Update on research into the effects of Leptospira serovars Hardjo and Pomona on sheep and beef cattle growth and reproduction

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Introduction

Leptospirosis is a bacterial zoonotic disease that can affect all livestock species (Faine et al. 1999). Among all the serovars present in New Zealand L. borgpetersenii serovar Hardjo type hardjobovis (Hardjo) and L. interrogans serovar Pomona (Pomona) are the most frequently found, with 97% of the sheep flocks and beef cattle herds having at least one animal exposed to either serovar (Dreyfus et al. 2011). Cattle and sheep have been shown to be reservoir species for serovar Hardjo, and pigs are the common reservoir host for serovar Pomona. In reservoir species the clinical disease, usually manifested by fever, anorexia, depression, haemolytic anaemia and/or renal failure is rare (Hathaway 1981).

Little is known about the subclinical effects of leptospirosis in reservoir species, in particular about the effects on production. Experimental challenges have associated serovars Hardjo and Pomona with abortion in cattle, usually when infected in the second part of gestation (Ferguson et al. 1957, Ellis and Michna 1977, Andreani et al. 1983, Ellis et al. 1985). These experimental findings have been confirmed by a high number of case publications, where leptospirosis was diagnosed as the cause of reproductive deficiency, mainly abortions and perinatal deaths (Te Punga and Bishop 1953, Corbould 1971, Hoare and Claxton 1972, Ellis and Michna 1976, Ellis et al. 1983, Elder et al. 1985, Gilmour 2007). Leptospires have been proved to be able to pass through the placenta and cause foetal leptospirosis, which can lead to abortion, stillbirth or weak progeny (Murphy and Jensen 1969). Clinical disease associated with Pomona in young lambs and calves leading to death has also been reported (Vermunt et al. 1994, Bruere 2013).

Recent work conducted on New Zealand farmed deer showed that leptospiral infection can cause a reduction in 12-month weight by a herd average of up to 6.4kg, and a reduction in weaning rates by up to 10 percentage points in high prevalence herds (Subharat et al. 2011, 2012). In beef cattle, Sanhueza et al. (2013) showed that up to 7.5% of abortions in New Zealand beef cattle could be attributed to infection by serovar Hardjo and up to 4.2% to serovar Pomona.

However, no study has been conducted so far to quantify the effect of natural leptospirosis infection on New Zealand sheep and beef cattle production or on the cost-effectiveness of leptospirosis vaccination in those species. This manuscript presents a brief update of provisional results of a 3-year study on the effects of Leptospira serovars Hardjo and Pomona on sheep and beef cattle growth and reproduction. Provisional results from the first stage of this study were presented in 2013 (Vallée et al. 2013).
Study design

The study was conducted on nine commercial sheep and beef farms in North and South Islands of New Zealand. The sheep study was conducted on eight farms and the cattle study on seven. Three cohorts of animals were used:

- **Sheep**: between 170 and 327 ewe lambs per farm, for a total of 2260, enrolled at tail docking in 2011.
- **Heifers**: between 26 and 198 heifers per farm, for a total of 851, enrolled just before the mating season in 2011.
- **Calves**: between 57 and 199 calves per farm, males and females, for a total of 1174, enrolled in 2011-2012, with the farm median age ranging from two to six months old.

One third of each cohort was vaccinated with “Leptavoid 2” (MSD Animal Health), according to the manufacturer’s recommendations.

The animals were monitored for growth by regular weight recordings, and for a range of reproduction outcomes. Comparisons were made between the vaccinated and the control animals, using bivariate statistical tests for each period within each farm, and overall using regression models.

The control animals were regularly blood-tested using the Microscopic Agglutination Test (MAT) for Hardjo and Pomona at the Hopkirk Leptospirosis Research Group, Massey University, to assess the exposure of the animals. A cut-off of 1:48 was used to define seropositivity.

This study was approved by the Massey University Animal Ethics Committee under protocol 11/40.

Infection pattern in sheep

On all the farms hoggets were exposed to Hardjo between 10 and 15 months old. On one farm, seroconversion was observed in 3-month-old lambs, although most seroconversion occurring between 10 and 15 months old.

Seroconversion showed a marked seasonal pattern with Hardjo exposure occurring predominantly in late winter-early spring on all farms and occasional exposure of lambs 1 to 3-months-old in spring. The seroprevalence reached 80% to 100% on all the farms in 12-18 month-old animals.

The sheep were exposed to Pomona on three of the eight farms, with seroconversion occurring in 8 to 15-month-old hoggets, between August and December. Seroprevalence reached a maximum of 20% to 54% during the study period, depending on the farm.

Sheep growth

Bivariate analysis showed a difference in average daily weight gain (ADG) on the farm upon which early seroconversion was observed. The ADG of vaccinated lambs was 12g/day higher than that of control lambs (p=0.04, simple linear regression after adjusting for docking weight) between the first two blood sampling and weighing episodes of ewe lambs which occurred at tail docking and 53 days later, i.e. between October and December. However, no difference was observed subsequently on this farm. Bivariate analysis did not show any difference in live weight or ADG between the vaccinated and the control sheep on other farms at any time period. This suggests that early exposure of young lambs to Hardjo can result in temporary lower growth rate.

Sheep reproduction

Six of the farms provided data for hoggets and two farms for two-tooths.

No difference in scanning rate, docking rate and weaning rate was observed when stratifying the analysis by farm. Hence, despite high exposure to Hardjo and/or Pomona in control hoggets, no reproductive losses were detected. Similarly, control two-tooths, exposed the previous season, did not have reproductive losses compared to vaccinated hoggets.
Infection pattern in cattle

The age at seroconversion was the same in the cattle born in 2010 and in 2011. Maternal antibodies for Hardjo and Pomona were detected in calves up to five months of age. However, no information is available on the protection conferred by maternally derived immunity up to that age. Hardjo seroconversion was observed on all but one farm between 13 and 17 months of age, showing a seasonal exposure during late winter-early spring months as for sheep. The within-farm Hardjo seroprevalence reached 75% to 100% where seroconversion was observed.

On one farm, the Pomona seroprevalence reached 90% in the heifers born in 2011, and titres were high. In this age cohort on the other farms the prevalence did not rise above 20%. In the heifers born in 2010, the seroprevalence ranged between 20-40% on three farms and was under 5% otherwise.

Cattle growth

Bivariate analysis confirmed that there was no difference in live weight between vaccinated and control cattle before seroconversion was observed.

On one farm, a marginal but non-significant difference in live weight of 8kg in 14-month-old heifers (linear model adjusting for enrolment weight, p=0.07) was observed, just before mating at 14 months, when Hardjo seroconversion was observed for the first time. The Hardjo seroprevalence on that date was 76% and Pomona seroprevalence was 1%. On a second farm, a marginal but non-significant difference of 14kg (linear model adjusting for weight at enrolment, p=0.07) was observed in 19-month-old heifers. This difference was recorded six months after the first observation of Hardjo seroconversion. The Hardjo seroprevalence on that date was 76%, and no animal was seropositive for Pomona. Since it was the last weighing on both farms, it is not possible to determine the longer term impact of this trend.

Cattle reproduction

Data recording was problematic for calving and weaning, thus the effective sample size for the effect of vaccine on scanning rate was 901 and 733 at the second scanning, 336 for calving rate and 188 for weaning rate.

No difference in scanning rate, calving rate and weaning rate was observed between the vaccinated and the control heifers in both cohorts, despite a high Hardjo challenge on seven of eight farms and high Pomona challenge on one farm.

However, there may be an indirect effect of leptospirosis via the lower live weight observed in control heifers around the mating season which could be related to delayed oestrus, possibly lowered conception rate and overall reduced economic efficiency of the replacement herd (Funston and Deutscher 2004).

Conclusion

Leptospirosis due to Hardjo was highly present in the study sheep and cattle, with around 80% of the animals in each flock or herd exposed in their first two years. Pomona was less frequent and not present on all the farms. The within-farm seroprevalence was also lower for Pomona than for Hardjo. This agrees with previous observations in New Zealand sheep and beef cattle (Dorjee et al. 2005, Dreyfus et al. 2011).

Neither serovar Hardjo nor Pomona was associated with reproduction losses in sheep or cattle in this study. Hardjo exposure has been observed on one farm in very young lambs, associated with a temporarily reduced ADG of 12g/day. It is still unknown how often this early exposure is occurring on New Zealand farms, thus in favourable climatic and epidemiologic conditions, production effects could be observed on a larger scale.

A trend for lower live weights by 8 to 14kg around the mating season was observed in non-vaccinated heifers, on two farms with high Hardjo exposure, but no conclusive statistical inference could be made. Further work using a bigger sample size would be required to confirm this trend.
Although a trend for reduced growth was observed in both lambs and calves, the exact impact of the disease is still inconclusive and may depend on the epidemiology of leptospirosis on the farm. The data presented suggests that the risk of leptospirosis causing economically important losses or growth and reproduction in sheep and beef cattle appears low in spite of a high exposure.

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