambing resulted in an average increase in ewe liveweight at weaning of 3.2kg, ($p<0.001$) with a range of 1.3-4.9 kilograms gain with a significant increase in twelve of the fourteen trials.

In some trials the ewes receiving Smartshot B12 Plus Se® (Smartshot), also had a significant production response, sometimes more than half of the response seen in the Bionic treated ewes which by inference is a measure of the effect of supplementation with selenium or vitamin B12. This indicates that it is likely that some of the benefit of using a controlled release capsule is attributable to the supplementation with trace elements. In one trial the difference in ewe liveweight at weaning between the Bionic capsule and untreated ewes was 1.99kg, however the difference between the Smartshot treated ewes and the untreated controls was 1.2kg in the same trial.

Ewe liveweight

The difference in ewe liveweight gain between treatment groups diminished between weaning and the premating period. The Bionic capsule treated ewes were on average 2.5kg heavier ($P<0.001$) than the untreated controls, with a range of -1.8kg to +4.5kg, and significantly different in 9 of 14 trials. Similarly the Smartshot treated ewes in some trials had a response that was greater than 50% of the response of the Bionic capsule treated ewes, in one case the Bionic capsule ewes had a response of +3.1kg, and the Smartshot ewes had a response of 2.5kg weight advantage over the untreated group premating.

Lamb liveweight

The difference in lamb weaning weight between was significant in 6 of 14 trials. The lambs born to Bionic capsule treated ewes were on average 1.55kg heavier than lambs born to untreated controls ($p<0.001$) with a range of +0.35 to +2.88kg.

Kilograms of lamb weaned

The effect of the Bionic capsule treatment on the kilograms of lamb weaned per ewe treated was not significant ($p= 0.51$). The overall mean response to Bionic capsule treatment was +2.1kg, however the range was -5.2 to +15.6kg. In 9 out of 14 trials the response was positive. Despite the advantage in lamb weaning weights there was not a significant benefit in terms of kilograms of lambs weaned per ewe treated. Given that the entry criteria for these trials were ewes pregnant with twins, the difference must be due to variation in the number of lambs weaned between the treatment groups.

Lamb survival

Of the 2322 ewes in the 14 trials, there was a 2.6% reduction in the Bionic capsule treated ewes that weaned multiple lambs compared to the untreated ewes. The number of lambs born per ewe, was 1.90, for the Bionic capsule treated group, 1.91 for the Smartshot plus Se treated groups and 1.86 for the untreated control groups ($p=0.304$).

Lamb survival from birth to weaning was on average 85.7% for the Bionic capsule treated groups, 87.5% for the Smartshot treated group and 87.9% for untreated control group. ($p=0.279$). On average lamb survival was 2.1% lower in the Bionic capsule treated groups than in the untreated. The variability between trials was high. Lamb survival between the Bionic treated groups and the untreated groups ranged from -9.9% to +9.8%, but in 8 of 14 trials the survival of lambs from the Bionic capsule treated ewes was lower.

Multiple regression analysis was used to examine the relative effects of lambs born, lamb survival and lamb weaning weight on the kg lambs weaned per ewe treated. Lamb survival was the most important variable ($R^2 =0.705$) accounting for 70.5% of the variation, and lamb weaning weight accounted for 28.9%, and both variables were significant ($p<0.001$). In contrast the number of lambs born per ewe accounted for 0.6% of the variation, this low result is expected given that ultrasound scan results of ewes having twins were an entry criteria for the experiment. Lamb survival was the most important factor, affecting kilograms of lamb weaned per ewe treated.

Dag score

Treatment with a Bionic capsule pre-lambing had a significant effect on weaning dag score (DS) in the ewes ($p<0.001$), with an average reduction in mean DS of 0.9 (range 0.3-1.5 units). There was a significant reduction in dag score in 11 of 13 trials. In one trial the dag scores were missed at one interval.

Body condition score

The interaction between treatment and ewe body condition score (BCS) was non-significant (p-values ranged from 0.234 to 0.667) for all output variables. Both high and low body condition score ewes responded similarly to the treatments given.

Discussion

The purpose of the study was to provide farmers with data on the expected production response from treatment of ewes with controlled release capsules. In particular the magnitude, direction and variation in response in ewes and lambs.

Anthelmintic use before or after lambing is common in New Zealand. The advent of long acting anthelmintic products has seen their adoption and use at lambing. The exposure-time relationship of nematodes to anthelmintics for these long acting products means that their use is likely to accelerate the development of anthelmintic resistance. (Lawrence *et al.* 2007, Leathwick *et al.* 2006),

This paradox of potential for production versus risk of resistance is an important area to focus on, in sheep medicine particularly as we move into an era of sustainable farming practice and justified use of animal treatments.

What does the literature say?

Looking at the literature on the published benefits of controlled release capsules we find;

Gogolewski *et al*. (1997) compared the weaning weights of ivermectin CRC treated ewes with those of untreated ewes on 10 commercial farms throughout New Zealand. There was a mean increase in ewe weaning weight of 1.1kg, however the high variability in response between farms, meant this difference was not statistically significant. Of concern - the treatment response was negative on some farms, i.e. the untreated ewes were heavier than the ivermectin capsule treated ewes.

Cook (2009) compared ewes treated with doramectin injection against untreated ewes on three farms. Treatment did not significantly change ewe liveweight, but had a slight positive effect of 0.2 mean body condition score gain at weaning. Lambs born to the doramectin treated ewes were an average of 0.7kg heavier at weaning. The effect of treatment was the same on high and low body condition score ewes.

Sumner *et al*. (1995) A small study in merino ewes (n=38) on a research farm found production benefits from a CRC pre-lambing and in the following autumn in ewe survival, ewe liveweight, and the number and weight of lambs weaned.

There have been several other New Zealand studies using controlled release capsules (Familton *et al*. 1995, West *et al*. 2009). These studies have shown production benefits, but because they used CRCs in a sequential manner they are not as relevant to the more specific question of appropriate and cost effective pre-lambing anthelmintic treatments.

Why are these treatments so popular?

The farmer sees better ewes at docking and weaning, bigger lambs, less dags and its human nature to want good things from something after we have invested in it - therefore it’s all good. If we look a little harder though this study demonstrates some of the things that we don’t hear much about – that there may considerable variation in response, that weight differences at weaning do not necessarily translate to a weight advantage at mating, that there are farms where trace element investigation and supplementation should be carried out, and that if there is no difference in kilograms of lambs reared per ewe treated - there may not be a positive economic return on investment.

The ewes are bigger?

The positive response to administration of a bionic capsule pre-lambing on ewe liveweight at weaning of 3.2kg and a significant difference noticed in 12 of 14 trials is consistent with the anecdotal reports from farmers that the ewes are bigger. However, all of this benefit was not carried through to mating with the average benefit retained being 2.5kg and fewer trials (9/14) that showed a significant difference. This indicates a period where the untreated ewes had better liveweight gain than the treated ewes following expiry of the controlled release capsule.

There is some evidence that this loss of the weight gain advantage in the Bionic treated ewes is related to parasitism in that the weight gain advantage in the Smartshot treated ewes, although much more subtle 0.3kg advantage at weaning and 0.8kg before mating, indicates that animals with trace element supplementation that were grazed in the same mobs as the capsule treated ewes were able to gain weight in that period. The cause of this phenomenon is not answered by this study. However it has previously been reported by Williamson 1995 and Sutherland et al 1999 that ewes treated with controlled release capsules have a reduced level of anti-parasite immunity in the period immediately after anthelmintic therapy ceases.

The variation is large - the range of weight difference between the Bionic capsule treated ewes and the untreated controls when measured before mating is from a loss of 1.8kg to +4.5kg gain and in more than a third of the trials there was no significant difference in ewe liveweights premating. So this means – not all the ewes are bigger. Understanding why this occurs is important if we are to provide good advice about whether or not to use controlled release capsules in ewes.

Effect of trace elements?

The response in the Smartshot treated ewes and comparing it to the capsule treated ewes provides evidence that the some of the benefit from controlled release capsules is their trace element supplementation. Whilst there was considerable variation in some trial the response of the Smartshot treated ewes was more than half of the response measured in the capsule treated ewes in the same mob. This result is important in that it demonstrates that the difference between untreated and capsule treated ewes is not necessarily the cost of parasitism (West *et al.* 2009). The response in the Smartshot treated animals indicates that trace element supplementation on some of these farms is beneficial, and investigation of the trace element status of the animals or their feed may reveal which element is deficient and animal supplementation via feed, water, fertiliser or other oral/injectable treatments should be explored to find and apply a cost effective solution.

The lambs are bigger?

On average the lambs are bigger 1.55kg, $p<0.001$, in six of fourteen trials the result was significant, and at least the range in the response is confined to the positives (0.35 +2.88kg). Of concern here is that in more than half of the trials 57% there was no significant difference in lamb weaning weights.

The amount of kilograms of lamb reared per ewe treated is not different?

This is the most serious of the results found, because the lack of a significant difference here could impact the economic return, although having the extra weight on the ewes is also valuable. Increased lambing weights do not necessarily result in a greater mass of lambs weaned per ewe treated. In 5 of 14 trials the lambs were heavier but, the kilograms of lamb reared per ewe treated was lower. In 9 of 14 trials the Bionic capsule treated ewes reared fewer lambs than untreated ewes, so is it an anomaly or is this a real effect?

The variation in lambs reared per ewe treated was explained by differences in birth rank, lamb survival, and the weight of lambs at weaning. Lamb survival was the most important, accounting for more than 70% of the variation. The variation in lamb survival is not explained by this data, and the consequences of a loss here indicate that perhaps more work in this area is indicated.

Body condition score effects?

There was no interaction between ewe body condition score at the time of treatment and the response to treatment. Ewes responded to treatment similarly irrespective of their body condition score. Use of body condition score criteria to guide anthelmintic treatment on the assumption that low BCS ewes are suffering the effects of parasitism more than ewes in good BCS seems improper. A similar response was reported by (Cook 2009). These results suggest that the benefit of treating with anthelmintics is more homogenous. The economic and welfare benefits to improving the body condition score of low BCS ewes, are a separate issue and should not be overlooked.

Evidence of resistance?

The issue of parasite resistance to anthelmintics was evident on several farms. Faecal egg count reduction tests were carried out on all farms in the study in both years. The existing resistance patterns found were similar to those seen in other Wairarapa farms and resistance status was not an entry criteria for the study.

Of concern in some trials was the prevalence of ewes maintaining positive egg counts even through the period of capsule payout. The distribution of larval species recovered from these eggs indicated these ewes had not lost their capsules, but rather these were parasite eggs being produced from benzimidazole + macrocyclic lactone resistant nematodes.

Where to from here?

For a farmer balancing the risk of developing resistance with the benefits of their use in sustainable lamb production – this is not an easy decision. The next step in this study is to use the data to complete a full cost benefit analysis in order to supply farmers with better information on the likely economic returns from treatment.

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